Optimising delivery of the Childsmile nursery supervised toothbrushing programme in Scotland

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Abstract

Background

Supervised toothbrushing in nurseries, delivered as a component of Childsmile, Scotland's national oral health improvement programme for children, is associated with reduced caries experience and cost savings in prevented dental treatments. There is also evidence that it is effective in reducing oral health inequalities, with greater improvements in oral health observed among children living in the most deprived areas. However Childsmile process evaluation data indicate that the nursery supervised toothbrushing programme does not take place as intended in all nursery settings. This highlighted the need to undertake further research to optimise its delivery, to maximise the gains for children's oral health and contribute to reducing oral health inequalities.

Aims

The overarching aim of the research is to optimise delivery of the nursery supervised toothbrushing programme, which is achieved by: further developing its Theory of Change; assessing the fidelity of its implementation compared with the Theory of Change; identifying the barriers and facilitators to its implementation; and identifying implementation strategies to overcome those barriers. It is intended that findings will be fed back into the Childsmile programme to inform ongoing improvement of the nursery supervised toothbrushing programme component.

Methods

The research was framed within the paradigm of pragmatism and utilised a mixed-methods approach, informed by a programme theory approach and implementation science methods, making it the first study of its kind to utilise this approach to investigate the implementation of a complex toothbrushing intervention delivered in educational settings. The researcher explicated the programme's Theory of Change via documentary review, to identify its key components (the inputs, activities and outcomes); and qualitative interviews and

focus groups with programme stakeholders, to discuss and agree the Theory of Change, which was depicted in a logic model.

Using a mixed methods approach, the researcher undertook national, cross-sectional surveys of nurseries, qualitative interviews with programme stakeholders and extracted data from ongoing Childsmile process evaluation, to assess fidelity of implementation and identify barriers and facilitators to delivery. Delivery-in-reality was assessed in comparison with the intended model (per the logic model developed in the previous stage of the research). The researcher used the Consolidated Framework for Implementation Research to categorise the barriers and facilitators identified and mapped these to the Expert Recommendations for Implementing Change compilation of implementation strategies to identify potential methods and techniques to overcome barriers to programme delivery.

Results

This novel study identified that optimising the Childsmile nursery supervised toothbrushing programme requires a shared vision to be developed and strengthened among partners involved in its implementation, supported by developing a formal implementation blueprint and further work to increase nursery staff's buy-in, such as local champions and enhanced training. The fidelity of programme delivery should continue to be monitored and evaluated using the methodology and logic model developed via this research.

The inputs, activities and outcomes comprising the Theory of Change of the nursery supervised toothbrushing programme were specified, with consensus on those reached among programme stakeholders. This included stating the primary aim of the programme: 100% of children brush their teeth in nursery, every day they attend. However, national survey results showed that this target was not met, with 92% of eligible children brushing in nurseries on the day of the survey and variation in percentages of children brushing across geographical health boards. Nurseries with 100% toothbrushing rates were more likely to have fewer children attending, only have a single age group attending and were situated in certain geographical health board areas and not others.

Using a mixed methods approach highlighted inconsistencies between these quantitative data on nurseries' participation and qualitative findings on stakeholders' perceptions about nurseries' participation. There were variations between health boards in the extent to which delivery-in-reality matched what was intended. This included the content and frequency of training provided to nursery staff to support their delivery of the programme, with no standardised training package available nationally. Relationships between Childsmile teams and local authorities' education departments were identified as important although these required careful management and communication. Barriers and facilitators influencing programme implementation before and during the Covid-19 pandemic were identified and the Consolidated Framework for Implementation Research provided good coverage of these (encompassing all five domains and 14 out of 26 constructs associated with intervention implementation). Relevant constructs included: 'Complexity', in relation to fitting toothbrushing in to nursery routines and perceptions about it being too time-consuming; 'Patient Needs and Resources', in terms of children's ability to perform the required actions as well as their reluctance to participate in toothbrushing instead of other available activities; and 'External Policies and Incentives', which related to the interpretation of early years policies which conflicted with directing children to participate in activities, including toothbrushing. An overarching theme related to the prioritisation of the nursery supervised toothbrushing programme by nursery staff, including the extent to which other activities were given precedence over it; and nursery staff's willingness to accommodate toothbrushing flexibly within nursery schedules.

The Covid-19 pandemic disrupted delivery of the programme due to nursery closures in 2020 and 2021, as well as creating additional pressures for nursery staff once establishments reopened. This affected the extent to which they engaged with efforts to restart the toothbrushing programme.

Conclusions

This research has explicated the Theory of Change for Childsmile's nursery supervised toothbrushing programme, from the perspective of programme stakeholders. There is scope for further specification of core, 'essential'

programme components and adaptable, peripheral components, to identify an acceptable level of delivery which will allow progress towards outcomes. There are also opportunities to work with stakeholders from other organisations, aside from Childsmile, to identify changes to the Theory of Change to enhance its fit with their needs and priorities.

In assessing the fidelity of programme implementation, it was found that aspects were delivered as intended; however, most logic model activities had components that were not being delivered with fidelity, including that less than 100% of children brushed their teeth every day they attended nursery. It was identified that the nursery context in which the programme is delivered was complex and fluctuating, with competing demands on nursery staff's time. This indicated a need to accept that the programme has to fit within overall nursery provision, to ensure it is given enough priority. This requires identifying implementation strategies to find ways to help it fit alongside other priorities, including strategies to enhance engagement among nursery staff while taking their perspectives into account.

A number of recommendations are made to support and optimise programme delivery going forward. These include supplementing the programme's ongoing work in fostering relationships with partners with a focused communications campaign, targeted at stakeholders in individual nurseries and local authority education departments, which demonstrates how the programme fits within the wider nursery curriculum and its contribution to children's health and wellbeing alongside information (tailored to stakeholders' roles) that clarifies what is involved in programme delivery. It is also recommended that a knowledge exchange and support network should be established among nurseries, led by champions (invited to undertake this role among nursery staff with an interest in oral health working in nurseries identified to deliver the programme well) who support and mentor their peers to overcome challenges to delivering the toothbrushing programme. This could include enhanced training, tailored to individual nurseries' needs, to provide practical solutions to overcome challenges encountered. To encourage participation among local authorities' education departments and individual establishments' head teachers and managers, it is recommended that further, supportive dialogue takes place

between the Childsmile programme, the Scottish Government and local authority education departments.

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I dedicate this thesis to my late grandfather, Alexander ‘Sonny’ Corstorphine (my Daye), who valued education greatly. He was always proud of my academic accomplishments and I am certain this achievement would have delighted him.

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It was shortly after I returned to work following maternity leave when Dr. Wendy Gnich approached me with the opportunity to undertake a PhD as part of the Childsmile evaluation, which complemented my role as Childsmile regional researcher. Seven years later, I have completed my thesis. It has, at times, been an arduous process to get to this point, never mind the disruption caused by the Covid-19 pandemic, but my mantra from the start of this journey has been "you only regret the things you don't do" and so I have kept going!

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Author's Declaration

I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

Name: Jennifer Lillian Eaves

Signature:

Abbreviations

The following abbreviations are used in this thesis:

BASCD	British Association for the Study of Community Dentistry
CFIR	Consolidated Framework for Implementation Research
CI	Confidence interval
COM-B	Capability, Opportunity, Motivation – Behaviour model
COREQ	Consolidated Criteria for Reporting Qualitative Research
CS	Childsmile
DHSW	Dental health support worker
dmft	Decayed, missing, or filled primary teeth
ECC	Early childhood caries
EDDN	Extended duties dental nurse
ERIC	Expert Recommendations for Implementing Change
GA	General anaesthetic
LA	Local authority
LM	Logic model
NDIP	National Dental Inspection Programme
NHS	National Health Service
NSTP	Nursery supervised toothbrushing programme
OHRQoL	Oral health-related quality of life
OLM	Overarching logic model
P1	Primary One
PARIHS	Promoting Action on Research Implementation in Health Services
ppmF	Parts per million fluoride
QoL	Quality of life
SIMD	Scottish Index of Multiple Deprivation
TDF	Theoretical Domains Framework
TICD	Tailored Implementation for Chronic Diseases
ToC	Theory of Change
WHO	World Health Organization

NHS boards abbreviations

The following abbreviations are used to denote geographical NHS board areas:

AA	Ayrshire & Arran
B	Borders
DG	Dumfries & Galloway
F	Fife
FV	Forth Valley
G	Grampian
GGC	Greater Glasgow & Clyde
H	Highland
La	Lanarkshire
Lo	Lothian
O	Orkney
S	Shetland
T	Tayside
WI	Western Isles
Islands	Orkney, Shetland & Western Isles (combined)
Sco	Scotland

1 Introduction

This chapter aims to set out the background to this doctoral research and place it within the wider context of the status of poor oral health among children in Scotland, inequalities, and the national child oral health improvement programme, Childsmile. Firstly, the problem of poor oral health among children is discussed, in relation to the definition of dental caries, its prevalence and impact, and approaches to prevention. The chapter then provides an overview of supervised toothbrushing programmes in nurseries and schools within published and grey literature. Approaches to oral health improvement and addressing oral health inequalities in Scotland is covered, focusing on the establishment and delivery of Scotland's national child oral health improvement programme, Childsmile, including its nursery supervised toothbrushing component. Finally, this chapter will establish how this doctoral research adds to the existing literature on supervised toothbrushing programmes as well as its contribution to the overarching, theory-based evaluation of the Childsmile programme.

It is important to highlight up front that this research took place partly during the Covid-19 pandemic. The pandemic disrupted the operation of the Childsmile programme, with two periods of educational establishment closures across Scotland between March 2020 and February 2021, resulting in the nursery supervised toothbrushing programme being suspended. Fieldwork including visits to nurseries to undertake interviews and focus groups with nursery staff and parents/carers of children attending, to assess delivery of the nursery supervised toothbrushing programme in reality, was due to take place from March 2020. However all arranged fieldwork was cancelled due to the pandemic lockdown measures and it was not possible to rearrange these for future dates (i.e. once establishments reopened), due to ongoing restrictions (which prevented in-person visits to nurseries) within the period available to complete the fieldwork. It was also not possible to undertake in-person fieldwork with Childsmile staff, due to lockdown measures in place and the redeployment of Childsmile staff to other roles within health boards to support the NHS pandemic response.

As an NHS employee myself, I was redeployed to support my employing health board's Covid-19 pandemic response from April 2020 to June 2021. Furthermore, I had two primary-school-aged children for whom I had sole responsibility for their care and home-schooling during working hours during the educational establishment closures; both of these factors presented challenges to completing this doctoral work. However, the pandemic also provided an opportunity to re-focus the final stages of fieldwork on investigating the remobilisation of the nursery supervised toothbrushing programme once establishments reopened, focusing on assessing fidelity of delivery of the nursery supervised toothbrushing programme during the pandemic and identifying barriers and facilitators to its delivery in this period.

1.1 Dental caries

Dental caries is a disease of the mouth, affecting the hard tooth tissues of enamel and dentine as well as the pulp (World Health Organization, 2017b) and can occur in individuals throughout the life course (Heilmann et al., 2015, Pitts et al., 2017). Bacteria present in dental plaque on tooth surfaces can metabolise free sugars coming into contact with the plaque biofilm to produce acid, lowering the pH level of the plaque which in turn causes demineralisation of tooth surfaces (Kidd and Fejerskov, 2016). The progression of caries development depends on whether tooth surfaces are remineralised, due to the pH of plaque biofilm being restored (e.g. by the presence of fluoride in saliva) which stops or reverses caries development; or continues to demineralise, leading to caries lesions developing over a period of time. This process is recognised to be dynamic, depending on the pH of the plaque biofilm, with intermitting periods of remineralisation and demineralisation (Selwitz et al., 2007, Peres et al., 2019).

While it is possible for caries to develop on any tooth surface where dental plaque has developed, in both primary and permanent teeth (Kidd and Fejerskov, 2016) it has been found that some tooth surfaces are more susceptible to caries than others. Caries are more likely to develop in the 'pit' and 'fissure' surfaces of children's posterior teeth, compared with the smooth

surfaces of the anterior teeth, which has been attributed to the accumulation of bacteria on those surfaces due to being more difficult to clean manually (Batchelor and Sheiham, 2004).

1.1.1 National and international prevalence of dental caries

Global rates of dental caries have been described as being *"of epidemic proportions"* (Edelstein et al., 2016, p.15) and a *"pending public health crisis"* (Bagramian et al., 2009, p.3), with Peres et al. (2019) identifying that oral diseases, including dental caries, affect 3.5 billion people globally. Dental caries is recognised to be the most common non-communicable disease worldwide (World Health Organization, 2017b) and as one of the most prevalent diseases affecting children throughout the world (Macpherson et al., 2019a). In their systematic review of 64 studies (from 29 countries) utilising World Health Organization criteria to assess and record caries, Uribe et al. (2021) found there was a 48% global prevalence of early childhood caries (ECC), which they defined as occurring in children under five-years-old, with one or more missing, filled or decayed primary teeth. (There are other definitions of ECC, such as that used by the American Academy of Pediatric Dentistry (2021): the presence of one or more decayed (non-cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in child aged under six.)

Historically, rates of childhood dental caries in Scotland have been high (Macpherson et al. 2010), particularly compared with children in other countries in the UK (Pitts et al, 2007). Epidemiological data on prevalence of caries experience among children in Scotland is gathered annually through the National Dental Inspection Programme for Scotland (NDIP). Detailed inspections are carried out by trained and calibrated dental care professionals, using a mirror, light and ball-ended probe; the status of each surface of each tooth is recorded to measure obvious decay (that has penetrated below the dentine) per British Association for the Study of Community Dentistry (BASCD) diagnostic criteria (Macpherson et al., 2020). Detailed inspections are carried out with a representative sample of children in Primary One (P1) classes, every two years; in 2020, 13,208 children in P1 received a detailed inspection, representing 22.5%

of the estimated P1 population. (Due to restrictions related to the Covid-19 pandemic, only basic dental inspections were carried out in 2022 with a smaller sample: 76% of P1 children, compared with 88% of the population receiving a basic inspection normally.) Children attending Primary Seven receive detailed inspections in the intervening years. The most recent data from detailed inspections showed that 73.5% of P1 children had no obvious decay experience (Macpherson et al., 2020), with 73.1% of P1 children receiving basic inspections found to have no obvious caries in 2022 (Conway et al., 2022). Figure 1 shows that the percentage of P1 receiving detailed dental inspections, assessed to have no obvious decay experience, has increased over time. (Data for Figure 1 were extracted from National Dental Inspection Programme reports of P1 detailed inspections published between 2008-2022: Merrett et al. (2008); Macpherson et al. (2010b, 2012, 2014, 2016, 2018, 2020).)

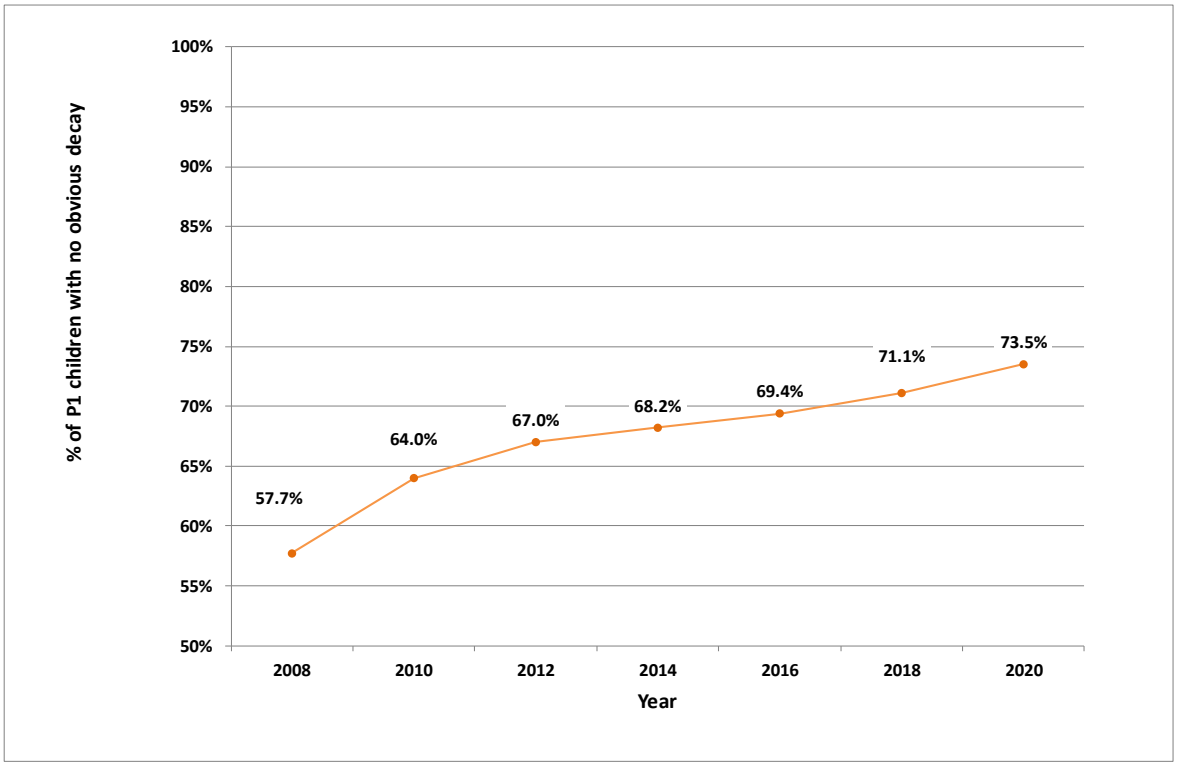

Figure 1 National Dental Inspection Programme data showing percentages of P1 children with no obvious caries experience, 2008-2020

However, while there has been year-on-year improvements in percentages of children without obvious decay, there remain considerable numbers of children starting primary school in Scotland with dental caries, as the most recent

National Dental Inspection Programme data show 26.9% of P1 children had caries experience (Conway et al., 2022).

Dental extractions due to caries under general anaesthetic have long been the most common reason for elective hospital admissions among children in Scotland (Scottish Government, 2016f), with recent data from Public Health Scotland showing that there were 7291 children admitted to hospital for dental extraction in 2019/20 (Public Health Scotland, 2022).

1.1.2 Impact of dental caries on children

It is recognised that poor oral health causes *"extreme pain and discomfort, infection, social embarrassment and interrupted work and education for a significant part of the Scottish population"* (Scottish Executive, 2002, p.7). Experiencing dental caries has a negative impact on children's quality of life (QoL) and disrupts eating, drinking, sleep, and nursery and school attendance (Clarke and Stevens, 2019). Research on oral health-related QoL (OHRQoL) among preschool children in Brazil found that children with dental caries commonly reported pain and experienced difficulties with eating and drinking (Abanto et al., 2011, Ramos-Jorge et al., 2014, Firmino et al., 2016) as well as missing preschool or school, disrupted sleep and impaired speech development (Ramos-Jorge et al., 2014, Abanto et al., 2011). Experiencing dental pain has an emotional impact, with Knapp et al. (2021) reporting over half of children (aged 5-16) participating in their study, who were awaiting treatment for dental caries, had cried because of painful teeth.

Dental caries may contribute to a 'failure to thrive' in children with no other underlying health conditions (Clarke and Stevens, 2019). While several studies have examined the relationship between dental caries, malnutrition and sub-optimal growth among children, evidence on the association between nutrition and dental caries among children remains inconclusive. For example, Tanner et al. (2021)'s systematic review found an association between dental caries and under-nutrition among children aged 0-18 years; and Sheiham (2006) found that bodyweight among children experiencing severe dental caries was significantly

lower than that of controls. This relationship has been attributed to dental pain preventing children from eating adequately, which restricts growth (Alkarimi et al., 2014, Plutzer and Spencer, 2008). Shen et al. (2019) described a bi-directional association between dental caries and children's height and weight from their longitudinal study of preschool children in China: dental caries hampered children's growth (height), while children with low weight at baseline were more susceptible to developing dental caries. Conversely, a systematic review by Hayden et al. (2013) found a significant relationship between obesity (rather than low weight) and dental caries in children from industrialized countries, while two further recent systematic reviews found that dental caries is associated with both high and low body mass indexes (Hooley et al., 2012, Chen et al., 2018). Indeed it is recognised that chronic, non-communicable diseases, including dental caries, have multi-factorial causes which require action targeted at a number of common risk factors; these include dietary factors (i.e. high sugar consumption), stress and low control, and environmental factors (Sheiham and Watt, 2000).

Experiencing dental caries may affect children's education: for example, examining US child health survey data from 2016/17, Guarnizo-Herreño et al. (2019) found that the odds of being absent from school was 1.54 times greater for those with caries, among children aged six-to-eleven years (95% CI 1.28-1.85). Systematic reviews have found that children experiencing decay were 1.43 (95% CI 1.24 to 1.63) to 1.57 (95% CI 1.08-2.05) times more likely to have poorer school attendance; and 1.44 (95% CI 1.24-1.64) to 1.52 (95% CI 1.20 to 1.83) times more likely to have poorer school performance, compared with children with no dental caries (Rebelo et al., 2019, Ruff et al., 2019); although Ribeiro et al. (2018)'s systematic review found too few studies of sufficient quality to be able to assess whether there was an association between dental caries and academic performance in children.

Experiencing dental caries can also have negative psychosocial impacts; for example, Guarnizo-Herreño et al. (2012) found that, among six-to-eleven-year-olds with caries, the odds of experiencing shyness was 1.37 times greater (95% CI 1.16-1.61); the odds of experiencing feeling worthless was 1.20 greater (95% CI

1.03-1.40); and the odds of experiencing feelings of unhappiness was 1.21 greater (95% CI 1.05-1.40), compared with those without caries. Families of children with dental caries also experience poorer QoL; Knapp et al. (2021) assessed the QoL of parents whose children were awaiting treatment for dental caries and found that 58.8% of participants reported disrupted sleep and 45.9% had taken time away from work due to their child's dental caries. Abed et al. (2020) linked data from the Child Dental Health Survey (undertaken in England, Wales and Northern Ireland in 2013) with participants' responses to QoL measures and found that parents/carers whose children experienced severe dental caries were more likely to have time off work; experience feelings of guilt or stress; and have disrupted sleep. Other studies have also reported parents/carers' experiencing distress and guilt due to their child's dental caries (Abanto et al., 2011, Abanto et al., 2012, Ramos-Jorge et al., 2014).

It is recommended that dental extractions under general anaesthesia should only be carried out as a last resort (i.e. if other methods for managing dental caries have not succeeded or are not appropriate) (Adewale et al., 2011, Oubenyahya and Bouhabba, 2019); however, it may be the only available treatment option in some cases, particularly for children aged five and under who may not understand what is required of them for treatment (Scottish Dental Clinical Effectiveness Programme, 2018). It is an expensive procedure, with Anopa et al. (2015) calculating that the cost of a dental extraction under general anaesthetic for a child in Scotland was £653 in 2009/10 (with costs likely to have increased since). It should also be noted that the Covid-19 pandemic has impacted on access to dental treatment, due to suspension of routine care including dental extractions under general anaesthetic, leading to longer waiting times for children requiring extractions (Elsherif et al., 2021) and these suspensions have had a greater impact on children from more deprived areas (Stennett and Tsakos, 2022).

1.1.3 Oral health inequalities

Health inequalities are differences in health occurring between social groups, which cause disproportionately higher levels of ill health and mortality among

the most disadvantaged communities (Scottish Government, 2008b, Jack et al., 2019). It is posited that health inequalities result from uneven distribution of power and resources which influence individual and group exposure to factors that damage or promote health (Macdonald et al., 2014). Factors influencing children and families' health-related behaviours, known as social determinants, include poverty, unemployment, housing, access to services and resources, educational attainment, loneliness and discrimination, which affect communities disproportionately due to unequal distribution of resources and power in society (Hall, 2018). As Watt and Sheiham (2012) highlighted, it is not possible to isolate individual health behaviours from the social context in which they take place, as patterns of behaviour in populations are driven by social environments.

It is recognised that some efforts aimed to improve aspects of public health may actually increase inequalities, by benefitting groups experiencing less disadvantage disproportionately, known as 'intervention-generated inequalities' (Watt, 2007, Lorenc et al., 2013, Thomson et al., 2018). For example, Lorenc et al. (2013)'s reported evidence from systematic reviews that showed media campaigns (targeting folic acid intake; and smoking behaviour), printed communications (on folic acid awareness) and a workplace-based ban on smoking, resulted in increased inequalities between different socioeconomic groups. This has led to calls for action to address health inequalities to focus on 'upstream factors' (i.e. targeting structural or policy-level determinants, such as environmental changes or legislative and regulatory controls) (Sheiham et al., 2011, Lee and Divaris, 2014, Foley and Akers, 2019, Tellez et al., 2014) as focusing on individual behaviours may increase inequality when those with better access to education and income are more able to respond positively (Watt, 2007, Marmot and Bell, 2011).

As with general health, poor oral health affects disadvantaged groups in society disproportionately and there is an association between socioeconomic status and experiencing dental caries (Watt, 2012, World Health Organization, 2017b, Peres et al., 2019). While Foley and Akers (2019) highlighted that dental caries was *"disproportionately a disease of the poor and disadvantaged"* (p.97) it is also

important to recognised that there is a social gradient in experiencing poor oral health across the social stratification (Watt and Sheiham, 2012).

The World Health Organization (2019) identified that the causes and prevention of early childhood caries are influenced by social determinants of health, including social, environmental and economic pressures, with Lee & Divaris (2014) emphasising that distal (rather than individual) factors, including political, economic and social influences, contributed to disparities among populations, leading to differences in oral health beliefs, cultural norms and access to resources within communities. Watt et al. (2018) posited that oral health inequalities resulted from systematic, societal differences between groups, resulting from *"unequal positions of power"* (p966) which were preventable, unacceptable and unfair.

Schwendicke et al. (2014)'s systematic review into the association between families' socioeconomic status and the child's caries experience found that children with lower socioeconomic status had an odds ratio (95% confidence interval) between 1.21 (1.03–1.41) and 1.48 (1.34–1.63) for experiencing caries compared with those with higher socioeconomic status (although the majority of studies included in the analyses were graded as low-quality, due to high risk of bias identified).

National Dental Inspection Programme data gathered between 2008 and 2022 showed consistently that there is a social gradient in caries experience among children in Scotland. The most recent data for P1 children receiving detailed inspections (gathered in 2020) showed that 42% of those residing in the most deprived fifth of the population (as identified using the Scottish Index of Multiple Deprivation [SIMD]) experienced dental decay, compared with 13% of children from the least deprived SIMD-fifth (Macpherson et al., 2020). Figure 2 below shows that, while there were increased percentages of P1 children participating in National Dental Inspection Programme inspections assessed to have no obvious decay experience, in the most-deprived (SIMD 1) and least-deprived (SIMD 5) fifths of the population, there remains a social gradient in decay experience between children residing in the most deprived fifth (SIMD 1)

and the least deprived fifth (SIMD 5) of the population, indicating persistent oral health inequalities among children in Scotland. (Data for Figure 2 were extracted from National Dental Inspection Programme reports of P1 detailed inspections published between 2008-2022: Merrett et al. (2008); Macpherson et al. (2010b, 2012, 2014, 2016, 2018, 2020).)

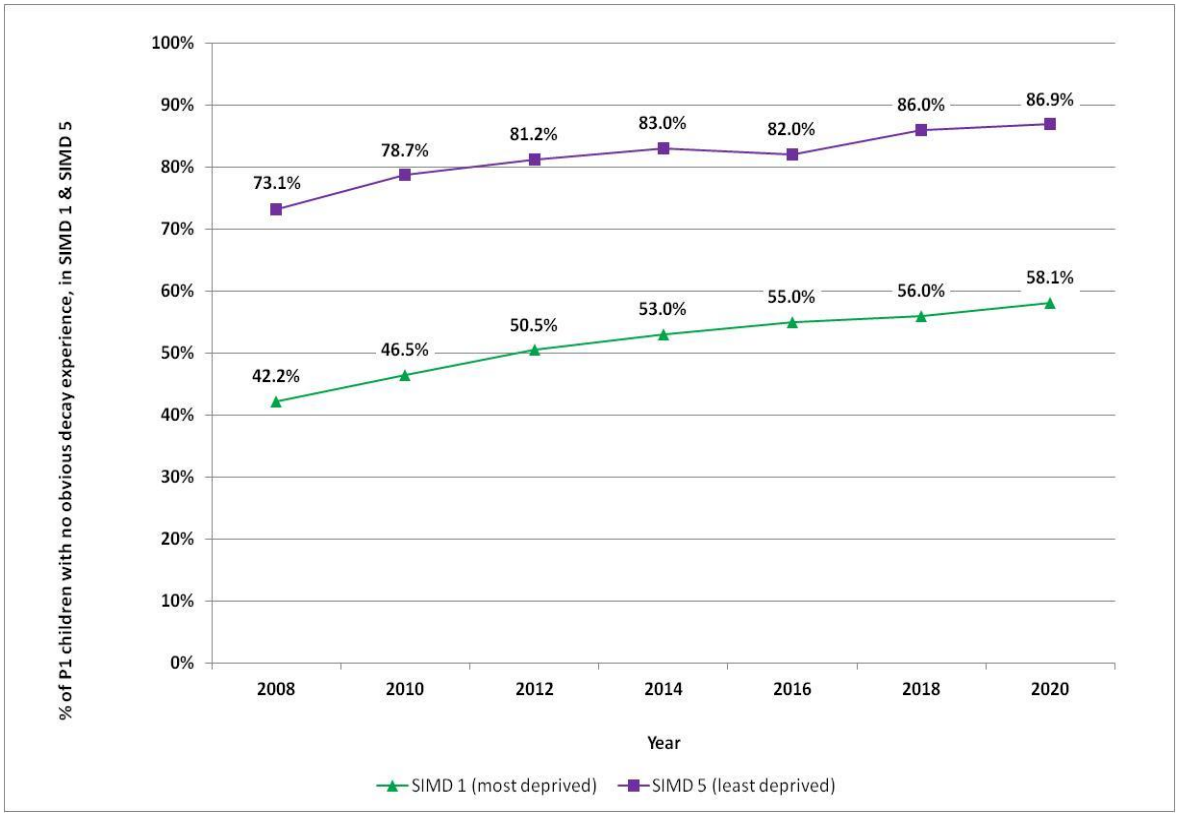

Figure 2 National Dental Inspection Programme data showing percentages of P1 children with no obvious caries experience in SIMD 1 & SIMD 5, 2008-2020

The Scottish Government (2016g) highlighted that addressing the social gradient in decay experience among children was a priority for oral health policy going forward, with Macpherson et al. (2019b) noting that addressing oral health inequalities among children in Scotland remained a significant challenge.

1.1.3.1 Prevention of oral health inequalities

Given that poor oral health affects disadvantaged groups in society disproportionately, due to social determinants which affect individuals across the social gradient to differing degrees, there is a need to look at the upstream, structural determinants of oral health in addition to downstream factors of individual behaviours (Watt and Sheiham, 2012). It is recognised that individuals'

health behaviours and their health outcomes are shaped by the socioeconomic environments in which they live, as their social position influences their access to education, employment and so on; and the resources they have available to them influences their access to physical and social support (World Health Organization, 2008, Marmot, 2010, Watt and Sheiham, 2012). Efforts to improve populations' oral health need to focus on those root causes of oral health inequalities (Lee and Divaris, 2014).

It has been highlighted that although oral health policies acknowledge upstream factors, they tend to focus on downstream, behavioural factors and clinical interventions, within the biomedical approach to prevention (Watt and Sheiham, 2012, Peres et al., 2019). This is known as known as 'lifestyle drift', or the tendency within public health approaches to focus on individual's lifestyle 'choices' (Marmot and Allen, 2014). This assumes that individuals' behaviours are 'choices' that can be altered by providing individuals information and skills, which fails to recognise that behaviours are actually determined by the socioeconomic environments in which individuals live (Watt, 2007). Indeed, there is evidence that behaviour change interventions cannot effect sustainable changes in oral health behaviours, without meaningful modification of the social environment (Watt and Sheiham, 2012); and providing downstream interventions alone may actually increase oral health inequalities (Watt, 2007).

Watt and Sheiham (2012) called for population-level action, focused on social determinants, following the approach of proportionate universalism; as described by Marmot (2010), this approach intends to reduce the steepness of the social gradient in health inequalities by providing universal action (to all groups in society) which is concentrated in proportion to levels of disadvantage. This includes action to empower communities, reduce poverty, increased access to education and employment, and provision of good quality housing (Lee and Divaris, 2014). It is recommended that downstream interventions for oral health improvement (such as toothbrushing) are combined with midstream and upstream approaches to ensure appropriate action takes place to address the underlying causes of poor oral health within populations (Watt et al., 2019).

1.1.4 Approaches to children's oral health improvement and preventing dental caries

Dental caries is preventable (Scottish Dental Clinical Effectiveness Programme, 2018, World Health Organization, 2019), with approaches to oral health improvement and prevention of dental caries among children focused on controlling plaque levels on tooth surfaces, ensuring exposure to appropriate levels of fluoride, and reducing consumption of free sugars (e.g. those added to foods) (Clarke and Stevens, 2019). More frequent episodes of free sugar intake lead to lower pH levels within the oral cavity for longer periods, due to bacterial metabolism, which contributes to demineralisation of tooth surfaces (Twetman, 2018, Clarke and Stevens, 2019). Twetman (2018) suggested that both downstream and upstream preventive actions were required to reduce sugar consumption among children, although Gussy et al. (2006) found that downstream interventions (focused on providing dietary advice to parents/carers) had a limited effect on changing their children's sugar consumption. Upstream actions to reduce sugar consumption may include regulating marketing of high-sugar products or legislating for reformulating those products (Moynihan, 2016). While addressing sugar consumption is important within overall efforts to preventing dental caries among children, the focus for the remainder of this section is on the role of fluoride in caries prevention.

1.1.4.1 Fluoride-based prevention of dental caries

There is strong evidence that fluoride has a role in preventing caries when delivered topically (via toothpastes, mouth rinses, varnishes or gels applied directly to teeth) or systemically (ingested via fluoride supplements, salts, milk or fluoridation of drinking water) (Tubert-Jeannin et al., 2011). The World Health Organization recommends water fluoridation for caries prevention (World Health Organization, 2017, World Health Organization, 2019); a Cochrane review found that water fluoridation resulted in a 15% increase of children without caries in primary teeth (95% CI 11% to 19%) and 14% increase of children without caries in permanent teeth (95% CI 5% to 23%) (Iheozor-Ejiofor et al., 2015). It is recognised that implementing water fluoridation would provide a cost-effective,

evidence-based measure to prevent dental caries in countries in the UK (Department of Health and Social Care, 2021).

There is limited evidence for the effectiveness of systemic fluoride for preventing caries. While Tubert-Jeannin et al. (2011)'s Cochrane review of fluoride supplements found that these were associated with reduced caries in children's permanent teeth, compared with no supplement use, the effect was unclear in relation to primary teeth and it was noted that fluoride supplements were unlikely to have any additional effect when used alongside topical fluorides such as toothpaste. There is also limited evidence on the effect of fluoridated salt on caries prevention (Espelid, 2009); two systematic reviews on various modes of fluoridation were unable to identify any studies evaluating fluoridated salt that met inclusion criteria (National Health & Medical Research Council, 2007, Cagetti et al., 2013). While the review undertaken by the Australian Government's National Health & Medical Research Council (2007) identified three cross-sectional studies that indicated reduced caries among those ingesting fluoridated salt, these studies were graded as low quality and excluded from the review. In relation to fluoridated milk, Yeung et al. (2015)'s Cochrane review included evidence from one randomised controlled trial, graded as low quality, which indicated a caries-preventive effect of ingesting fluoridated milk among three-year-old children; however, it was highlighted that further research of sufficient quality was required to evaluate the efficacy of fluoridated milk.

There is strong evidence for using topical fluoride in preventing caries (Rugg-Gunn, 2013, Scottish Intercollegiate Guidelines Network, 2014, Phantumvanit et al., 2018) which is thought to influence the processes of enamel demineralisation and remineralisation as well as bacterial metabolism of sugars (Tinanoff, 2016, Kidd and Fejerskov, 2016, Chestnutt, 2016). Marinho et al.'s (2003b) Cochrane review investigated different modes of topical fluoride (including toothpastes, varnishes, mouth rinses and gels) among children and adolescents, which found a 26% pooled prevented fraction estimate of decayed, missing or filled tooth surfaces as a result of using topical fluorides. It has been suggested that topical fluoride delivery is more effective than systemic modes in inhibiting demineralisation, enhancing remineralisation and reducing bacterial

activity in plaque (Featherstone, 1999); and 'systemic' modes of delivery are thought to work through topical effect, where the fluoride-containing product comes into contact with the teeth) (Sampaio and Levy, 2011).

1.1.4.2 Fluoride toothpaste for caries prevention

Evidence from several systematic reviews shows that brushing with fluoride toothpaste reduces development of dental caries, compared with using non-fluoride toothpaste or no toothpaste at all (Marinho et al., 2003a, Walsh et al., 2010). In their updated Cochrane review, Walsh et al. (2019b) found continued evidence that using fluoride toothpaste prevented caries, compared with non-fluoride toothpaste; and toothpastes with stronger fluoride concentrations had an increased preventive effect.

Daily toothbrushing with fluoride toothpaste is associated with reducing incidence and severity of dental decay among children (Public Health England, 2016); and commencing toothbrushing with children from an early age has been found to significantly improve oral health outcomes in later life (Winter et al., 2017). In a systematic review looking at the effect of toothbrushing with fluoride toothpaste on preventing dental caries among preschool children, which included eight studies, dos Santos et al. (2013) found that daily toothbrushing with fluoride toothpaste significantly reduces caries incidence among children aged three to six years.

1.1.4.3 Supervision of toothbrushing

In addition to delivering fluoride, toothbrushing helps to prevent caries by removing plaque from tooth surfaces (Hollins, 2015, Clarke and Stevens, 2019) which removes the source of acid-producing bacteria involved in tooth demineralisation and caries development. However it is recognised that children under the age of seven require assistance or supervision from parents/carers while brushing as their manual dexterity is not sufficient to remove plaque effectively (Levine and Stillman-Lowe, 2019). Systematic reviews have found that supervising children while brushing has a greater impact on dental caries than unsupervised brushing (Twetman et al., 2003, Twetman, 2009) and

supervising young children while toothbrushing is recommended for safety reasons, to minimise toothpaste consumption (Wright et al., 2014, Scottish Intercollegiate Guidelines Network, 2014) and ensure adequate infection prevention and control (Childsmile, 2019).

The definition of 'supervision' of toothbrushing within the literature is ambiguous as it may refer to an adult observing a child who is toothbrushing, or the adult brushing the child's teeth themselves (dos Santos et al., 2018). Clark (2017) described supervision of toothbrushing as ensuring children used an appropriate amount of toothpaste, overseeing children while they brushed their teeth (assisting as required), and ensuring toothbrushing took place for an adequate amount of time. It is suggested that being observed by an adult while toothbrushing may prompt children to clean their teeth thoroughly and for longer duration, which dos Santos et al. (2018) described as a *"prolonged Hawthorne effect"* (p. 4). The concept of supervision within the context of the Childsmile nursery supervised toothbrushing programme will be examined in further detail in Chapter 3 of this thesis.

It is posited that patterns of behaviour adopted in the early years are often fixed into adulthood, which requires early intervention to establish appropriate and healthy behaviours (Livingston and Muirden, 1980, Watt et al., 2001, Leal et al., 2002, Petersen et al., 2015). For example, it has been highlighted that children require support, including frequent repetition and positive reinforcement, to learn the sequences of coordinated movements and develop the complex motor skills required for toothbrushing (Poche et al., 1982, Aunger, 2007, Makuch et al., 2011). Furthermore, Aunger (2007) described toothbrushing as a complex sequence of behaviours occurring together, learned through experience, with memories about previous toothbrushing experiences providing a 'script' to support appropriate sequences of actions in response to cues; these become 'routinised' to avoid cognitive effort of searching through all potential responses each time toothbrushing cues are encountered. Leal et al. (2002) emphasised that encouraging the acquisition of toothbrushing skills at an early age helped to establish toothbrushing as a norm within daily routines. Educational settings play an important role in developing children's lifelong attitudes, skills and

behaviours (Woodall et al., 2013) and it is thought that classroom-based toothbrushing interventions provide ongoing reinforcement to support skills acquisition (Lee, 1980) as well as reaching large populations of children efficiently (Woodall et al., 2014, Dickson-Swift et al., 2017).

1.2 Nursery- and school-based supervised toothbrushing interventions

This section provides an overview of supervised toothbrushing interventions taking place in nursery and primary school settings[1], reported in published, scientific literature and grey literature, focusing on their implementation. Databases were searched systematically using appropriate search terms for the population, intervention and settings of interest (see Appendix 1A for search strategy), supplemented by searching for grey literature using the Google search engine. These searches yielded 20 standalone studies involving daily, supervised toothbrushing interventions taking place in nursery or primary school settings and a further 39 examples of ongoing dental public health programmes which included supervised toothbrushing in nursery and primary school settings. (Table 25 in Appendix 2 summarises the main components of the supervised toothbrushing interventions involved in the standalone studies as well as providing commentary on the studies' quality; while Tables 26 and 27 in Appendix 2 outline the ongoing programmes.)

1.2.1 Evidence for supervised toothbrushing interventions in nursery- and school-settings

Among the 20 examples of standalone studies involving supervised toothbrushing interventions identified, nine studies were randomized controlled trials (You et al., 2002, Curnow et al., 2002, Rong et al., 2003, Jackson et al., 2005, Petersen

[1] The term 'nursery' is used to cover a range of early years childcare settings (which may also be known as 'kindergarten' or 'preschool'); and the term 'primary school' is used to cover educational settings for children aged 5-11 (which may also be known as 'elementary school').

et al., 2015, Pieper et al., 2016, Babaei et al., 2020, Samuel et al., 2020, Natapov et al., 2021), with the remainder including: cohort studies (Pakhomov et al., 1997, Al-Jundi et al., 2006, Monse et al., 2013, Wolff et al., 2016); repeated cross-sectional study (Gasoyan et al., 2019); and quasi-experimental studies (Lo et al., 1998, Schwarz et al., 1998, Leal et al., 2002, Wind et al., 2005, Andruskeviciene et al., 2008, Cakar et al., 2018).

Sixteen studies (reported in 19 papers) evaluated the effect of participating in supervised toothbrushing, using fluoride toothpaste, in nursery or school settings, on children's caries experience, compared with controls (Pakhomov et al., 1997, Lo et al., 1998, Schwarz et al., 1998, You et al., 2002, Curnow et al., 2002, Rong et al., 2003, Jackson et al., 2005, Al-Jundi et al., 2006, Pine et al., 2007, Andruskeviciene et al., 2008, Monse et al., 2013, Petersen et al., 2015, Wolff et al., 2016, Pieper et al., 2016, Winter et al., 2017, Cakar et al., 2018, Gasoyan et al., 2019, Samuel et al., 2020, Natapov et al., 2021), while one study evaluated the intervention's impact on children's oral hygiene status (Babaei et al., 2020). Most of these studies indicated that there was some statistically significant, positive effect of participating in the supervised toothbrushing interventions on participants' caries experience (whether in primary or permanent dentition) compared to controls, apart from Monse et al. (2013) and Natapov et al. (2021) where no differences between groups were found.

Aside from these studies assessing the impact of participating in supervised toothbrushing interventions on children's caries experience, one study assessed the impact of participating in daily, supervised toothbrushing on children's self-reported oral health knowledge and behaviours: Wind et al. (2005) found that while toothbrushing frequency increased among the intervention group initially, this was not maintained after one year and no differences were found in attitudes towards toothbrushing or habit strength between experimental and control groups.

A further two studies assessed the impact of toothbrushing interventions delivered in educational settings on children's toothbrushing efficacy and technique, which found that individual toothbrushing instruction (compared with

group-based audiovisual or using a child-as-model methods) resulted in greatest reduction in participant's plaque scores (Leal et al., 2002) and that more children displayed correct toothbrushing positioning and movement after receiving demonstrations with human models (i.e. with the child or another person) compared with techniques that used teeth or animal puppet models (Makuch et al., 2011).

There were various limitations affecting these studies which must be considered when interpreting the results reported. For example, protocols for delivering the toothbrushing intervention were not provided for several of these studies, making it impossible to render close replication of these studies. This included not specifying the fluoride content of the toothpaste used with experimental groups (Pakhomov et al., 1997, Rong et al., 2003, Babaei et al., 2020); not specifying the duration of toothbrushing taking place each day (Curnow et al., 2002, Jackson et al., 2005, Al-Jundi et al., 2006, Andruskeviciene et al., 2008, Pieper et al., 2016, Cakar et al., 2018, Samuel et al., 2020, Babaei et al., 2020, Natapov et al., 2021); not identifying who was responsible for supervising toothbrushing (You et al., 2002, Andruskeviciene et al., 2008, Babaei et al., 2020, Natapov et al., 2021) or describing the role of toothbrushing personnel recruited for the study (Pieper et al., 2016).

There were issues relating to risk of selection bias for seven of the studies, such as selecting settings based on being the largest in the area (Lo et al., 1998, Schwarz et al., 1998, Rong et al., 2003), control settings selected by a government department involved with the programme, not at random (Monse et al., 2013) or a lack of clarity on how participating settings were selected (Cakar et al., 2018, Natapov et al., 2021). There were also issues relating to loss-to-follow up affecting several of these studies, with 25-30% fewer participants included in post-intervention dental examinations (compared with those present at the outset) in four studies, which was not acknowledged by the authors (Pakhomov et al., 1997, Rong et al., 2003, Jackson et al., 2005, Petersen et al., 2015). There is also evidence of selective analysis or reporting in some of the studies. In Jackson et al. (2005), 161 participants who remained caries-free for the duration of the study were excluded from analyses (68 from the

experimental group and 93 from the control group), representing 44% of participants who received dental examinations post-intervention, which the authors claimed was done to evaluate the intervention's effectiveness on a *"less caries-resistant group"* (p.110). You et al. (2002) referred to a subset of 85 participants who did not comply with *"study protocol continuance criteria"* (p.181); however, it is not clear what this criteria consisted of or how it was assessed, and it is not made explicit whether these participants were included in final analyses or not. It is also unclear why Petersen et al. (2015) assessed caries experience in the permanent dentition only; given the age of the participants it is likely many would still have had primary dentition, and some may not have had any permanent dentition present, but no reference to assessing caries experience in primary dentition was made within the paper. Similarly, Pine et al. (2007) reported differences in caries experience in participants' first permanent molars only and it is unclear if caries experience affecting other teeth was examined or analysed within this study.

Taking these limitations into account, the majority of these studies provided evidence that participating in supervised toothbrushing interventions resulted in reduced caries experience among participants compared to controls, in terms of their primary dentition (Pakmohov et al., 1997, Lo et al., 1998, Schwarz et al., 1998, You et al., 2002, Rong et al., 2003, Jackson et al., 2005, Al-Jundi et al., 2006, Andruskeviciene et al., 2008, Wolff et al., 2016, Pieper et al., 2016, Cakar et al., 2018, Samuel et al., 2020) or permanent dentition (Curnow et al., 2002, Al-Jundi et al., 2006, Petersen et al., 2015, Cakar et al., 2018, Gasoyan et al., 2019).

1.2.2 Implementation of supervised toothbrushing interventions in educational settings

There are various factors to be considered when establishing supervised toothbrushing programmes in educational settings, including training for staff involved in delivery; ages of children involved; supervision; whether brushing takes place at sinks ('wet brushing') or away from sinks ('dry brushing'); fluoride

content of toothpaste; and duration and frequency of brushing (Public Health England, 2016, Dickson-Swift et al., 2017, Childsmile, 2019).

There were differences apparent in these factors among the 20 standalone supervised toothbrushing interventions studies and several lacked adequate description of these factors. For example, while toothbrushing took place once per day, with each brushing episode lasting two minutes, for most of the studies, brushing took place for 60 seconds, twice per day in You et al. (2002) and Rong et al. (2003). The duration of toothbrushing episode was not specified for eight studies (Curnow et al., 2002, Jackson et al., 2005, Al-Jundi et al., 2006, Pine et al., 2007, Andruskeviciene et al., 2008, Pieper et al., 2016, Winter et al., 2017, Cakar et al., 2018, Samuel et al., 2020, Babaei et al., 2020, or Natapov et al., 2021).

In terms of supervision of toothbrushing, it was mainly nursery/school staff responsible for day-to-day delivery of these interventions and supervising children while brushing in these studies. However, some studies utilised other personnel including parent volunteers (Curnow et al., 2002, Pine et al., 2007) or others recruited for the purpose of the study (Al-Jundi et al., 2006, Pieper et al., 2016, Winter et al., 2017). You et al. (2002), Andruskeviciene et al. (2008), Babaei et al. (2020) and Natapov et al. (2021) did not specify who was responsible for supervising children while brushing.

There was variation in the fluoride content of the toothpaste used in these studies, ranging from 500 parts per million fluoride (ppmF) (Al-Jundi et al., 2006, Andruskeviciene et al., 2008, Pieper et al., 2016, Winter et al., 2017, Cakar et al., 2018) to 1450 ppmF (Jackson et al., 2005, Monse et al., 2013, Petersen et al., 2015). This was not specified in Pakhomov et al. (1997), Rong et al. (2003) or Babaei et al. (2020).

The ages of children involved in the interventions evaluated in these studies ranged from two-years-old (Pieper et al., 2016) to 12 years old (Pakhomov et al., 1997, Wolff et al., 2016, Cakar et al., 2018). The interventions were delivered in nurseries in nine studies (Pakhomov et al., 1997, Lo et al., 1998, Schwarz et al.,

1998, You et al., 2002, Rong et al., 2003, Andruskeviciene et al., 2008, Petersen et al., 2015, Pieper et al., 2016, Winter et al., 2017, Samuel et al., 2020, Natapov et al., 2021) and in primary schools in nine studies (Pakhomov et al., 1997, Curnow et al., 2002, Pine et al., 2007, Jackson et al., 2005, Al-Jundi et al., 2006, Monse et al., 2013, Wolff et al., 2016, Cakar et al., 2018, Gasoyan et al., 2019, Babaei et al., 2020) (the intervention was delivered in both setting types in Pakhomov et al. (1997)).

Other differences between studies included how long interventions were delivered; and how long after participation that children's caries status was measured (ranging from one to nine years).

1.2.3 Ongoing dental public health programmes including supervised toothbrushing component

Thirty-nine ongoing dental public health programmes were identified: twenty-six of these took place in countries in the UK, mainly in England (23), with single, overarching programmes offered in Wales, Northern Ireland and Isle of Man. Unlike in Scotland and Wales, where the governments have funded national child oral health programmes with standardised methods for targeting and delivery, budgets for oral health improvement for children and young people were devolved to local authorities in England due to the Health and Social Care Act, 2012 (Public Health England, 2014). While Public Health England (2014) recommended that local authorities commissioned supervised toothbrushing programmes in nurseries and schools, given the strong evidence available on their effectiveness in reducing dental caries among children, it is recognised that local commissioning has led to significant variation in whether supervised toothbrushing interventions are available in nurseries and schools in England as well as differences in delivery of those that are commissioned (Jones, 2021). This variation is reflected in the supervised toothbrushing programmes in England identified through the search. For example, in addition to programmes delivered by NHS and local authority public health and oral health promotion teams, there were various examples of programmes in England being delivered by public-private partnerships or social enterprises, including Teeth Team, Live

Smart and the Devon supervised toothbrushing programme (Teeth Team Limited, 2018, Dental Wellness Trust, 2021, Peninsula Dental, 2022).

Further to those programmes, there were thirteen ongoing programmes in countries in the rest of the world (Australia, Chile, Croatia, New Zealand, South Africa, United Arab Emirates, USA and Vanuatu).

There were various stages of implementation among the programmes identified, depending on when they commenced. Some were well-established, such as Designed to Smile in Wales, which began in 2008 and was rolled out to establishments across the country (Morgan and Wilson, 2020), while others were still in pilot stage and delivered in small numbers of establishments, such as programmes in Barnet and Bradford (Local Government Association, 2022, Barnet Council, 2022).

For the majority of programmes, supervision was carried out by nursery and/or school staff, although this was not specified for 10 programmes in England (Keep Smiling: Wright and Robertson, 2013, Calderdale's Toothbrushing in Schools scheme: Woodall et al., 2014, Brush Bus (Hull): Hull City Council, 2017, Happy Teeth, Happy Smiles: Leicester City Council, 2017, Healthy Smiles Brent: Local Government Association, 2018, Brush Bus (Manchester): Manchester City Council, 2018, Smile4Life: Burgess-Allen et al., 2018, Brush Up Portsmouth: University of Portsmouth Dental Academy, 2019, Smile Squad: Worcestershire Children First, 2022, and Barnet Young Brushers: Barnet Council, 2022); or four programmes in the rest of the world (Victoria Department of Human Services, 2002, Graesser et al., 2017, Dimitropoulos et al., 2018, Dimitropoulos et al., 2019, Reddy, 2019).

Seventeen programmes included both nurseries and primary schools, with 19 taking place in nurseries only and five in primary schools only. The age range of children participating in these programmes ranged from 0 to 11 years, with most concentrated on ages three to five years.

Toothbrushing took place once per day for the majority of programmes (22) although two programmes indicated that brushing would happen more than once

per day (Sembrando Sonrisas: Ministerio Del Salud. Gobierno De Chile, 2018, Barnet Young Brushers: Barnet Council, 2022). Fifteen programmes did not specify the frequency of brushing. While eleven programmes specified that each brushing episode would take place for two minutes (with one indicating it would be less than two minutes and another one that it would be more than two minutes), this was not identified for the majority of programmes (26).

The fluoride content of the toothpaste used was 1350-1500 ppmF for 14 programmes (including two that specified this was for children over three years old); 1000 ppmF for five programmes (including two that specified this was for children under the age of three and one that specified this was for children aged six and over); and 500 ppmF for one programme, for children aged five and under. Twenty-two programmes did not specify the fluoride content of toothpaste.

Among programmes with protocols for delivery available, these often provided similar information, relating to infection prevention and control measures, storage and cleaning of toothbrushing equipment, safe dispensing of toothpaste, and using an appropriate size of toothbrush and amount of toothpaste depending on the age of the child (Suffolk County Council, 2017, Leicester City Council, 2017, Ministerio Del Salud, Gobierno De Chile, 2018, Cambridgeshire Community Services NHS Trust, 2020, St Helens Wellbeing, 2020, Croatian Institute for Public Health, 2020, Doncaster Council, 2022, Isle of Man Government, Designed to Smile). There were some differences in models of delivery, where these were described; several programmes allowed flexibility in whether establishments chose to brush at sinks (also known as the ‘wet’ model) or away from sinks (the ‘dry’ model) (e.g. Leicester City Council, 2017, Suffolk County Council, 2017, Isle of Man Government Department of Health and Social Care, 2018, Nottinghamshire Oral Health Promotion Team, 2019, St Helens Wellbeing, 2020, Solent NHS Trust, 2020, Croatian Institute for Public Health, 2020). In two programmes it was noted that dry brushing was the only model permitted, due to infection prevention and control considerations arising from the Covid-19 pandemic (Cambridgeshire Community Services NHS Trust, 2020, Doncaster

Council, 2022). Similarly, the national programme in Wales, Designed to Smile, only described the dry model of delivery (Designed to Smile).

Programmes in Wales, Chile and parts of England (Nottinghamshire and Devon) were targeted via area-based deprivation (Morgan, 2019, Nottinghamshire Oral Health Promotion Team, 2019, Carvajal Pavez and Hevia, 2020, Allen and Witton, 2021) while others were targeted using dental epidemiological data e.g.in Bradford (Local Government Association, 2022) and the Live Smart programme in London and South-East England (Dental Wellness Trust, 2021). However it is not clear if targeting was used for the majority of programmes. In USA, Early Head Start and Head Start programmes support families with low income across the whole country, including pre-school education and childcare for children aged five and under. One of the standards governing delivery of the programmes is that every child attending a Head Start setting is offered the opportunity to brush their teeth with fluoride toothpaste once per day (US Department of Health and Human Services, 2020). There were also examples of state-wide requirements for supervised toothbrushing programmes in early learning and childcare settings in Massachusetts and Arizona (Massachusetts Department of Public Health: Office of Oral Health, 2009, Arizona Department of Health Services, 2014).

1.2.4 Evaluation of dental public health programmes

Evaluation of public health programmes is concerned with assessing impact and effectiveness; that is, determining whether the programme's goals or objectives, or 'desired changes', have been achieved, known as 'outcome' or 'summative' evaluation (Green and South, 2006, Stufflebeam and Coryn, 2014, The Health Foundation, 2015, Rossi et al., 2019). This is linked to accountability, ensuring that public funds are used appropriately on interventions that benefit populations, are cost-effective, and have no unanticipated, adverse effects (Parsons, 2017, Rossi et al., 2019).

However, *how* a programme's goals were achieved has equal importance to whether or not they were achieved (Chen, 2005). It is recognised that

evaluations should go beyond whether a programme ‘works’ or not, to investigate how and why it works (or not), to contribute to ‘real-world’ decisions about appropriate methods to address social problems (Stufflebeam and Coryn, 2014, Parsons, 2017, Skivington et al., 2021). This contributes to knowledge generation about which interventions are effective, under which circumstances, in addressing particular problems (Rossi et al., 2019, Bartholomew et al., 2006).

The UK Medical Research Council’s guidance on developing and evaluating complex interventions, first published in 2000 and now in its fourth iteration, defines complex interventions as having multiple, interacting components, which depend on behaviours undertaken by those delivering and receiving the intervention, and which require some level of tailoring to ensure appropriate fit within a given setting or context (Skivington et al., 2021). The guidance indicates that it is not sufficient to limit evaluation of these interventions to experimental designs, as estimating effectiveness is context-dependent and unlikely to be applicable across varied settings where complex interventions are implemented. Instead, it is important to consider how the context within which an intervention is delivered contributed to its outcomes (Chen, 2005, Skivington et al., 2021) which can also contribute to understanding whether programmes can be adapted and delivered in different settings or to different populations (Green and South, 2006, Parsons, 2017) and how to support programme sustainment over time, given shifting economic, political and social contexts (Shadish, 2006).

Incorporating process evaluation alongside outcome evaluation is advocated to provide a more nuanced understanding of how and why interventions work in particular contexts (Skivington et al., 2015). Process evaluations also contribute to quality assurance and improvement within programmes, enabling those involved in programmes to review progress and make adjustments to delivery where required, to achieve programme goals (Green and South, 2006, Stufflebeam and Coryn, 2014). By assessing the quality and fidelity of the programme implementation, it can be ascertained whether delivery-in-reality matched what was intended; and if the programme reached its intended recipients (Moore et al., 2015, Fox et al., 2016, Rossi et al., 2019). In relation to

public health programmes, it is recognised that process evaluations are required to identify *what* was delivered, *how* it was delivered, and *who* it was delivered to, as it cannot be assumed that programmes are implemented as intended, without variation, in all settings (Valente, 2002, Moore et al., 2015). Uncovering these variations between intended and actual programme delivery through process evaluations provides opportunities to address barriers to implementation and improve programme fidelity (Parsons, 2017). This also requires the acceptability of an intervention among those involved in delivery and its recipients, and the barriers, facilitators and contextual factors influencing its delivery, to be assessed (Windsor, 2015, Fox et al., 2016).

Process evaluations also support interpretation of the results of outcome evaluations, as these can help uncover which programme factors were associated with its success or failure (Chen, 2005, Green and South, 2006). Assessing whether a programme was delivered as intended enables attribution of the outcomes achieved to its delivery (Bartholomew et al., 2006, Aarestrup et al., 2014); that is, process evaluations help to identify whether a programme's observed outcomes are due to its theorised causal mechanisms, or reflect the way in which it was implemented (Oakley et al., 2006, Carroll et al., 2007). This is particularly relevant for programmes implemented across multiple settings, which introduces the potential for variations in delivery (Oakley et al., 2006).

All of the cited factors denoting complexity are evident in relation to supervised toothbrushing interventions delivered in nursery or school settings. For example, there are multiple components and behaviours involved for staff in nurseries and schools to provide opportunities for children to brush their teeth each day while ensuring appropriate supervision and infection prevention controls, within the context of the wider routine taking place in those settings. The Medical Research Council guidance is recognised as being widely used and influential in conceptualising complexity within interventions (Tanner-Smith and Grant, 2018, O'Cathain et al., 2019); however, none of the ongoing programmes appeared to have utilised the guidance to develop or evaluate the interventions. This represents a gap in these programmes, as a central part of the Medical Research Council guidance is that complex interventions should be theory-driven, to

ensure fuller understanding of how and why they work, specifically in terms of how the activities undertaken lead to outcomes (Skivington et al., 2021). The Childsmile programme has an embedded, theory-based evaluation (described further in Section 1.4.3 in this chapter) which aims to identify the causal links between the programme's inputs and activities to its intended outcomes. This includes an ongoing process evaluation which assesses programme delivery-in-reality in comparison to the intended programme Theory of Change, to identify potential risks in implementation and delivery, to inform ongoing programme refinement and improvement (Macpherson et al., 2019b).

The Designed to Smile programme in Wales includes embedded monitoring and evaluation, undertaken by Cardiff University (Dental Public Health Unit and Welsh Oral Health Information Unit) (Morgan, 2018a). Annual monitoring reports have been produced since 2013-14 with the report for 2021-22 due to be published (Morgan, 2014c, Morgan, 2015, Morgan, 2016, Morgan, 2018b, Morgan, 2019, Morgan and Wilson, 2020). Evaluation of different aspects of the programme was carried out which included interviews and surveys with dental staff and school staff involved in delivering the programme and parents/carers of children participating in the programme (Trubey and Chestnutt, 2009, Trubey and Chestnutt, 2010, Trubey and Chestnutt 2011, Trubey and Chestnutt, 2012, Trubey and Chestnutt, 2013, Stanton and Chestnutt, 2015). Outcome evaluation of the Sembrando Sonrisas programme in Chile was undertaken as part of doctoral research (Celis et al., 2021, Celis, 2022), which found that caries experience among six-year-olds reduced by 17% (95% CI -21%, -13%) between 2008 and 2019 (during which the programme commenced); and process evaluation of the programme was carried out in 2019-20 by Carvajal Pavez and Hevia (2020).

Aside from these examples, there were no other programmes reported to have embedded evaluations. While there were evaluations of the Calderdale Toothbrushing in Schools Scheme (commissioned by South West Yorkshire Partnership NHS Foundation Trust and published in 2013) (Woodall et al., 2013) and the Smile4Life pilot programme (carried out by Derby City Council in 2013-

14) (Burgess-Allen et al., 2018), there doesn't appear to have been any ongoing evaluation of these programmes.

A further literature search was carried out, using the same databases and search terms for the population, intervention and settings of interest (as detailed in Appendix 1A) plus additional search terms related to the outcome for the research, reflecting the complex, mixed methodology based on a programme theory approach used for this doctoral research (included in Appendix 1B). This yielded zero results, demonstrating that this research is novel in terms of its approach to investigating the implementation of this complex toothbrushing intervention delivered in educational settings.

1.3 Scotland's approach to improving health and reducing inequalities

The problem of persistent health inequalities in Scotland has long been recognised (Scottish Executive, 2005b) particularly in relation to the demands these placed on public services (Scottish Government, 2011) therefore addressing health inequalities has been a priority for the Scottish Government for over a decade (Scottish Government, 2008b, Jack et al., 2019, Scottish Government, 2021b). As noted, health outcomes follow a social gradient across the population and it is recognised that it is not sufficient to focus efforts on the most disadvantaged communities alone, as this might stigmatise those communities as well as being a missed opportunity to improve health across the social gradient (Macdonald et al., 2014).

Professor Sir Michael Marmot's independent review of strategies to reduce health inequalities in England (the Marmot Review) was published initially in 2010 and updated in 2020. The Review has influenced approaches to tackling health inequalities in Scotland, particularly the 'proportionate universalism' approach which recognises the need for universal action for all parts of the population, tailored to meet specific levels of disadvantage within different sectors (Marmot, 2010, Marmot et al., 2020).

Within public health, interventions to improve health are described as upstream (focused on the social and economic factors affecting health, such as employment or education, which are recognised to constrain individuals' behaviour); midstream (occurring at the local, community level, seeking to reduce individuals' exposure to risks to their health); or downstream (focused on individuals' behaviours, but do not address the causes of the risks to their health) (Williams and Fullagar, 2019, National Collaborating Centre for Determinants of Health, 2014, Macpherson et al., 2019a). It is recognised that, as health inequalities arise from social determinants, there needs to be systematic efforts to address the societal-level causes of poor health (Marmot, 2010, Braveman et al., 2011).

The Childsmile programme is comprised of interventions focused at the midstream (i.e. universal provision of toothbrushes and toothpaste distributed via health visitors and educational settings; supervised toothbrushing programmes and fluoride varnishing programmes in nurseries and primary schools; dental health support workers and health visitors identifying families who would benefit from support) and downstream levels (i.e. individual, tailored oral health advice and support for children and families; signposting and linking individuals with relevant health services and community organisations) (Ross et al., 2023). Upstream activities undertaken through the programme include influencing national, prevention-focused public health and dental policies, such as food and nutrition policies in nurseries and schools (Macpherson et al., 2019b).

Programme stakeholders involved in developing Childsmile applied the proportionate universalism approach, recognising the need for both universal and targeted components (Deas et al., 2013). Universal components of Childsmile include: oral hygiene instruction, dietary advice and six-monthly fluoride varnish applications in dental practice settings; free toothbrushes and fluoride toothpaste between birth and age of five; and supervised toothbrushing in all nurseries (Ross et al., 2023).

Targeted components of Childsmile are intended to provide additional support to more vulnerable sectors of the population; these include intensive dental care and oral health promotion delivered in dental practice settings; targeted support delivered by dental health support workers to families referred by health visitors, via home visits and/or telephone contacts, to support toothbrushing, facilitate child dental registration and attendance, and link to other community organisations where appropriate; fluoride varnish applications provided in targeted nurseries and primary schools; and supervised toothbrushing in targeted primary schools (Ross et al., 2023).

Prevention is central to addressing inequalities; the Christie Commission (Scottish Government, 2011) recommended a *"presumption in favour of prioritising preventative action"* (p. 57) in developing and delivering public services in Scotland, which advocates 'preventative spend' approaches to prioritise public expenditure on services preventing negative outcomes, in response to estimates that up to 40 percent of spending on public services goes towards interventions addressing preventable problems (Scottish Government, 2011, Anopa et al., 2015).

1.3.1 The role of partnership working between organisations

While prevention of poor health was traditionally within the remit of the National Health Service (NHS), it became apparent that actions to address wider social determinants contributing to health inequalities required input from a range of organisations (Marmot, 2010). The Scottish Government's (2008c) Early Years Framework highlighted the need for collaborative working, including between public, private and voluntary sectors, to deliver early years services; and the Christie Commission emphasised the need for effective joint-working between public service organisations in Scotland to achieve positive outcomes for the whole population (Scottish Government, 2011). More recently, the Scottish Government (2017b) stated that all organisations working with children should work collaboratively and *"across organisational boundaries"* (p. 5) to ensure optimal outcomes for children and young people.

The Scottish Executive's (2005a) *Action Plan for Improving Oral Health* highlighted that stakeholders involved in caring for children in any capacity, including local authorities and health services, were responsible for protecting and improving children's oral health. The Scottish Government's (2016g) updated Oral Health Action Plan continued to recognise the need for partnerships between stakeholders (including parents/carers, education staff and health and social care staff) to improve oral health outcomes. These messages have been taken on board by education partners in Scotland as one of the key priorities in the National Improvement Framework for Education in Scotland is improving children and young people's health and wellbeing (Scottish Government, 2017a), with the Scottish Government (2016e) highlighting the central role of children's health and wellbeing in enabling their progress in learning. Furthermore, the Curriculum for Excellence (the national curriculum for children and young people aged 3-18) incorporates learning on health and wellbeing (including oral health care) across the curriculum to ensure development of important life skills necessary to maximise wellbeing throughout the life course, which will in turn contribute to improved health and wellbeing outcomes for subsequent generations of children in Scotland (Scottish Government, 2008a, Education Scotland, 2017a).

1.4 Addressing dental caries in children in Scotland

1.4.1 Establishing the Childsmile programme

Childsmile was established in 2006 to address poor oral health among children in Scotland following the publication of *An Action Plan for Improving Oral Health and Modernising Dental Services in Scotland* (Scottish Executive, 2005a). Childsmile is Scotland's national programme for child oral health improvement, utilising preventive approaches to improve children's oral health and reduce inequalities in oral health and access to dental services (Macpherson et al., 2010a, Deas et al., 2013). It was piloted from 2006 with two demonstration projects (one in East of Scotland, to deliver nursery- and school-based clinical prevention activities aimed at children aged three years and over; and the other in West of Scotland, which targeted children from birth to promote oral health

improvement and caries prevention through dental practices and community settings) (Macpherson et al., 2010a).

The programme was then rolled out nationally to all 14 geographic NHS boards by 2011 (Macpherson et al., 2019b). As described in Section 1.3, the integrated Childsmile programme is comprised of components delivered at upstream, midstream and downstream levels and includes both universal components (e.g. provision of free toothbrushes and fluoride toothpaste between birth and age of five; oral hygiene instruction, dietary advice and six-monthly fluoride varnish applications in dental practice settings; and the nursery supervised toothbrushing programme); and targeted components (e.g. intensive dental care delivered via dental practices; targeted support for families focused on toothbrushing and dietary advice, child dental registration and attendance and linking to other support in the community, delivered by dental health support workers; fluoride varnish applications delivered by extended duties dental nurses to children attending targeted nurseries and primary schools; and supervised toothbrushing for children attending Primary One and Primary Two classes in schools in socioeconomically disadvantaged areas (Macpherson et al., 2010a, Macpherson et al., 2019b, Ross et al. 2023). Programme policy and decision-making is overseen by the Childsmile Executive committee, comprising two programme directors and two programme managers. Childsmile coordinators based in each geographic health board are responsible for local planning and delivery of the programme; and each health board employs dental health support workers and extended duties dental nurses to deliver programme components (Eaves and Gnich, 2013).

1.4.2 Childsmile nursery supervised toothbrushing programme

Through Childsmile, it is intended that every child (in their ante-pre-school and pre-school years) accesses free, daily supervised toothbrushing in nursery (Childsmile, 2016b), with the rationale that regular use of fluoride toothpaste prevents dental caries (Childsmile, 2019) and programme stakeholders have highlighted that the programme establishes oral hygiene routines among children from an early age (Eaves and Gnich, 2013).

Nursery toothbrushing programmes operated in several health boards in Scotland prior to the establishment of Childsmile, in some cases for several decades, with varying numbers of nurseries taking part (Childsmile Central Evaluaton and Research Team, 2010, Macpherson et al., 2013, Macpherson et al., 2019b) and with variations in practice given that they were developed locally (Anopa et al., 2015). The Scottish Executive funded a national, standardised nursery toothbrushing programme in 2001/02, which was incorporated into the integrated Childsmile programme in 2011.

National Standards for Nursery and School Toothbrushing Programmes (henceforth 'Toothbrushing Standards') were developed initially in 2005 to set out requirements for organisation, effective preventive practice, and prevention and control of infection for all nurseries and primary schools delivering the toothbrushing programme. The Toothbrushing Standards are reviewed and updated periodically with wide consultation among dental professionals in Scotland as well as external partners including the Care Inspectorate, with the most recent iteration published in 2019 (version 4) (Childsmile, 2019).

The Toothbrushing Standards state that all nurseries should participate in the programme and that it is offered to all children, every day they attend the nursery, although this can take place at a time that suits each establishment and be done in groups or individually. Further points in the guidance included that each nursery should have a designated person responsible for the toothbrushing programme and that toothbrushing supervisors within nurseries (usually nursery staff) are trained in effective toothbrushing and infection prevention and control procedures. In terms of day-to-day delivery, children use toothbrushes and fluoride toothpaste supplied by Childsmile, using an appropriate amount of toothpaste depending on their age, and are supervised (usually by a member of nursery staff) while toothbrushing. Toothbrushes are stored and cleaned, and toothpaste dispensed, to minimise the risk of cross-contamination and infection. Local Childsmile teams are expected to provide support and guidance to nurseries, including visiting each establishment twice per year, to monitor delivery against the Toothbrushing Standards (Childsmile, 2019) although visits will take place more often where there are issues relating to an establishment's

delivery or if staff in the establishment require further support (Childsmile Central Evaluation and Research Team, 2017a). In the majority of health boards, Toothbrushing Standards monitoring visits are carried out by dental health support workers (lay workers employed in health boards to support delivery of various components of Childsmile, including the nursery supervised toothbrushing programme) although other staff, such as oral health educators, undertake monitoring visits in some areas (Childsmile Central Evaluation and Research Team, 2011).

1.4.3 National evaluation of Childsmile

The evaluation of Childsmile is undertaken by the Central Evaluation and Research Team at University of Glasgow's Community Oral Health Section with funding received for discrete studies and monitoring. The evaluation utilises a programme-theory approach (Macpherson et al., 2010a, Macpherson et al., 2019b, Ross et al., 2023). Programme theory, or 'Theory of Change', describes how an intervention is hypothesised to lead to outcomes, under particular conditions, setting out 'how' and 'why' a programme is thought to work and the links between programme activities, outcomes and context (Chen, 1990, Weiss, 1995, Donaldson and Lipsey, 2006) . For complex interventions, it is intended that the Theory of Change explains both why each individual programme component works and how those components work together within a larger system (Childsmile Central Evaluaton and Research Team, 2010).

Weiss (1995) noted that developing the Theory of Change prompts those involved in programmes (strategically and operationally) to discuss and agree what the programme is attempting to do and why; without this consensus, it is argued that participants' differing implicit theories may lead to divergent activities. It is thought that stakeholders' assumptions about how and why a programme works, which may relate to how to address the problem of interest or how activities contribute to outcomes), influences their decision-making (Nkwake and Morrow, 2016, Mertens, 2016).

Programme stakeholders have a central role in developing the Theory of Change, as this makes explicit what they hope to achieve, the actions that will be used to achieve this, and how these proposed actions are thought to reach the intended outcomes, as well as understanding the wider context within which the programme or intervention is operating (Mason and Barnes, 2007). Connell and Kubisch (1998) recommended that developing a Theory of Change starts with identifying the long-term outcomes a programme is intended to achieve; thereafter, working back to identify interim- and short-term outcomes, programme activities and inputs/resources. However the authors cautioned that it may be difficult to get stakeholders to identify the intended outcomes of their programme; and in some cases processes, rather than outcomes, dominate programmes' work (Connell and Kubisch, 1998).

The Theory of Change is often represented visually in a logic model to show the intended course from inputs/activities to outputs/outcomes which allows stakeholders to see clearly the intended rationale for a programme as well as making explicit the previously implicit assumptions (Renger and Titcomb, 2002). The Childsmile Central Evaluation and Research Team developed logic models showing Childsmile's Theory of Change, to uncover why programme stakeholders expected programme activities to lead to intended results, identify potential assumptions, and support the evaluation design (Childsmile Central Evaluaton and Research Team, 2010, Macpherson et al., 2019b). Those logic models were developed through reviewing programme documentation and existing knowledge of the programme (obtained through observing programme meetings and interacting with key stakeholders) to set out links between activities, outputs, and short-, interim and long-term outcomes and developed further through workshops with programme stakeholders (which included programme directors, managers, coordinators and consultants in dental public health from a range of Scottish health boards) in 2009. Final versions of the logic models were produced in November 2009. This process aimed to make stakeholders' assumptions explicit: that targeting and tailoring Childsmile's activities will reduce inequalities in oral health; that it is possible to re-orient dental services towards prevention; that delivering Childsmile's activities as planned will improve oral

health in children in Scotland; and that Childsmile activities can be delivered as intended in all areas (Childsmile Central Evaluaton and Research Team, 2010).

1.4.3.1 Process evaluation of Childsmile

As noted in Section 1.2.3.1, process evaluations are important components of public health programme evaluations, as these identify how contextual factors influence programme impacts, explore the mechanisms of change through which the programme works, and assess the fidelity of implementation of programme components, including whether it reaches its intended recipients (Moore et al., 2015, Fox et al., 2016, Rossi et al., 2019). This allows for ongoing programme improvement, as identifying areas not taking place as intended enables programme stakeholders to make adjustments to delivery (Green and South, 2006, Stufflebeam and Coryn, 2014). It also allows for observed outcomes to be attributed to the programme being evaluated or not (Oakley et al., 2006, Carroll et al., 2007).

Childsmile's embedded, theory-based evaluation incorporates an ongoing process evaluation, which gathers qualitative data on programme implementation, and barriers, facilitators and contextual factors impacting on implementation. These data are used to assess whether the programme is being delivered as intended and to identify variations from the intended model that may pose risks to achieving outcomes. These findings are shared regularly with programme stakeholders, to contribute to formative programme improvements (Childsmile Central Evaluation and Research Team, 2017a, Macpherson et al., 2019b, Ross et al., 2023).

1.4.3.2 Monitoring and evaluation of the Childsmile Nursery Supervised Toothbrushing Programme

Participating in the Childsmile nursery supervised toothbrushing programme is associated with reduced decay experience among children. In their ecological analysis of cross-sectional dental epidemiology surveys of five-year-old children in Scotland undertaken annually between 1987 and 2009 (via the National Dental

Inspection Programme), Macpherson et al. (2013) found that mean numbers of decayed, missing, or filled primary teeth (dmft) reduced by 0.99, from 3.06 at the programme's outset to 2.07 by years 10-12 of delivery (95% CI –1·08 to –0·90, p<0·0001) with the largest improvements seen for children living in the most deprived areas (numbers of decayed, missing or filled primary teeth reduced by 1.71, 95% CI –1·93 to –1·49; p<0·0001) compared with children from the least deprived areas (numbers of decayed, missing or filled primary teeth reduced by 0.43, 95% CI –0·60 to –0·25; p<0·0001) (Macpherson et al., 2013, Anopa et al., 2014).

Anopa et al. (2015) undertook a cost analysis of the Childsmile nursery supervised toothbrushing programme which used the estimated cost of dental treatment for decayed, filled or extracted primary teeth to evaluate the cost-savings of prevented numbers of children experiencing decayed, missing or filled teeth (obtained via annual National Dental Inspection Programme P1 data). This found that the programme was associated with significant cost savings for prevented NHS dental treatments (e.g. extractions and fillings): £4.7 million in 2009, which equated to 54% of programme costs at the outset.

A large-scale data linkage cohort study was undertaken as part of the evaluation of Childsmile which involved linking individual, child-level data for a cohort of 50,379 children attending P1 classes in the 2014/2015 school year (aged between four- and six-years-old) on participation in various interventions delivered through Childsmile with caries experience (gathered through the National Dental Inspection Programme) (Kidd, 2019, Kidd et al., 2020). This included using data recorded on individual parental consent for children's participation as a proxy measure for participating in the toothbrushing programme. It was found that children defined as participating in the programme for two or more years had lower odds of experiencing dental caries compared with children who were not consented to participate (adjusted odds ratio 0.60; 95% CI 0.55 to 0.66).

Kidd et al. (2020) also found that participating in the nursery supervised toothbrushing programme was most effective for children living in the most deprived areas: the adjusted odds ratio of experiencing caries among children

residing in the most deprived fifth of the population, participating in the programme for more than three years, was 0.49 (95% CI 0.39 to 0.60) versus those who did not participate; while the adjusted odds ratio for children from the least deprived population fifth participating for more than three years was 0.70 (95% CI 0.56 to 0.88) compared with those not participating. This demonstrates that the nursery supervised toothbrushing programme has the potential to address oral health inequalities among children in Scotland. While it is provided universally to all nurseries regardless of area-based deprivation, this finding indicates that there are gains to be achieved with additional effort to improve implementation of the programme in nurseries in the most deprived areas in Scotland, particularly when it is has been found that children living in the most deprived areas in Scotland reported brushing less frequently than those in the least deprived areas (Masson et al., 2010); and that parents/carers living in areas of socioeconomic deprivation report barriers to undertaking regular supervised brushing with their children (Marshman et al., 2016).

Evidence from both ecological- and individual-level studies indicates that the Childsmile nursery supervised toothbrushing programme is associated with reductions in caries among five-year-olds in Scotland, with indications that these reductions are greater among those from more deprived areas. However, there were some limitations associated with those studies. For example, while Kidd et al. (2020) used individual, child-level data, this used consent for toothbrushing (which is collected once per child) as a proxy for participation, which does not indicate the extent to which toothbrushing was delivered consistently in individual nurseries; furthermore, the study reported analysis of data from one year only. Anopa et al. (2015) acknowledged that they were unable to access reliable historical data on children aged five years and under with teeth extracted under general anaesthetic, therefore made assumptions based on numbers of missing teeth from National Dental Inspection Programme data on extraction methods (and associated costs). The authors also made assumptions about the rate of roll-out and participation among nurseries across Scotland, which may not have reflected reality in terms of day-to-day delivery of the programme in individual nurseries. Indeed, data from the Childsmile process evaluation indicate that not all nurseries take part in the supervised

toothbrushing programme and not all children have the opportunity to participate in toothbrushing every day; having consent to participate does not guarantee that children actually participated therefore the extent to which every child received the intervention as intended is not known (Eaves and Gnich, 2013, Childsmile Central Evaluation and Research Team, 2017a). Stakeholders involved in developing Childsmile have commented that local differences in implementation risked moving away from a shared vision for the programme (Deas et al., 2013) which may lead to sub-optimal delivery and implementation of the nursery supervised toothbrushing programme in some areas. This doctoral research will focus on reviewing and optimising implementation of the nursery supervised toothbrushing programme, to maximise its contribution to improving children's oral health and reducing inequalities.

1.5 Covid-19 pandemic

The Covid-19 pandemic disrupted delivery of Childsmile's supervised toothbrushing programmes in nurseries and schools, with no toothbrushing taking place for several months due to two periods of educational establishment closures throughout Scotland between March 2020 and February 2021. Table 1 sets out key developments during the Covid-19 pandemic in Scotland impacting on supervised toothbrushing programmes in nurseries and schools.

Table 1 Timeline of Covid-19 pandemic developments relating to supervised toothbrushing programmes in nurseries and schools

Dates	Developments
1 March 2020	First case of Covid-19 in Scotland confirmed
11 March 2020	WHO declares global pandemic
17 March 2020	Chief Dental Officer for Scotland's letter to health boards; includes advice to continue delivering supervised toothbrushing programme in nurseries and schools
23 March 2020	Nurseries and schools throughout Scotland are closed; supervised toothbrushing programme is suspended at this time.
15 July 2020	Childcare services in Scotland are allowed to reopen
30 July 2020	First version of the Covid-19 Interim Childsmile Toothbrushing Standards in Nursery and School (known as the 'Toothbrushing Standards addendum') was published

	and shared with health boards
11 August 2020	Schools reopen
w/c 21 December 2020	Nurseries and schools throughout Scotland are closed; supervised toothbrushing programme is suspended again
22 February 2021	Nurseries and schools (Primaries one to three only) reopen
15 March 2021	All other pupils return to school
August 2021	Version two of the Covid-19 Interim Childsmile Toothbrushing Standards in Nursery and School (known as the 'Toothbrushing Standards addendum') was published and shared with health boards

World Health Organization (2020) declared COVID-19 a global pandemic on 11 March 2020, with community transmission of the virus identified in Scotland in mid-March, prompting Scottish Government advice on 17 March 2020 that non-essential social contact should cease (Scottish Government, 2020d). The Chief Dental Officer for Scotland wrote to health boards on 17 March 2020 to advise that toothbrushing in nurseries and schools should continue at that time (although other national oral health programmes, including fluoride varnish applications in nurseries and schools and home visits delivered by Childsmile staff, were suspended) (Scottish Government, 2020a). The First Minister then announced that all nurseries and schools in Scotland would close from 23 March 2020, resulting in the supervised toothbrushing programmes in nurseries and schools being suspended (Scottish Government, 2020c).

Nurseries and schools remained closed for five months during 2020, until the Scottish Government announced that childcare providers would reopen from 15 July 2020 and schools would reopen on 11 August 2020 (Scottish Government, 2020e, Scottish Government, 2020f). Scottish Government guidance on reopening nurseries and schools encouraged resumption of preventive programmes such as Childsmile when possible (Scottish Government, 2020e). The Childsmile Executive published guidance to support the re-introduction of supervised toothbrushing programmes in nurseries and schools in July 2020 (known as the 'Toothbrushing Standards addendum'), developed in consultation with national partners (including the Chief Dental Officer for Scotland, Care Inspectorate and Health Protection Scotland). The first version of the addendum

stipulated that toothbrushing should not take place at sinks and children should dispose of excess toothpaste by spitting into tissues or paper towels (known as ‘dry brushing’ or ‘Model B’) (Childsmile, 2020). This was amended in the second version of the addendum, published in August 2021, to include both ‘wet’ (at sink) and ‘dry’ (away from sink) models, following consultation with partners in Public Health Scotland’s ‘Covid-19 guidance cell’ (established since the first version of the Toothbrushing Standards addendum was developed). There were also concessions made in relation to nursery staff supporting and assisting children while toothbrushing.

Educational establishments remained open until the end of term in December 2020, when the Scottish Government announced that nurseries and schools would close again with the start of the new school term delayed in response to rising incidence of Covid-19 in the population (Scottish Government, 2020b). The supervised toothbrushing programme was suspended again for two months, until children returned to nurseries and Primary one to three classes from 22 February 2021 (older children returned to school from 15 March 2021) (Scottish Government, 2021a, Scottish Parliament Information Centre, 2021).

1.6 Chapter summary

This chapter has established that dental caries affects children throughout the world and that while rates of childhood dental caries have reduced in Scotland in recent years, there remain large numbers of children experiencing dental caries (with 26.5% of children in P1 identified to have caries via the National Dental Inspection Programme carried out in 2020), with a persistent gradient across the social strata. A range of studies evaluating supervised toothbrushing interventions taking place in nursery and school settings were identified, many of which reported a positive effect of participating in these interventions on children’s caries experience; however, the quality of these studies was varied. There was also a range of ongoing public health programmes delivering supervised toothbrushing interventions identified, taking place in UK countries and in the rest of the world. However there were limited examples of these programmes having embedded evaluations and none appeared to follow the

Medical Research Council guidance for developing and evaluating complex interventions.

This chapter has identified that Childsmile is a theory-driven programme, incorporating a nursery-and school-based supervised toothbrushing component, which was developed to address the issue of poor oral health and inequalities among children in Scotland. Finally, the strong evidence that the supervised toothbrushing component of Childsmile is effective in preventing dental caries among children, addresses oral health inequalities and achieves cost savings in prevented dental treatments was highlighted. However, process evaluation data has indicated that the programme is not delivered as intended in all areas, as some nurseries do not participate and not all children have the opportunity to participate in toothbrushing every day. The extent to which every child received the intervention as intended is not known, as having consent to participate does not guarantee that children actually brushed their teeth in nursery. This highlights the need for this doctoral research to optimise delivery of the nursery supervised toothbrushing programme, particularly in light of the disruption caused by the Covid-19 pandemic, and maximise the gains for children's oral health in Scotland.

2 Research aims and methodology

This chapter describes the aims, objectives and research questions for this thesis; and sets out the methodology employed. As will be outlined below, the aims for this research are aligned with 'real world' objectives, to identify how the nursery supervised toothbrushing programme was intended to be delivered, assess whether it was being delivered as intended, and to uncover barriers and facilitators to its delivery, to inform recommendations to optimise programme delivery. Accordingly, the methodology is informed by pragmatism, which is recommended for mixed-methods studies (Johnson and Onwuegbuzie, 2004) and sets aside the search for universal truth (which underpins traditional summative designs) and aims to gain understanding that is sufficient and necessary to solve problems (Dewey, 1988). In simple terms methods were selected based on their suitability for answering the research questions (Kaushik and Walsh, 2019), namely a mixed methods approach with a) qualitative methods used to answer research questions requiring detailed descriptions of processes or focused on participants' experiences and perspectives on challenges and facilitators to delivery, complemented by b) quantitative methods to support descriptions of programme delivery. The overarching pragmatic approach, and the pragmatic constructivist approach to qualitative data collection and analysis, is described further in this chapter.

This research is also concerned with the processes involved in the implementation of the nursery supervised toothbrushing programme, therefore this chapter also sets out the approach used to select and apply the theoretical implementation framework, the Consolidated Framework for Implementation Research (CFIR) (Damschroder et al., 2009), which was used to elucidate factors associated with whether or not the nursery supervised toothbrushing programme was delivered as intended in the real work.

2.1 Aims & Objectives

The overarching aim of this research was to optimise delivery of the nursery supervised toothbrushing programme in Scotland (forming part of Childsmile, Scotland's national oral health programme for children).

This aim is supported by the following objectives and associated research questions.

2.1.1 Objectives and Research Questions

Objective one: To explore and agree the intended model of delivery for the nursery supervised toothbrushing programme with key stakeholders, through further explication of the Theory of Change of this component; to depict this in a logic model.

Research questions associated with objective one are:

1. What is the Theory of Change for Childsmile's nursery supervised toothbrushing programme?

    a. What do strategic programme stakeholders understand to be the intended activities, outputs, outcomes, the causal linkages between them, and the overall Theory of Change for Childsmile's nursery supervised toothbrushing programme?

    b. Has the Theory of Change for Childsmile's nursery supervised toothbrushing programme been developed sufficiently? (i.e. are there any additions or changes required to fully represent the Theory of Change?)

    c. Does the Theory of Change reflect ongoing and future developments within the programme?

Objective two: To assess the fidelity of implementation of the nursery supervised toothbrushing programme in reality, in comparison with the intended model developed and agreed with programme stakeholders.

Research questions associated with objective two are:

2. Does delivery of the nursery supervised toothbrushing programme in reality match the intended model (as depicted in the logic model developed and agreed with programme stakeholders)?

    a. Which nursery characteristics are associated with 100% of children brushing?

    b. How did delivery of the toothbrushing programme in reality differ from the intended model in the period: prior to the Covid-19 pandemic (i.e. before March 2020); and during the Covid-19 pandemic (i.e. since March 2020)?

Objective three: To identify and categorise the main barriers and facilitators influencing whether the nursery supervised toothbrushing programme is delivered as intended; and identify appropriate implementation strategies to optimise programme delivery.

Research questions associated with objective three are:

3. What are the main barriers and facilitators to implementing the nursery supervised toothbrushing programme as intended?

    a. Using an appropriate theoretical implementation framework, which factors are relevant in understanding the implementation of the nursery supervised toothbrushing programme?

    b. How can the barriers and facilitators identified be used to select implementation strategies to optimise programme delivery?

2.2 Methodology

2.2.1 Developing and evaluating complex interventions

This research is aligned with the UK Medical Research Council's framework for developing and evaluating complex interventions, shown in Figure 3, specifically the implementation phase. In common with each of the phases shown in Figure 3, investigating the implementation of complex interventions using the framework involves developing and refining the programme theory underpinning the intervention, exploring how the intervention interacts with its context, incorporating stakeholders' views and identifying 'uncertainties' requiring further investigation, leading to refining and improving the intervention.

This doctoral research will develop and refine the Theory of Change for the nursery supervised toothbrushing programme and then investigate how it is implemented, incorporating a range of stakeholders' views, taking into account how contextual factors influence programme delivery. This will lead to recommendations to address barriers uncovered, to optimise programme delivery, as well as suggest further research to address any uncertainties identified.

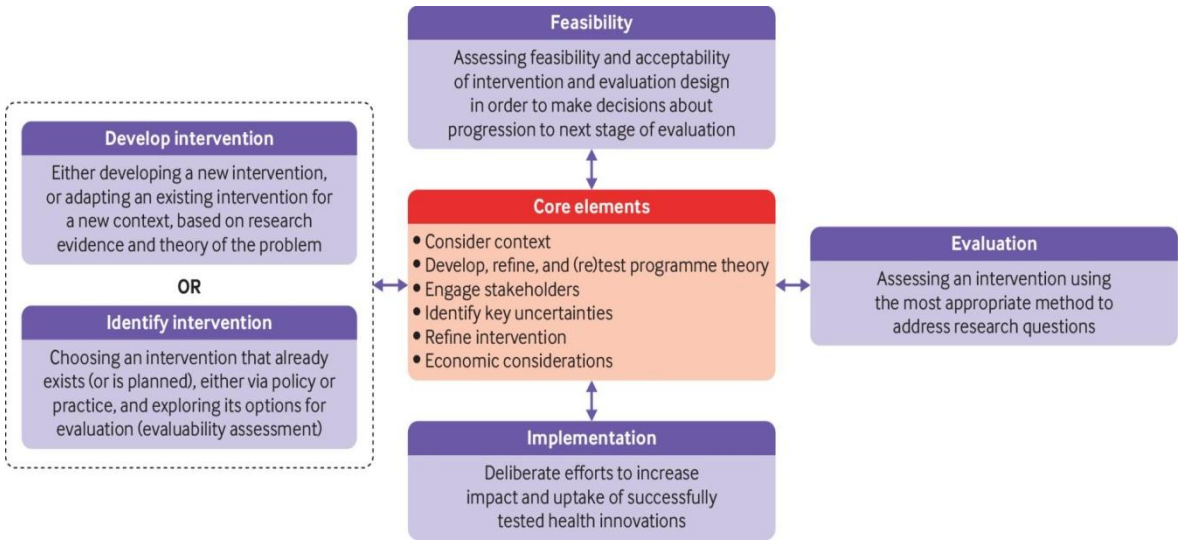

Figure 3 Medical Research Council Framework for Developing and Evaluating Complex Interventions (Adapted from Skivington et al. (2021) A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. *British Medical Journal*, 374, n2061. Published and distributed under Creative Commons CC BY 4.0 license.)

2.2.2 Pragmatism

The overarching aim for this research is to gather practical, real-world findings to improve delivery of Childsmile's nursery supervised toothbrushing programme. To this end, the research is framed within the paradigm of pragmatism, which prioritises research questions of interest instead of any specific philosophical assumptions underpinning particular ontological or epistemological stances (Biesta, 2010). Research informed by pragmatism is characterised as being outcome-oriented and concerned with creating practical solutions to social problems, with the research question central to the selection of methods (Shannon-Baker, 2016).

Pragmatism puts forward the perspective that knowledge is generated through the experiences, actions and consequences of those actions arising from the ongoing interaction between individuals' minds and the world (Denzin, 2012, Hall, 2013, Morgan, 2014b) with each individual's experience considered equally real. Pragmatism also posits that 'truth' is not absolute, but is relative to the context or situation at that time (McCaslin, 2008); an individual's particular circumstances and the context in which they operate influence what they place value on, which is not static but may change according to new experiences at any given time (James, 1879, Dewey, 1908, Ormerod, 2006). It is therefore noted that pragmatism requires awareness of the range of perspectives and opinions that exist and consideration of how those impact on the 'problem' being investigated (Wills and Lake, 2020).

Wills and Lake (2020) assert that pragmatism is concerned with practical, applied 'problem-solving' in everyday life and requires those affected by an identified 'problem' to be involved in its definition and identifying priorities for action, according to their own experiences. This means that developing and applying research questions and methods is "guided by the problematic situation and the need to resolve the problem at hand" (Wills and Lake, 2020, p30), utilising knowledge from all disciplines as relevant to the research question of interest (Webb, 2007), rather than "appealing to a generalised set of abstract principles" (Ormerod, 2006, p.905). This focus on applied research and creating

‘useful’ knowledge allows for research methods to be selected to best meet the needs of the research (Long et al., 2018, Kaushik and Walsh, 2019).

Outcomes resulting from pragmatic inquiry are relevant to the situation in which actions were undertaken; while those outcomes may be useful for guiding observations in similar situations, pragmatism cautions against assuming that the outcome from one situation can be generalised to all similar situations, across time (Biesta, 2010, Morgan, 2014b). Indeed it is noted that pragmatic inquiry is not concerned with establishing universal truths, as these are dependent on individuals’ interactions with an ever-changing environment (Hall, 2013). It is therefore concerned with creating and refining knowledge, based on further experience and dependent on context, with importance place on challenging and further evaluating knowledge, based on individuals’ experiences at different points in time (Ormerod, 2006, Webb, 2007, Prasad, 2021).

2.2.2.1 Pragmatic constructivism

Within the overall approach of pragmatism guiding this research, qualitative aspects of data collection and analysis were informed by pragmatic constructivism.

The constructivist paradigm rejects the positivist idea that there is an external, objective reality, distinct from knowledge of that reality (Costantino, 2008); instead, constructivism propounds that a) knowledge is constructed by humans as a result of their experiences and interactions within the world, and b) the ‘real’ world is simply what we know it to be (Gordon, 2009). This means that knowledge is shaped by individuals’ perspectives and experiences, including those of the researcher, therefore it is not value-free (Gordon, 2009).

Various authors have highlighted links between pragmatism and constructivism, most prominently the importance placed on individuals’ experiences and their responses to those experiences (e.g. Reich and Neubert, 2009, McWilliams, 2016). For example, both pragmatism and constructivism posit that, through active participation in events, participants obtain deeper understanding of

processes and rules involved in those events (Gordon, 2009, Neubert and Reich, 2006). Pragmatic constructivist inquiry is therefore concerned with understanding events in terms of the contexts in which they occur and the conditions present that influence those events (McWilliams, 2016) and is open to multiple perspectives that lead to various interpretations and meanings given to events (Reich and Neubert, 2009).

2.2.3 Identifying appropriate methods: mixed methods approach

Following the pragmatist approach, which welcomes multiple perspectives to inform knowledge creation (Reich and Neubert, 2009), the methods selected for this research were chosen to complement one another in answering the research questions (Christensen, 2022). Johnson and Onwuegbuzie (2004, p.17) term this a 'needs-based' approach to methods selection. The aim of this research is to optimise delivery of Childsmile's nursery supervised toothbrushing programme. Taking this aim and the research objectives as a starting point, a mixed methods design was selected: qualitative methods were identified as most appropriate to answer all three research questions, with quantitative methods also utilised in relation to research question two (to support the assessment of programme delivery in reality, by quantifying participation in the programme).

Quantitative and qualitative research methods are complementary as they allow phenomena to be explored from different perspectives (Bower and Scambler, 2007). For example, qualitative research aids interpretation of quantitative research findings (Pope and Mays, 2006, Doyle et al., 2016); within this research, qualitative research complemented the quantitative data collected, to help understand the data recorded on nurseries' participation in the programme. Triangulating data obtained through both quantitative and qualitative methods allows for a broader scope of complementary evidence to be considered in answering research questions (Shannon-Baker, 2016, Shorten and Smith, 2017), providing a more comprehensive understanding of the subject being investigated (Flick, 2016, Doyle et al., 2016). It allows for the strengths of both qualitative and quantitative approaches to be combined, to optimise the methods used to meet a given study's research objectives and ensure that key findings are not

missed if only a single approach was used (Johnson and Onwuegbuzie, 2004, O'Cathain, 2010, Condon and Coulson, 2017). This 'holistic triangulation' (Turner et al., 2016) goes beyond the traditional conception of triangulation for the purpose of convergent validation of findings, to provide additional coverage leading to more holistic understanding of the phenomena being studied, than would be achieved through a single method (Jick, 1979, Heale and Forbes, 2014, Morgan, 2014, Flick, 2018). In this research, holistic triangulation was used to integrate quantitative data (gathered to quantify nurseries' participation in the programme) with qualitative data (collected to elucidate stakeholders' perceptions about the nursery supervised toothbrushing programme) to delivery), to provide a fuller picture of programme delivery which would enable recommendations for optimising the programme to be identified.

Detailed descriptions of the methods used are provided in Chapters 3, 4 and 5; the following section outlines the rationale for the methods used.

2.2.3.1 Qualitative research methods

Qualitative methods allow social phenomena to be explored via participants' experiences and the meanings they ascribe to those experiences, within their 'natural', everyday settings (Pope and Mays, 1995, Pope and Mays, 2006, Castleberry and Nolen, 2018). The aim is to understand how people make sense of and interpret their experience within the world, while recognising the importance of context in interpretations; as knowledge is derived from individuals' experiences, it is open to multiple versions of 'truth' (Ravitch, 2020). This entails researchers engaging with individuals in their natural contexts through fieldwork, which enables the complex processes and meanings involved in individuals' experiences to be described and analysed, to uncover how individuals make sense of their experience and how these relate to the wider social context in which they take place (Pope and Mays, 1995, Ravitch, 2020). An example would be to uncover detailed descriptions of aspects of service delivery which influence participants' experiences or perceptions that may be otherwise overlooked (Bourgeault et al., 2010). This involves interacting with individuals, using procedures such as interviewing and observation, to gain understanding

about the meaning and significance of particular phenomena in a given social context (Morgan, 2014a, Sullivan, 2019).

Qualitative approaches were deemed most suitable to answer the research questions posed for this work, as gaining understanding of the views, experiences and interpretations of individuals involved in programme planning and delivery were central to: identifying the Theory of Change for the nursery supervised toothbrushing programme; assessing the extent to which delivery-in-reality took place as intended; and identifying barriers and facilitators to delivering the programme as intended. Furthermore, the interpretive, inductive approach of qualitative research, to identify and develop insights emerging from data as it is gathered (Ravitch, 2020), fits with developing and agreeing the toothbrushing programme's Theory of Change (described in Chapter 4) which was developed iteratively through several stages of fieldwork with participants.

2.2.3.2 Qualitative data analysis

Analysing qualitative data requires interrogation and critical thinking, to reach meaningful interpretation that is relevant to the research question (Bazeley, 2020). To this end, qualitative data gathered for this research were analysed using the Thematic Analysis approach, as described by Braun and Clarke (2006). Thematic Analysis is appropriate for research questions related to understanding participants' experiences, perspectives, motivations and behaviours within particular contexts (Kiger and Varpio, 2020, Braun and Clarke, 2022).

Thematic Analysis provides a flexible approach to analyzing qualitative data. At its core the approach is concerned with identifying themes across a dataset; Braun and Clarke (2019, 2022) define themes as analytic outputs developed from coding data which represent shared patterns of meaning. Themes may contain manifest content (i.e. that is directly observable) or latent content (i.e. implicit concepts or assumptions underpinning the overt content of the data) (Joffe, 2011, Braun and Clarke). Additionally, themes may be constructed deductively, from theoretical concepts brought by the researcher to the research; or inductively, from the data itself with no preconceived ideas brought by the

researcher (Joffe, 2011, Kiger and Varpio, 2020, Braun and Clarke, 2021). More deductive approaches to thematic analysis include template analysis (Brooks et al., 2015, Ramani and Mann, 2016) which specifically allows interpretation of qualitative data using a priori themes (the 'template') to guide coding while still allowing flexibility and thus for new subthemes to emerge (King and Brooks, 2017). Joffe (2011) advocates using both deductive and inductive approaches to constructing themes to allow for themes to meet the requirements to answer the research question as well as remaining open to new concepts apparent from the data.

Thematic Analysis fits within the pragmatic constructivism approach guiding the qualitative aspects of this research, as it also places importance on the contextually-bound nature of interpreting data (Braun and Clarke, 2019) as well as recognizing that the knowledge and experiences brought by the researcher will inform the codes and themes that are created (Terry et al., 2017). Indeed, Braun and Clarke (2016, 2019) conceptualise themes as being actively created by the researcher, through their interpretation of the data, rather than themes already being present within the data waiting to be discovered; this aligns with the view within pragmatic constructivism that knowledge does not simply 'exist' but is constructed by individuals through their interactions with the world (Gordon, 2009). While Thematic Analysis is not aligned to any particular theoretical or epistemological approach (Joffe, 2011), Braun and Clarke (2021) describe the approach as being theoretically flexible, but not 'atheoretical', and researchers should be aware of the theoretical and epistemological assumptions they bring to interpreting the data (Braun et al., 2022).

Braun and Clarke (2006) set out six stages for carrying out Thematic Analysis, which has been further described and expanded on by other authors, including Joffe (2011), Terry et al. (2017) and Kiger and Varpio (2020). These stages are not intended to be carried out in a linear process, but requires researchers to work iteratively, going between stages as necessary (Braun and Clarke, 2006, Byrne, 2022).

The initial stage involves thorough familiarization with all qualitative data collected (i.e. through repeated reading) to be able to develop and apply codes to the data, and to observe and recognise patterns within the data. The next step entails developing a coding frame, using deductive and inductive codes, to categorise data according to the initial themes, which is then applied to the whole dataset. Coding is described as the systematic formation of labels to be attached to segments of the data (Terry et al., 2017) and it is recognised that the coding process is iterative and requires ongoing revision.

The next stage involves developing candidate themes by examining the coded data closely, looking at the relationships between codes, to develop the 'story' told by the data. This involves the researcher making choices about which segments of data are salient, in relation to the research question. Candidate themes are then reviewed to check if each has sufficient, coherent supporting data and if the themes reflect the whole dataset adequately; themes may be further clarified or refined, or rejected, based on this stage. The final stages involve defining and describing the themes; and reporting the analysis using narrative descriptions and representative data extracts to illustrate the themes and explain how the analysis answers the research question. The analysis includes examining the prevalence, inter-connections, similarities and differences between themes (Joffe, 2011, Kiger and Varpio, 2020), although the frequency of a theme appearing within data is not equated with importance, as themes that are central to the research question may arise from data gathered from a small number of participants (Braun and Clarke, 2022). Further description of how the Thematic Analysis approach was applied to analysing qualitative data collected for this research is provided in the relevant results chapters.

2.2.3.3 Theoretical sufficiency

This research used the concept of 'theoretical sufficiency' (instead of 'saturation') to ensure rigour in the collection and analysis of qualitative data (Vasileiou et al., 2018, Ladonna et al., 2021, Braun and Clarke, 2022). 'Saturation' is often used as a criterion to assess the rigour of qualitative data collection and analysis within the literature (Guest et al., 2006, Harding, 2018,

Schreier, 2018, Hennink and Kaiser, 2022). Saturation is usually defined as the point at which no new information is gleaned from additional data collection, in terms of emergent codes and themes (Guest et al., 2006, Booth et al., 2007, Francis et al., 2010). However, conceptualising saturation as reaching 'completeness' in data collection and analysis has been criticised within the literature, as it is posited that further theoretical insights can always be made with continued data collection and analysis (Nelson, 2016, Low, 2019, Tight, 2023).

Theoretical sufficiency is based on whether the data collected and analysed provide the researcher with an adequate account of the topic being investigated, to be able to meet the aims of a given research study (Vasileiou et al., 2018, Braun and Clarke, 2022). Based on the aims of this study, theoretical sufficiency was met, as the principal researcher obtained sufficient understanding of the purposively selected strategic stakeholders' perspectives on the programme's Theory of Change. Furthermore, including participants from all geographic health boards in Scotland and exploring with them their experiences in implementing all activities included in the nursery supervised toothbrushing programme logic model allowed the principal researcher to gain sufficient understanding of the local contextual factors influencing programme delivery, thus reaching theoretical sufficiency in assessing fidelity of programme delivery in reality and identifying barriers and facilitators affecting delivery.

2.2.3.4 Quantitative research methods

To complement the qualitative approach utilised to answer research question two, concerned with assessing extent to which the nursery supervised toothbrushing was being delivered as per the Theory of Change (reported in Chapter 4), a survey was used to quantify participation in the programme. Quantitative data captured via the survey were categorised to describe nurseries' characteristics, including: percentage of children brushing on the day of the survey; type (e.g. operated by the local authority or private sector); size (based on numbers of children attending); range of age groups attending; area-based deprivation; and health board location. Descriptive statistics calculated

for these data included simple tabulations and frequencies to provide an overview of numbers of nurseries and children participating in the toothbrushing programme. Further inferential statistical analyses were undertaking using cross-tabulations and Chi-Squared Tests of Independence, to investigate associations between nursery characteristics and rates of toothbrushing taking place. All quantitative data analysis was carried out using IBM SPSS (version 28).

These data were triangulated with the qualitative data gathered to provide a holistic assessment, with a view to providing a more complete understanding of the phenomena under investigation (that is, delivery of the nursery supervised toothbrushing programme, in reality) (Bryman, 2006, Denzin, 2012, Mertens and Hesse-Biber, 2012).

2.2.4 Investigating implementation

This research is concerned with the implementation of the nursery supervised toothbrushing programme, in terms of the fidelity of its implementation as well as identifying barriers and facilitators to its implementation. This requires an appropriate implementation research framework to be selected to guide research into these areas.

Implementation research has grown as a dedicated area of interest in recent years in the medical sciences. Previously, researchers focused on generating evidence, with sparse attention given to translating research findings into practice, which was left to practitioners; however, evidence-based practice does not become routine spontaneously, but requires focused efforts (Bauer et al., 2015). While there has been a shift in focus towards the impact of research, limited resources are available to support continued use of evidence-based interventions over the longer term. However, without this support, it is unlikely that translating evidence into practice will be sustained (Bauer et al., 2015). For example, clinicians often have limited experience and knowledge of implementing evidence-based interventions into routine practice and strong evidence alone is not enough to change practice (Lynch et al., 2018).

The field of implementation science was developed to understand the factors associated with successful integration of interventions in various settings, to address the 'research-to-practice gap' (Huijg et al., 2014b, Rabin and Brownson, 2018). Nilsen (2015) characterises implementation as the process of putting new practices into use and integrating them into routine usage, with May (2013) highlighting the need to understand and evaluate the implementation of complex interventions in practice, to understand how to operationalise them in the 'real world'. Implementation science is also concerned with developing and applying implementation strategies, to overcome barriers and enhance facilitators identified to affect uptake and routine use of interventions (Bauer and Kirchner, 2020).

2.2.4.1 Theoretical implementation frameworks

Theories are intended to structure observation, understanding and explanation of the world via analytical principles and statements (Nilsen, 2015). A theory is defined as a proposed, meaningful relationship or interaction between constructs or variables (Bauer et al., 2015, Davidoff et al., 2015); that is, explaining how and why specific relationships lead to specific events (Nilsen, 2015).

Bauer et al.(2015) distinguished between theoretical models, which provide a simplified depiction of more complex world and set out assumptions about cause and effect, and frameworks, which are described as broad sets of constructs that organise concepts or data without specifying causal relationships. However Birken et al. (2018) suggested that both models and frameworks provided a 'checklist' of factors relevant to various aspects of implementation, with models useful for describing how research findings were translated into practice and frameworks used to identify the determinants of implementation. Additionally, Nilsen (2015) noted that the distinction between a theory and a model was not always clear; however, frameworks described empirical phenomena via a structured overview of various descriptive categories (e.g. concepts, variables or constructs) and relationships between them.

Utilising a theoretical framework to explore implementation is necessary, as without this theoretical underpinning it is difficult to understand and explain how and why implementation succeeds or fails, which limits opportunities to identify factors related to successful implementation (Nilsen, 2015). Theoretical approaches support translation of learning between projects and contexts (Davidoff et al., 2015) and provide cognitive tools to assist with planning and evaluating the process of implementing evidence into practice (Birken et al., 2017b, Birken et al., 2018, Lynch et al., 2018). Theoretical implementation frameworks may be used at various stages of research: prior to implementation (to inform the implementation strategy, identify potential barriers, and engage relevant stakeholders); during implementation (to support the initiation and embedding of new ways of working, and investigate the process of change); and after implementation, to evaluate and report on outcomes (Lynch et al., 2018). While the latter use described here is thought to be used most often, to retrospectively evaluate or interpret findings from completed implementation projects, Lynch et al. (2018) suggest missed opportunities in planning and guiding implementation using a theoretical approach.

2.2.4.2 Selecting a theoretical approach for implementation research

Identifying and selecting an appropriate theoretical approach in implementation research is recognised to be challenging, given the vast range of theories, models and frameworks available within implementation science (Nilsen, 2015, Birken et al., 2017b), which were developed for different purposes, using disparate methods and have diverging underlying assumptions (Lynch et al., 2018). There is little evidence available on the relative advantages of any specific approach in implementation research, and the disparate terminology used for various theoretical approaches in implementation research has contributed to challenges in selecting suitable approaches (Nilsen, 2015, Moullin et al., 2015). Birken et al. (2017b) posited that researchers selected implementation approaches based on convenience or their familiarity with particular approaches. It is also noted that implementation theories, models and frameworks do not provide an accurate representation of the complex systems within which implementation takes place (Damschroder, 2019). While several

authors have proposed strategies to support researchers' selection of theoretical approaches to implementation research (e.g. Tabak et al., 2012, Tabak et al., 2018, Lynch et al., 2018), Birken et al. (2017b) called for implementation researchers to provide transparent explanations of how and why they used particular theoretical frameworks, to encourage researchers to consider the suitability of a given approach, rather than defaulting to those that were convenient or familiar.

For the purposes of this research, reviews and commentaries on implementation theories and frameworks by Tabak et al. (2012), Flottorp et al. (2013), May (2013), Nilsen (2015) and Rabin and Brownson (2018) were used to identify four commonly used implementation frameworks and approaches which might be pertinent. These were: Tailored Implementation for Chronic Diseases (TICD) (Wensing et al., 2011, Wensing et al., 2014, Wensing, 2017); Promoting Action on Research Implementation in Health Services (PARIHS) (Kitson et al., 1998, Rycroft-Malone et al., 2002, Rycroft-Malone, 2004, Harvey and Kitson, 2016); Theoretical Domains Framework (TDF), and the Behaviour Change Wheel and COM-B model which are based on the TDF (Michie et al., 2005, Michie et al., 2011, Michie et al., 2014); and Consolidated Framework for Implementation Research (CFIR) (Damschroder et al., 2009).

Further information about each of these frameworks and approaches was gathered to assess their suitability for this research, including papers describing or critiquing the frameworks and a selection utilising the frameworks, to gain understanding of their application. These were identified using search terms shown in Table 27 (Appendix 3) and supplemented by identifying further papers written by the lead authors of the identified frameworks. Searches were carried out in the Implementation Science journal and the following databases: Applied Social Sciences Index & Abstracts; CINAHL; Medline; Proquest Public Health database; PsycARTICLES; Psychology and Behavioural Sciences Collection; PsycINFO; Sociological Abstracts.

2.2.4.3 Overview and critique of the candidate frameworks

1. Tailored Implementation for Chronic Diseases (TICD)

Tailored Implementation for Chronic Diseases provides a protocol for developing tailored implementation interventions to achieve changes in practice, based on the determinants (barriers and facilitators) of practice, with a view to tailoring interventions to local contexts (Wensing et al., 2011, Wensing, 2017). Determinants of practice relate to professionals' behaviours, organisational factors, patients' behaviours, social or political environmental factors, and may be modifiable or non-modifiable. Wensing et al. (2011) claimed it was unclear how best to identify determinants of practice or match those to implementation interventions, although it should be noted that both CFIR (Damschroder et al., 2009) and TDF/BCW (Michie et al., 2005, Michie et al., 2011) frameworks provide established methods for identifying factors influencing implementation and means for addressing those factors to improve implementation.

Tailored Implementation for Chronic Diseases was used to design and evaluate five tailored interventions (Aakhus et al., 2016, Goodfellow et al., 2016, van Lieshout et al., 2016, Jager et al., 2017, Wensing, 2017); however, none of the interventions were found to have any effect on outcomes. Goodfellow et al. (2016) suggested that further development of TICD was needed to ensure that interventions could be targeted at the most influential determinants of practice, with Wensing et al. (2017) highlighting the need for ongoing monitoring and adaptation of interventions, to address emerging needs. Given that the development of TICD is still ongoing and research utilising it has been limited to date, it appears that other approaches offered more robust methods for investigating implementation within this research.

2. Promoting Action on Research Implementation in Health Services (PARIHS)

Promoting Action on Research Implementation in Health Services is intended to explain or predict successful implementation of evidence into practice (Rycroft-Malone, 2010), focusing on the interaction between the nature of the evidence, the context (environment or setting in which practice occurs), and the method of facilitation, with context and facilitation given the same level of consideration as evidence when implementing evidence-based interventions (Kitson et al., 1998). Achieving successful implementation is more likely with

high quality evidence that matches professional consensus and patient needs; a context that is receptive to change (in terms of culture and leadership); and appropriate facilitation by skilled facilitators who support stakeholders to change attitudes, habits or skills, to challenge existing practices and develop new ways of working. (Rycroft-Malone et al., 2002, Harvey et al., 2002, Rycroft-Malone and Bucknall, 2010).

While its authors recommended using PARIHS to develop interventions and implementation strategies (Harvey and Kitson, 2016), there are limited examples of it being used formatively (Ullrich et al., 2014). It has been suggested that the components of PARIHS required greater conceptual clarity, as overlapping constructs might obscure identification of the main drivers in a given implementation effort (Helfrich et al., 2010, Ullrich et al., 2014). Promoting Action on Research Implementation in Health Services has been described as difficult to operationalise, with limited guidance on its application (Stetler et al., 2011, Ullrich et al., 2014). The role of 'facilitation' within the framework has been questioned, in terms of this activity being delivered by individuals, which did not reflect facets of implementation activities carried out by multiple actors across various settings (Helfrich et al., 2010). Other authors have noted that PARIHS lacked focus on the wider societal- or political-level influences on implementation (Tabak et al., 2012, Flottorp et al., 2013) and the role of individuals in implementing interventions (Rycroft-Malone et al., 2013).

A revised version of PARIHS was published, which recognised the role of external context and individual actors in implementation (Harvey and Kitson, 2016). Mekki et al. (2017) utilised this version to design, implement and evaluate an intervention and commented that while it was useful for these purposes, further consideration of the relationships and roles of stakeholders at different levels in organisations would help to understand how these influence those enacting interventions on-the-ground.

3. Theoretical Domains Framework (TDF); Behaviour Change Wheel (BCW); and Capability, Opportunity, Motivation – Behaviour (COM-B) model

The TDF encourages researchers to consider the range of theories and constructs relevant to behaviour change, by simplifying these into theoretical domains, with a view to assessing implementation and informing intervention design (Michie et al., 2005, Lynch et al., 2018). Michie et al. (2005) recognised that evidence-based guidelines were often not implemented effectively, and that previous implementation research was often not theory-based. To address this, the authors grouped similar constructs within psychological theories into domains, to facilitate researchers' assessment of behaviours to be changed to achieve implementation. Drawing on 33 psychological theories, 128 constructs were identified, which were grouped into 12 domains of similar constructs[2]. Cane et al. (2012) undertook an exercise to validate the TDF which increased the number of domains to 14, and removed 34 of the original constructs, with the remaining domains and constructs described as more defined and focused, providing comprehensive coverage of the range of factors influencing behaviour. The revised version of the TDF retained the nine of the original domains (Knowledge; Skills; Social/Professional Role & Identity; Beliefs about Capabilities; Beliefs about Consequences; Memory, Attention & Decision-Making Processes; Environmental Context & Resources; Social Influences; and Behavioural Regulation); added or amended five domains (Optimism; Reinforcement; Intentions; Goals; and Emotions) and removed the Nature of the Behaviour domain

Michie et al. (2011) built on the TDF by simplifying the domains into the COM-B ('Capability, Opportunity, Motivation – Behaviour') model. This states that, to perform a specific behaviour, individuals require the skills necessary for the task (capability); no environmental barriers that prevent the task being done (opportunity); and the intention to perform the task (motivation), with changes

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[2] (i) Knowledge; (ii) Skills; (iii) Social/Professional Role & Identity; (iv) Beliefs about Capabilities; (v) Beliefs about Consequences; (vi) Motivation & Goals; (vii) Memory, Attention & Decision-Making Processes; (viii) Environmental Context & Resources; (ix) Social Influences; (x) Emotion Regulation; (xi) Behavioural Regulation; and (xii) Nature of the Behaviour.

in behaviour influenced by changing one or more of these components. The authors also proposed the Behaviour Change Wheel (BCW) as a systematic method to design behaviour change interventions utilising the COM-B model (Michie et al., 2011, Michie et al., 2014). This entails understanding the behaviour in question to identify which behaviours need to change (via the COM-B model); and identifying options for the content and implementation of the intervention. Michie et al. (2014) identified nine 'intervention functions' that mapped to COM-B components, indicating which type of intervention was most suitable to address the behavioural component of interest; thereafter the authors proposed various behaviour change techniques to form the active components of the behaviour change interventions (Michie et al., 2013).

While TDF, COM-B and BCW have been cited in a range of studies investigating various aspects of behaviour change (Francis et al., 2012, Atkins et al., 2017, Gould et al., 2017), these are largely limited to identifying barriers and enablers to engaging in target behaviours (e.g. Duncan et al., 2012, Curran et al., 2013, Tavender et al., 2014, Gnich et al., 2018, Cassidy et al., 2019). There are fewer examples of the TDF, COM-B and BCW applied to designing and developing interventions (Cowdell and Dyson, 2019) and it has been recognised that these frameworks lack guidance on appropriate use or application to design interventions (Francis et al., 2012, Atkins et al., 2017). Where authors have developed interventions using these frameworks, these are often not operationalised, tested or evaluated (e.g. McSharry et al., 2016, Barker et al., 2018, Munir et al., 2018, Phillips et al., 2018); and Albarracin and Glasman (2016) noted that current evidence on the efficacy of behaviour change interventions developed using these approaches are limited. For example, while Ojo et al. (2019) identified a large number of potential behaviour change techniques to reduce sedentary behaviours in their study, these were not applied into a fully developed intervention. Craig et al. (2017) highlighted the need for further guidance on selecting behaviour change techniques and developing interventions, as their study (using the TDF to identify target behaviours, which were mapped to behaviour change techniques) relied on researcher and stakeholder opinion to select which behaviour change techniques to use. Similarly, Webb et al. (2016) found that developing an intervention using

the BCW was time-consuming and the number of potential behaviour change techniques overwhelming.

Several authors identified that the primary focus on individual-level determinants, with limited constructs focused at the collective or organisational level, was a limitation of the TDF, COM-B and BCW approach (French et al., 2012, Atkins et al., 2017, Birken et al., 2017a) . For example, Huijg et al. (2014a) highlighted that the TDF did not take into account factors related to intervention characteristics and delivery methods, setting or organisational context, implying that the framework did not elaborate factors outside those relating to individuals adequately.

While the TDF, COM-B and BCW attempt to make psychological behavioural theories more accessible and practical, oversimplifying theories might lose important nuances between them, when integrated into models (Teixeira, 2016). It is also suggested that the TDF, COM-B and BCW do not account for idiosyncratic, individual factors that intervene between intended and actual behaviours, which may explain why some behaviour change interventions have been found to be effective for only some people, some of the time (Ogden, 2016).

4. Consolidated Framework for Implementation Research (CFIR)

The CFIR was developed to address difficulties in translating evidence-based interventions into real-world contexts, following the recognition that existing implementation theories used different terminology and had overlapping or missing constructs (Damschroder et al., 2009). This involved identifying, reviewing and consolidating 19 theories (and their component constructs) related to translating research findings into practice, as well as proposing shared definitions for these. The CFIR builds on the PARIHS framework as its components of evidence, context and facilitation provided a basis to illuminate the core influences on implementation.

The CFIR consists of five domains: intervention characteristics; outer setting; inner setting; characteristics of individuals involved; and process of implementation. Each domain comprises a number of related constructs (shown in Table 2 below) to provide a common language for researchers to identify determinants of implementation (Kirk et al., 2016). Damschroder and Hagedorn (2011) described CFIR as an "*organising framework*" (p195) for knowledge and explanations about what works in relation to implementation, to support development of evidence-based implementation activities which fit the specific contexts into which implementation occurs.

Table 2 Consolidated Framework for Implementation Research: domains and constructs (Damschroder et al., 2009)

Domain	Constructs	
1: **Intervention Characteristics**	**a. Intervention source**	Was it developed internally or externally? Is this a legitimate source?
	b. Quality and strength of the evidence	Perceptions about the evidence for the intervention, which may come from multiple sources (e.g. anecdotal evidence from colleagues and patients' experiences, in addition to published literature).
	c. Relative advantage	Perceptions about the advantages of implementing the intervention versus an alternative solution.
	d. Adaptability	Can the intervention can be adapted to meet local needs (adaptable periphery) while retaining core components, which cannot be altered? (This is thought to be required to avoid poor fit with the setting and resistance from users.)
	e. Trialability	Can the intervention be tested on a small-scale (and implementation reversed, if required)?
	f. Complexity	Perceptions about the difficulty of implementation, such as whether it requires significant changes from existing practices.
	g. Quality of intervention design and packaging	How the intervention is packaged and presented.
	h. Cost of intervention	Including costs associated with implementation.

Domain	Constructs	
2: Inner Setting *(i.e. the structural, political, economic and cultural contexts into which implementation takes place)*	**a. Structural characteristics**	An organisation's social composition, age, size, decision-making structures & processes.
	b. Networks and communications	The nature and quality of social networks; formal and informal communications; links between individuals, units and teams; and whether there is a 'shared vision'.
	c. Culture	An organisation's norms, values and basic assumptions.
	d. Implementation climate	An organisation's capacity, receptiveness and support for change; There are six related sub-constructs: **i.** **tension for change**: do stakeholders perceive a pressing need for the intervention? **ii.** **compatibility**: does the intervention fit with stakeholders' own norms, values and existing work processes? **iii.** **relative priority**: shared perceptions that implementing the intervention is important**.** **iv.** **organisational incentives and rewards**: which may be extrinsic (e.g. awards) or less tangible (e.g. respect) **v.** **goals and feedback**: are these clearly communicated? **vi.** **learning climate**: do leaders seek staff's assistance and input? Do staff feel valued, able to try new methods have time for evaluation/reflection?
	e. Readiness for implementation	An organisation's commitment to implementing an intervention; There are three sub-constructs: **i.** **leadership engagement with implementation**

Domain	Constructs	
		ii. **available resources**: for implementation and ongoing delivery **iii.** **access to information and knowledge**: applicable, easy-to-use information about the intervention.
3: Outer Setting *(i.e. the economic, political and social context in which an organisation sits; this may overlap with the Inner Setting domain)*	**a. Patients' needs & resources**	Are these are known and prioritised?
	b. Cosmopolitanism	The networks between organisations; 'social capital' in relation to shared visions and information-sharing.
	c. Peer pressure	Have peers (within similar organisations) already implemented the intervention?
	d. External policies and incentives	Strategies, policies, regulations, recommendations and guidelines that influence implementation of the intervention.
4: Characteristics of Individuals Involved *(i.e. the influence of those involved in implementing and delivering an intervention)*	**a. Knowledge and beliefs about intervention**	Individuals' attitudes towards intervention, the value placed on it; knowledge about the intervention (e.g. how to use it, its underlying principles and rationale)
	b. Self-efficacy	Individuals' beliefs in own abilities to achieve implementation.
	c. Individual identification with organisation	Individuals' perceptions about an organisation and their relationship with/commitment to it, which influences willingness to commit to implementation and use the intervention.
	d. Individual stage of change	Progress towards skilled, enthusiastic, sustained use of the intervention.

Domain	Constructs	
	e. Other personal attributes	Any other individual traits or attributes influencing implementation.
5: Process of Implementation *(i.e. the active change process to achieve individual and organisational use of an intervention)*	**a. Planning**	Planning/developing methods for implementation in advance, with appropriate tailoring to account for stakeholders' needs.
	b. Engaging	Are relevant stakeholders involved in implementing and using the intervention (e.g. implementation leaders/champions)?
	c. Executing	Carrying out implementation according to plan.
	d. Reflecting & evaluating	Feedback on the progress and quality of implementation.

Recognising that interventions are only effective under specific conditions, various implementation researchers have highlighted the need for clarity on interventions' core components or 'active ingredients' essential for achieving outcomes, relating to content, setting and mode of delivery, to support more efficient implementation and inform adaptations to suit local contexts (Michie et al., 2009, Bartholomew and Mullen, 2011, Peters et al., 2015). Researchers also need to explore and reflect contexts when developing implementation strategies, to address local realities which may affect an intervention's potential for sustainment (Pinnock et al., 2017), as it is recognised that contexts and settings in which implementation takes place fluctuate and are rarely static (McCormack et al., 2002). The CFIR supports and informs adaptation of interventions, to ensure that they fit with local needs and contexts while retaining the core, essential components; and formative evaluation is encouraged, to assess potential or actual influences on implementation and tailor implementation strategies accordingly (Damschroder and Hagedorn, 2011).

Since its initial publication, the CFIR has been used to investigate implementation of interventions in a wide range of settings (Kirk et al., 2016, Damschroder et al., 2022b). Kirk et al. (2016)'s systematic review of studies using CFIR found that it was most often used during or after implementation, to assess determinants affecting implementation of interventions. Authors have reported that using the CFIR helped them to identify barriers and facilitators to implementing interventions, including motivational interviewing approaches in child behavioural services (Barwick et al., 2020), falls prevention guidelines in hospitals (Breimaier et al., 2015), and healthy eating and physical activity policies (Lobczowska et al., 2022). It is highlighted that the CFIR provides a structured approach to investigating implementation and has wide coverage of potential factors that may affect implementation (Kirk et al., 2016, Safaeinili et al., 2020, Jorgenson et al., 2022).

Understanding the wider organisational and environmental context is considered vital for elucidating the determinants of implementation (Damschroder and Hagedorn, 2011, Nilsen, 2015). For example, in reviewing factors associated with successful implementation of complex hospital-based interventions, Geerligs et al. (2018) recommended that researchers fully understood the broader

organisational context into which an intervention was being implemented, particularly where this took place across multiple sites; and Allen et al. (2017) highlighted that understanding the organisational factors that impacted adoption and implementation of interventions was essential to address the gap between evidence and implementation of interventions.

Authors using the CFIR in implementation research have highlighted its contribution in investigating the factors influencing implementation at the organisational level, in addition to individual-level factors (e.g. Gould et al., 2014, Graham-Rowe et al., 2016, Sales et al., 2016, Birken et al., 2017a). For example, Ross et al. (2018) noted that a thorough understanding of the context into which their intervention was implemented was obtained using the CFIR, which supported the needs of those implementing the intervention; and Garbutt et al. (2018) highlighted that the CFIR supported comprehensive assessment of all factors pertaining to individuals, organisations, and the external environment, which guide the planning and development of the implementation of their intervention. Smith (2017) reported it was useful to include both Inner Setting and Outer Setting domains in the framework as this acknowledged the influence of multiple partners on implementation, particularly in inter-organisational collaborations.

In contrast, theories and frameworks pertaining to individual behaviour change (such as TDF, COM-B and BCW) lacked explication of the influence of organisational contexts on individuals' behaviours (Cummings et al., 2007, Proctor et al., 2013, Li et al., 2018). While Birken et al. (2017a) suggested that both CFIR and TDF included determinants at individual and collective levels, meaning either framework would be sufficient on its own, it remains that a major source of difference between these frameworks is the level at which they are primarily focused (Lynch et al., 2018). While the TDF includes one domain related to the environmental context, it is predominantly focused on individual determinants of behaviour, whereas CFIR is focused on organisational determinants alongside individual characteristics influencing implementation.

However there were some drawbacks identified, such as perceptions that some of the constructs overlapped, or had very broad definitions, making it difficult to

identify which were most salient (Ilott et al., 2013, Breimaier et al., 2015, Jorgenson et al., 2022). This was apparent in a number of the studies using the CFIR to investigate implementation in nursery settings, as all found barriers relating to time constraints and prioritising intervention delivery within schedules; however, these were mapped to various constructs by different authors, such as 'implementation climate' ('compatibility' sub-construct) (Norman et al., 2019, Meshkovska et al., 2022), 'readiness for implementation' ('available resources' sub-construct) (Asada et al., 2023), or 'structural characteristics' (Müller and Hassel, 2021).

Breimaier et al. (2015) highlighted encountering challenges in that the CFIR did not account for stakeholders having differing aims, needs and views about the intervention being implemented. It has also been suggested that the comprehensiveness and complexity of the CFIR, in terms of the number of domains and constructs, is a barrier to utilising it efficiently (Sorensen and Kosten, 2011, Safaeinili et al., 2020).

While Breimaier et al. (2015) criticised the CFIR for not taking into account the existing context into which an intervention is being implemented, such as pre-existing work practices, from using the CFIR within this research it was apparent that existing constructs within the original CFIR, such as the 'Implementation Climate' sub-construct, 'Compatibility' (Inner Setting domain) or 'Complexity' (Intervention Characteristics domain) related to an intervention's fit within existing work practices. It was also identified that constructs relating to scaling up and maintaining interventions were not included in the original CFIR (Ilott et al., 2013).

2.2.4.4 Approach used in this research: Consolidated Framework for Implementation Research (CFIR)

Based on the strengths and weaknesses of each of the candidate frameworks, and informed by Tabak et al. (2012)'s and Lynch et al. (2018)'s guidance, the CFIR (Damschroder et al., 2009) was identified as the most appropriate theoretical approach for this research. Tabak et al. (2012) categorised the CFIR as focused on implementation activities (i.e. concerned with integrating an intervention within a setting, as opposed to dissemination); with a high level of

specificity regarding its constructs; and attention given to community and organisational socio-ecological levels (Tabak et al., 2018). These features fit with the intended purpose of this research, specifically the consideration given to local, organisational, contextual and environmental factors influencing implementation, as features of the wider organisational context into which the programme is implemented are thought to influence its delivery. Other features of the CFIR which fit with aims of this research are the attention given to sustainment of interventions as part of the implementation process (Palinkas et al., 2016) and the use of tailoring and adaptation to meet local circumstances (Keith et al., 2017). The CFIR also fits within the pragmatic approach given its focus on supporting real-world translation of evidence into practice (Damschroder et al., 2009, Huebschmann et al., 2019).

It should be noted that there have been recent updates made to the original CFIR (occurring after it was utilised in this doctoral research). The original authors of the CFIR published a proposed 'outcomes addendum' for the framework, to support researchers in identifying implementation outcomes to be addressed and consider which determinants influence those outcomes (Damschroder et al., 2022a). This followed Kirk et al. (2016)'s finding that few studies using the CFIR to evaluate implementation outcomes (i.e. the extent to which implementation was successful), which other authors ascribed a lack of guidance on identifying how the determinants affecting implementation operate, their inter-relationships, or how to address them to improve implementation outcomes (Sorensen and Kosten, 2011, Lobczowska et al., 2022). The CFIR authors have also published an updated version of the CFIR recently, taking into account feedback and suggestions from authors using the framework (Damschroder et al., 2022b). This acknowledged feedback about the complexity of the original CFIR, which was often ascribed to the number of constructs included, although it was also highlighted that several authors had suggested additions to the framework.

2.2.4.5 Selecting appropriate implementation strategies to optimise programme delivery

Given the overarching aim to optimise the nursery supervised toothbrushing programme, the end-point for this research is to provide practical

recommendations to support programme delivery. In addition to identifying the barriers and facilitators affecting the uptake and use of interventions, a key goal of implementation research is to identify and apply implementation strategies that overcome those identified barriers and enhance those identified facilitators (Bauer and Kirchner, 2020). Implementation strategies are comprised of methods and techniques that enhance the adoption, implementation and sustainment of interventions (Powell et al., 2013). Perry et al. (2019) note that while implementation frameworks (such as the CFIR) provide established methods for investigating factors that impact on implementation, these do not necessarily provide guidance on how to identify implementation strategies to address those factors.

It has also been recognised that there are difficulties in identifying feasible and effective implementation strategies, due to the range of terms and definitions used for these within the literature (Waltz et al., 2014). To address these challenges, Powell et al. (2015) consulted with a panel of 71 implementation researchers and practitioners to produce a set of 73 implementation strategies, with accompanying definitions, known as the Expert Recommendations for Implementing Change (ERIC) strategies. These implementation strategies were further reviewed and categorised by Waltz et al. (2015) in consultation with a panel of 35 implementation research experts, which grouped the 73 ERIC strategies into nine clusters.

A CFIR-ERIC Implementation Strategy Matching Tool is available on the CFIR website (www.cfirguide.org), which was developed from an exercise carried out with a panel of implementation researchers and practitioners to map CFIR constructs to ERIC implementation strategies, to identify which ERIC strategies were most appropriate to address barriers linked to each CFIR construct (Waltz et al., 2019). The authors intended that this tool provided a structured approach to generating potential implementation strategies which could be selected from depending on specific contexts. However, the authors found that an average of six strategies were identified per barrier, with substantial heterogeneity in strategies chosen to address each barrier; given this lack of consensus, they highlighted that the tool should be used with caution. In the absence of any other published guidance on matching CFIR constructs to implementation

strategies, the results of Waltz et al. (2019) and the CFIR-ERIC Implementation Strategy Matching Tool will be used within this research to inform the selection of implementation strategies to enhance delivery of the nursery supervised toothbrushing programme, whilst acknowledging the potential limitations of the approach.

2.2.5 Researcher reflexivity

It is recognised that researchers' backgrounds, previous experiences, social characteristics, values, beliefs and assumptions influence how they conduct research and interpret data, which in turn shapes their research findings and conclusions (Finlay, 2002, Berger, 2013, Rae and Green, 2016, Patnaik, 2013).

Reflexivity is the process that acknowledges the role of the researcher in constructing knowledge (Patnaik, 2013), which requires researchers to make *"conscious and deliberate effort to be attuned to one's own reactions to respondents and to the way in which the research account is constructed"* (Berger, 2013, p.221). This requires ongoing, critical self-reflection and evaluation, to identify and understand how the researcher's underlying assumptions and values affect the research produced (Dowling, 2006, Berger, 2013, Alley et al., 2015). Rae and Green (2016) suggested that researchers should reflect on their motivations to research the topic, their relationships with the field of study, and the shared or divergent understandings between themselves and participants.

Reflexivity also requires researchers to acknowledge how they may influence participants' responses (Finlay, 2002); for example, Berger (2013) suggested that respondents may be more willing to share information and experiences with a researcher they perceived to empathise with their situation.

In terms of my approach to reflexivity for this research, it was important to acknowledge that I have worked with the Childsmile programme as a regional researcher since 2009, therefore have developed detailed knowledge of the programme, observed its development over time and have developed relationships with programme stakeholders.

While my background and experience within the programme benefitted the research, such as having already established rapport with many of the participants, I was aware that this risked participants making assumptions about what I already knew therefore not providing details about aspects of programme delivery. To address this, as far as possible I have tried to elicit full answers from participants by probing answers during interviews as required.

I am aware that I came into this doctoral research with preconceived ideas and assumptions about the nursery supervised toothbrushing programme (based on data gathered from process evaluation). To address this, I have made a conscious effort to recognise this throughout fieldwork and analysis and maintain a more neutral, exploratory perspective. This has been a continual feature of discussions with my supervisory team during fieldwork and analysis, to check and, where relevant, challenge my assumptions and interpretations.

In summary, the chapters that follow describe applied research in a real world context, taking a pragmatic mixed-methods approached based on implementation theory, and utilising quantitative and qualitative data gathering and analytic procedures to meet the aims of the work. Study-specific methods are presented in each of the results chapters. Reporting for this research was guided by the Consolidated Criteria for Reporting Qualitative Research (COREQ) (Tong et al., 2007); a completed COREQ checklist is included in Appendix 4.

3 Explicating the Theory of Change for the nursery supervised toothbrushing programme

As described in Chapter 1, the purpose of this doctoral research is to optimise delivery of the nursery supervised toothbrushing programme in light of Childsmile process evaluation data indicating that it is not delivered as intended in all areas, as not all nurseries participated and not all children had the opportunity to brush every day they attended nursery (Eaves and Gnich, 2013, Childsmile Central Evaluation and Research Team, 2017a). Revisiting the overarching logic model depicting Childsmile's Theory of Change was the first step in optimising programme delivery.

Reviewing the activities and outcomes within the overarching logic model, it became apparent that those parts relating to the nursery supervised toothbrushing programme were sparse and required further thought and development. This was to be expected given that the overarching logic model, which was developed in 2009, was focused at a high level to encompass the complexity and scale of Childsmile as a whole. It was therefore identified that the Theory of Change required further development, which fits with Medical Research Council guidance that the programme theory underpinning complex interventions should be developed and refined, to understand how and why their activities lead to outcomes (Skivington et al., 2021). This chapter reports the process of developing and further explicating the Theory of Change specific to the nursery supervised toothbrushing programme.

3.1 Chapter aim and research questions

The aim for this chapter was to explore and agree the intended model of delivery for the nursery supervised toothbrushing programme with key stakeholders by further explicating the Theory of Change of this component and depicting this in a logic model. The research questions associated with this aim were:

1. What is the Theory of Change for Childsmile's nursery supervised toothbrushing programme?

    a. What do strategic programme stakeholders understand to be the intended activities, outputs, outcomes, the causal linkages between them, and the overall Theory of Change for Childsmile's nursery supervised toothbrushing programme?

    b. Has the Theory of Change for Childsmile's nursery supervised toothbrushing programme been developed sufficiently? (i.e. are there any additions or changes required to fully represent the Theory of Change?)

    c. Does the Theory of Change reflect ongoing and future developments within the programme?

3.2 Ethical approval

The West of Scotland Research Ethics Service (WOSRES) advised that this study met the definition of 'service evaluation' therefore did not require NHS ethical review. (Confirmation provided by WOSRES is included in Appendix 5.)

University of Glasgow, College of Medical, Veterinary and Life Sciences (MVLS) Ethics Committee provided ethical approval for the overarching Childsmile service evaluation, which included this study within its work packages. (Documentation confirming MVLS ethics committee approval is provided in Appendix 5.)

3.3 Methods

The approach used to review and further develop the toothbrushing programme's Theory of Change was based on that used to develop the original Theory of Change and logic models for the overarching Childsmile programme (Childsmile Central Evaluaton and Research Team, 2010, Macpherson et al., 2019b). This followed Connell and Kubisch (1998)'s recommended approach of

identifying a programme's long-term outcomes first then working back to identify interim- and short-term outcomes, programme activities and inputs/resources.

Methods used to review and develop the toothbrushing programme's Theory of Change involved a combination of documentary review and qualitative research with key programme stakeholders (Figure 4). Documentary analysis was undertaken to identify and further specify activities and outcomes related to the nursery supervised toothbrushing programme within existing Childsmile Theory of Change. It is recognised that documents provide insight into decision-making and planning within specific time periods and contexts, therefore analysing these documents yields useful data to inform understanding of particular events (May, 2011, Tight, 2019).

Documents for inclusion in this stage were identified from published papers relating to the development of Childsmile, namely Macpherson et al. (2010a) and Deas et al. (2013); supplemented by consulting with key stakeholders involved in developing and implementing Childsmile. Categories of documents to be reviewed included: Childsmile programme documentation describing delivery of the nursery supervised toothbrushing programme; reports and peer-reviewed articles produced by Childsmile Central Evaluation and Research Team and Regional Research Teams; Scottish Government publications (related to oral health specifically plus other relevant topics including early years provision, early learning and childcare, education, and addressing inequalities) to identify high-level objectives feeding into Childsmile's development; and other publications and guidelines forming the evidence base for Childsmile. (A full list of documents reviewed is provided in Appendix 6.)

Information relating to or informing activities and outcomes associated with the nursery supervised toothbrushing programme was extracted from documents by the principal researcher, focusing on descriptions of what was expected to happen in delivering toothbrushing in nurseries, including the 'key ingredients' (e.g. frequency, duration, reach etc); and the expected outcomes arising from delivering this programme component. These were used to develop an initial

version of a logic model depicting the Theory of Change for the nursery supervised toothbrushing programme (Logic Model One).

This stage was followed up with qualitative, semi-structured interviews with five programme stakeholders (programme directors and managers plus a representative of the Scottish Government) selected purposively for their role in strategic decision-making within the Childsmile programme, to gain their insight into the intended activities and outcomes of the nursery supervised toothbrushing programme. Interviews were carried out by the principal researcher between January and March 2018. These participants represented all relevant stakeholders with responsibility for strategic decision-making in relation to Childsmile at that time. Participants were contacted by email to provide information about the research and invited to participate. Prior to interviews they were asked to provide written consent to participate (see Appendix 7). The duration of these interviews ranged from 30-75 minutes (averaging 50 minutes) and took place in participants' workplaces. Interviews were audio-recorded using encrypted recording devices; recordings were transferred to a secured drive and original recordings were permanently deleted from the recording device. Data were anonymised by removing identifiable information (e.g. names and locations) prior to analysis.

During interviews, participants were taken through each part of Logic Model One and asked whether they thought it represented what was intended in terms of the outcomes and activities of the nursery supervised toothbrushing programme; and to obtain further clarity on the following points:

- Defining 'supervised toothbrushing';
- What toothbrushing 'on a daily basis' means;
- Who should be targeted;
- Expectations around participation (in relation to all children attending nurseries having the opportunity to brush); and
- Expectations around the partnership-working and support provided to nurseries.

The topic guide for these interviews is included in Appendix 8. Data collected during interviews were analysed by the principal researcher to identify areas of the logic model requiring addition or amendment based on participants' feedback.

The final stage in developing the Theory of Change involved the principal researcher facilitating a focus group with the Childsmile Executive in June 2018, to gain their input on a number of points requiring further consideration within the revised logic model and reach final consensus. Key points discussed included: how to reflect national-level partnerships in the logic model; how to describe supervision of toothbrushing within the logic model; and whether an interim outcome relating to toothbrushing in the home as a result of participating in the programme should be added.

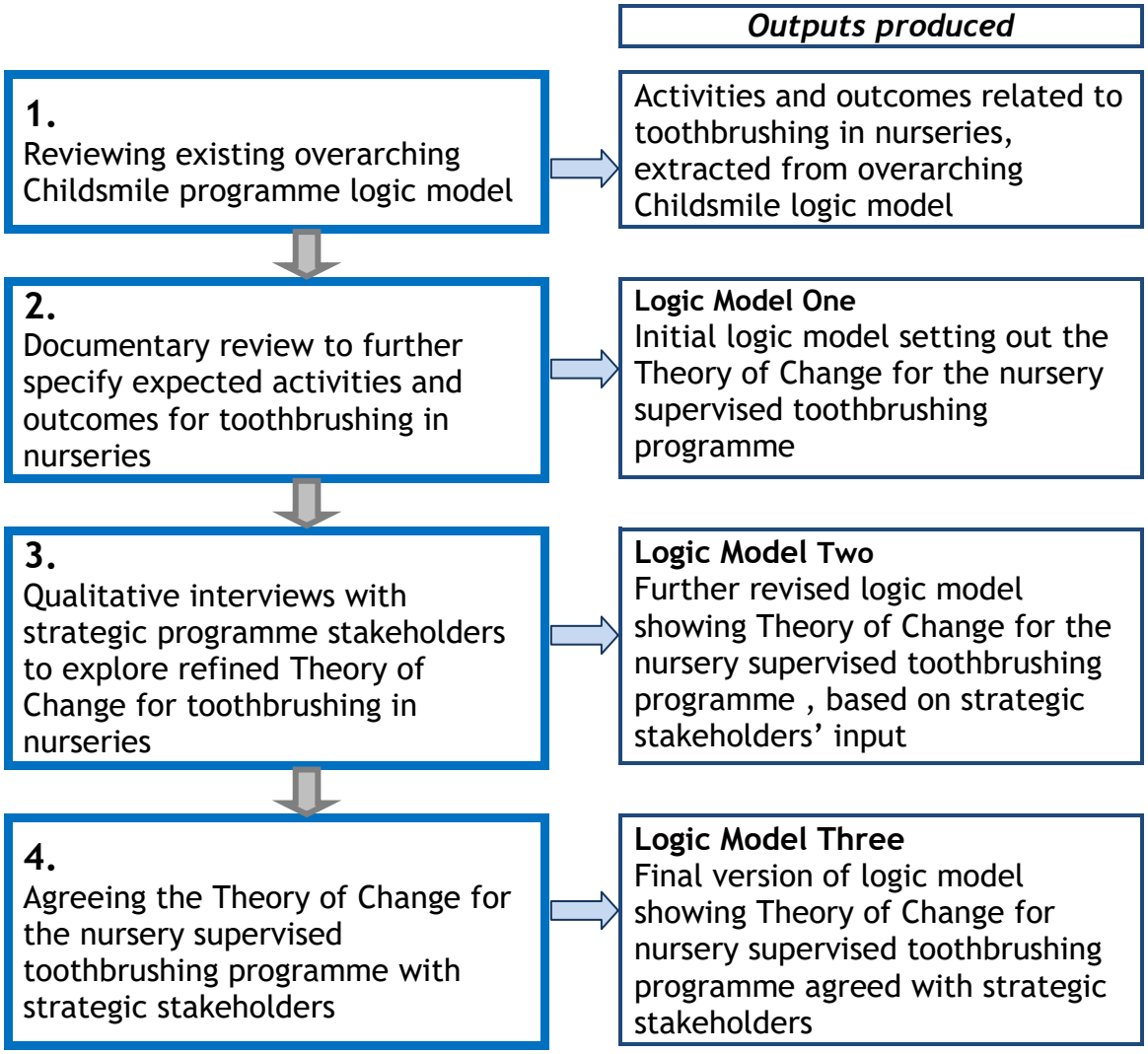


Figure 4 Flowchart of steps undertaken to explicate the nursery supervised toothbrushing programme Theory of Change

3.4 Results

3.4.1 Reviewing existing Childsmile programme logic model

The first step in explicating the toothbrushing programme's Theory of Change involved reviewing the overarching logic model to extract relevant activities and outcomes. The only activity relating to the nursery supervised toothbrushing programme within the overarching logic model was: *"All nurseries (local authority & private) implement daily, supervised toothbrushing programme"* (see Figure 4). This indicated that activities relating to the nursery supervised toothbrushing programme required further thought and development, to specify more clearly the steps in its delivery.

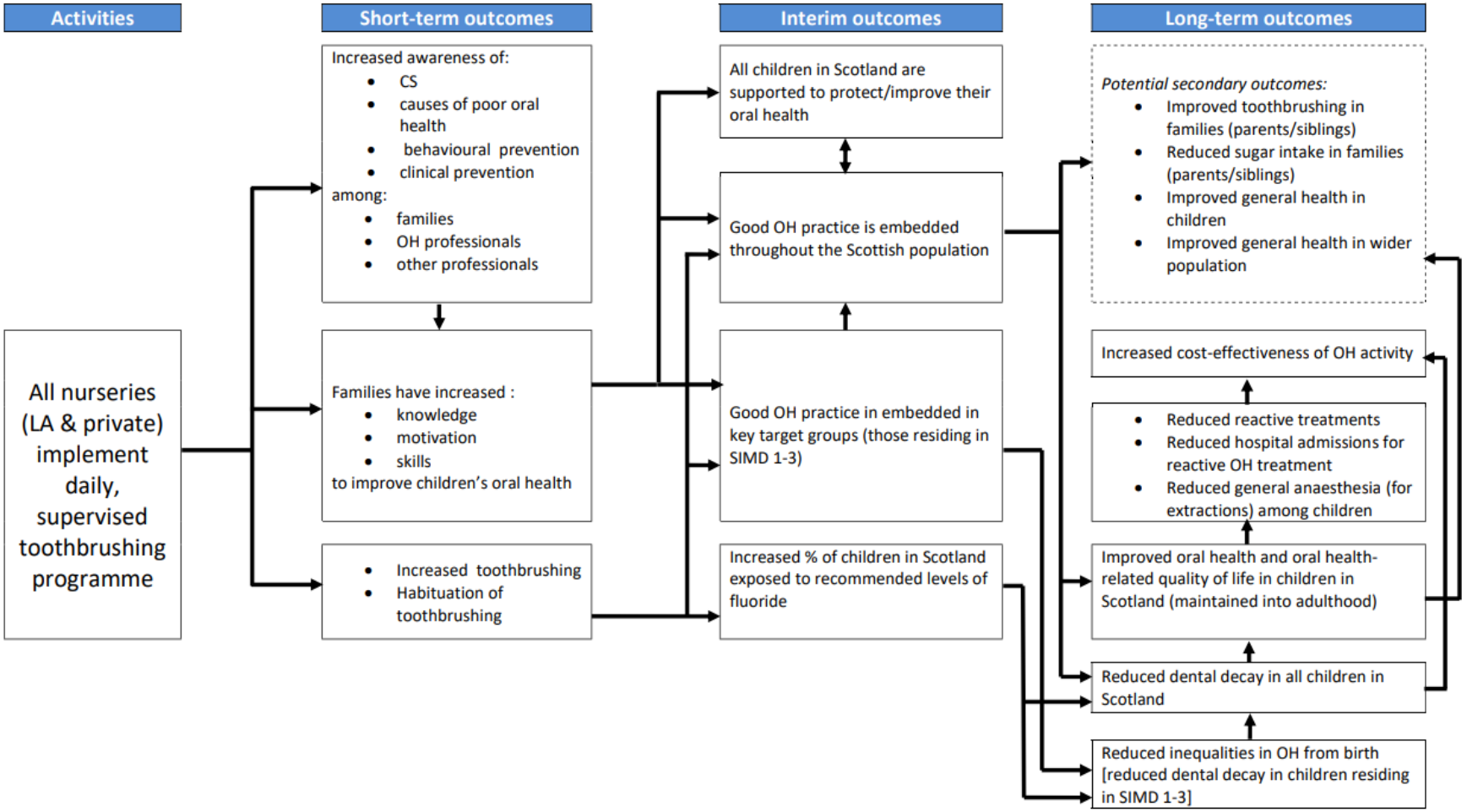


Figure 5 Activities and outcomes related to toothbrushing in nurseries, extracted from the overarching Childsmile logic model

3.4.2 Documentary review to further specify expected activities and outcomes for toothbrushing in nurseries

Using the relevant outcomes and activities extracted from the overarching logic model as a basic framework, the next step involved reviewing relevant documentation (see Appendix 6) to obtain greater detail and clarity about the anticipated outcomes and activities involved. Extracted data were organised into relevant components within a logic model (showing activities and outcomes, plus linkages between these) to set out the Theory of Change (henceforth referred to as 'Logic Model One'). Tables 3-5 below set out the changes made to the activities and short, interim- and long-term outcomes between Logic Model One and Logic Model Two.

Table 3 Activities included in previous (overarching logic model) and revised (Logic Model One) versions

Activities included in overarching logic model	Activities included in Logic Model One
All nurseries (local authority & private) implement daily, supervised toothbrushing programme	Three- and four-year-old children attending nurseries (local authority, voluntary, private or partner provider) brush their teeth in the nursery setting, on a daily basis
	Education staff involved in supervising toothbrushing are trained by Childsmile staff; training covers effective toothbrushing & infection control procedures
	Local Childsmile teams provide regular support to education staff to deliver toothbrushing; monitor delivery of toothbrushing in establishments (twice per year); and supply appropriate resources (toothbrushes & toothpaste)
	Establish partnerships with Education (at the local authority level; with individual establishments; with individual staff members)

Table 3 indicates that the sole activity included in the overarching logic model did not provide sufficient detail about what was expected in implementing and

delivering the nursery supervised toothbrushing programme. The revised logic model (Logic Model One) included four compound activities to provide richer detail about the target population and settings, frequency of the activity, and supporting activities involving nursery staff and Childsmile staff required to enable the primary activity of toothbrushing to take place.

Table 4 Short-term outcomes included in overarching logic model and Logic Model One

Short-term outcomes included in overarching logic model	Short-term outcomes included in Logic Model One
Increased awareness of: Childsmile; causes of poor oral health; behavioural prevention; clinical prevention, among: families; oral health professionals; other professionals	Every three- and four-year-old child attending a local authority, voluntary, private or partner provider nursery, on a full- or part-time basis, participates in supervised toothbrushing using toothpaste with an appropriate fluoride content, in their nursery setting, on a daily basis
Families have increased : knowledge, motivation and skills to improve children's oral health	Children use appropriate toothbrushing techniques and brush their teeth for at least two minutes
Increased toothbrushing and habituation of toothbrushing	Children establish good oral hygiene routines within nurseries
	Toothbrushing is an integral part of health & wellbeing activities in nurseries, with early years education professionals invested in the toothbrushing programme and effectively supporting children to maintain their oral health

Table 4 shows that the short-term outcomes included in the overarching logic model did not explicitly link to activities carried out for the nursery supervised toothbrushing programme. Based on the documents reviewed, four alternative short-term outcomes were identified which linked to the suggested activities of the nursery supervised toothbrushing programme directly. These specified the delivery of toothbrushing in nurseries further, including its frequency and duration, establishing positive oral hygiene routines, and the role of partners working in nurseries in delivering the programme.

The interim and long-term outcomes included in the overarching logic model reflected the overall outcomes for the Childsmile programme and were relevant to toothbrushing (as one of the main components of Childsmile). These existing outcomes were therefore maintained with some modifications to link more closely to the delivery of the toothbrushing programme; for example, instead of *"Increased % of children in Scotland exposed to recommended levels of fluoride"* as presented in Logic Model One, the revised outcome specified that children will be exposed to appropriate levels of fluoride through toothbrushing in nurseries. The revised outcomes are shown in Table 5. Figure 6 shows the revised logic model (Logic Model One), which was then used as a discursive prompt to explore the Theory of Change in detail with strategic programme stakeholders.

Table 5 Interim and long-term outcomes included in overarching logic model and Logic Model One

	Included in overarching logic model	Included in Logic Model One
Interim outcomes	Increased % of children in Scotland exposed to recommended levels of fluoride	More children in Scotland are exposed to appropriate levels of fluoride through brushing their teeth in nurseries
	All children in Scotland are supported to protect/improve their oral health	Children develop skills and motivation to maintain their oral health
	Good oral health practice is embedded throughout the Scottish population	
	Good oral health practice in embedded in key target groups (those residing in SIMD 1-3)	
Long-term outcomes	Reduced dental decay in all children in Scotland	Prevent dental decay in children in Scotland
	Improved oral health and oral health-related quality of life in children in Scotland (maintained into adulthood)	Fewer children (and their families) experience the negative effects of dental decay (e.g. pain, time off school/work, impact on quality of life etc)
	Increased cost-effectiveness of oral health activity	Reduced cost of dental treatments (e.g. dental extractions under general anaesthetic)
	Reduced inequalities in oral health from birth [reduced dental decay in children residing in SIMD 1-3	Address oral health inequalities among children
Potential secondary outcomes	*Improved toothbrushing in families (parents/siblings)* *Reduced sugar intake in families (parents/siblings)* *Improved general health in children* *Improved general health in wider population* *Reduced reactive treatments* *Reduced hospital admissions for reactive oral health treatment*	

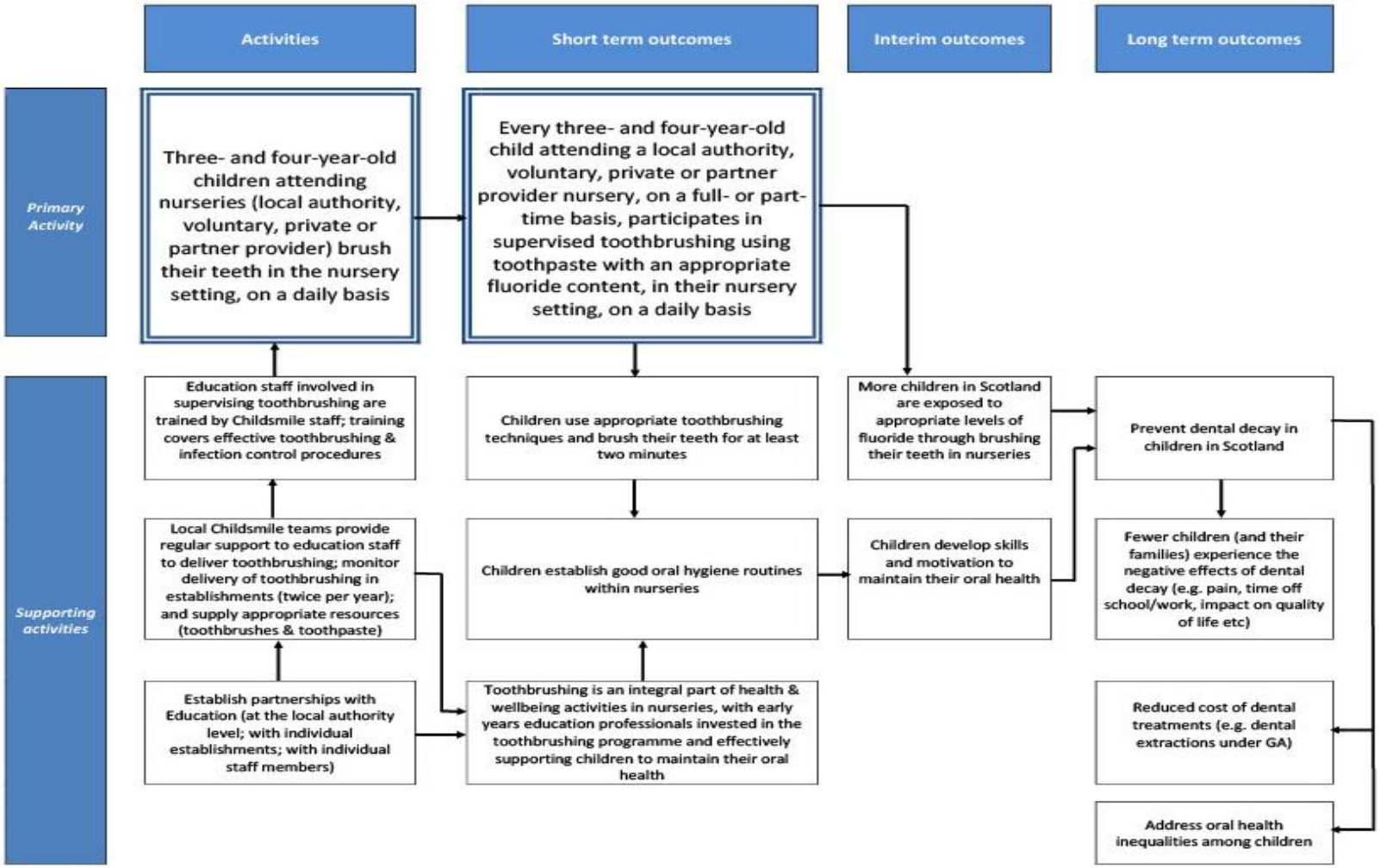


Figure 6 Revised logic model setting out the further developed Theory of Change for toothbrushing in nurseries (Logic Model One)

3.4.3 Qualitative interviews with strategic programme stakeholders

As noted, the purpose of undertaking qualitative interviews with strategic programme stakeholders was to gain insight to further refine Logic Model One and produce an updated version of the logic model (henceforth referred to as 'Logic Model Two').

3.4.3.1 Primary aim of the nursery supervised toothbrushing programme

There was consensus that the statement shown in Logic Model One, "Every three- and four-year-old child attending a local authority, voluntary, private or partner provider nursery, on a full- or part-time basis, participates in supervised toothbrushing using toothpaste with an appropriate fluoride content in their nursery setting, on a daily basis", represented the primary aim of the nursery supervised toothbrushing programme. Some amendments to terminology were suggested to improve the specificity of this aim, such as specifying that children should be *offered the opportunity* to participate in toothbrushing; and stating that children may participate in toothbrushing *every day they attended* (which was thought to be more specific than 'on a daily basis'). Table 6 shows the suggested revisions.

Table 6 Primary aim included in Logic Model One and Logic Model Two

Primary aim included in Logic Model One	Primary aim included in Logic Model Two
Every three- and four-year-old child attending a local authority, voluntary, private or partner provider nursery, on a full- or part-time basis, participates in supervised toothbrushing using toothpaste with an appropriate fluoride content in their nursery setting, on a daily basis	Every ante-pre-school and pre-school child attending a local authority, voluntary, private or partner provider nursery, on a full- or part-time basis, is offered the opportunity to participate in supervised toothbrushing using toothpaste with an appropriate fluoride content in their nursery, every day they attend.

3.4.3.2 Nursery supervised toothbrushing programme activities

The supporting activities shown in Logic Model One were then explored with participants. First, the component parts of the activity *"All nurseries provide access to toothbrushing to three- and four-year old children attending, on a daily basis"* were considered. In relation to the ages of participating children, participants indicated that as nursery provision (at that time) catered for children aged three-years-old to five-years-old, which participants noted were often referred to as 'ante-pre-school' and 'pre-school' children.

Participants agreed with the target of 100% of nurseries participating in the toothbrushing programme and all thought it was appropriate to include all types of nurseries (i.e. local authority, voluntary, private, and partner provider nurseries). However it was acknowledged that achieving participation of 100% of nurseries was challenging. Childsmile monitoring data showed around 98% of nurseries in Scotland participated in the toothbrushing programme (Childsmile Central Evaluation and Research Team, 2017b); however, these data do not indicate the extent of establishments' participation (i.e. whether toothbrushing takes place every day) and only show those nurseries with at least one toothbrushing monitoring contact recorded during the reporting period.[3]

In relation to toothbrushing on a 'daily basis', participants agreed that it was intended that every child brushed their teeth every day they attended nursery. However, this had not been interpreted as such among all nurseries, as found in the exercise carried out by Childsmile in 2017 to quantify participation in the programme (Childsmile, 2017). For example, participants suggested that some nurseries interpreted 'daily' to mean brushing took place *at one point within the nursery each day* (rather than daily for every child when they attended the

[3] The programme's Toothbrushing Standards requires that local Childsmile teams undertake a monitoring visit in each establishment, twice per year, to monitor delivery; these are recorded on the Childsmile@HIC monitoring database (held by Health Informatics Centre, University of Dundee). Data on numbers of establishments participating in the toothbrushing programme, defined as establishments that had at least one toothbrushing monitoring contact recorded on the Childsmile@HIC system, are extracted and reported by the Childsmile Central Evaluation and Research Team, University of Glasgow.

nursery) which led to children not present at the designated 'toothbrushing time' not taking part.

Participants expressed different views about what supervision of toothbrushing involved: some thought this entailed watching children closely while they were toothbrushing to ensure it was taking place for two minutes duration and that they spit out the toothpaste afterwards; others suggested the programme's supervision requirements related to infection prevention and control procedures and providing a safe environment for toothbrushing. However there was consensus among participants that nursery staff should not brush children's teeth for them, as all participants agreed that children should be encouraged to develop skills to brush their own teeth. To reflect these views, the related activities in the logic model were developed further to provide a description of supervision as well as acknowledging infection prevention and control procedures.

Logic model activities relating to partnership-working were also developed further following discussions with participants, to reflect the different levels of partnership working required, such as between local Childsmile teams and nurseries/staff; between local Childsmile coordinators and local authorities; and between the Childsmile programme and relevant national stakeholders (e.g. Scottish Government, Education Scotland and Care Inspectorate).

Participants emphasised the need to develop partnerships at various levels (e.g. with individual nurseries and staff; relevant local authority stakeholders; and at the Scottish Government-level). In particular, developing rapport between Childsmile staff and nursery staff was thought to be crucial for success, although it was recognised that relationships between the programme and nurseries often required sensitive management and careful negotiation as placing too much pressure on nurseries in relation to toothbrushing delivery might result in their withdrawal from the programme. Participants acknowledged that nurseries faced a wide range of pressures and that toothbrushing was often not their most pressing priority; indeed, one respondent advocated using a pragmatic approach to nurseries' participation and implementation, suggesting that 'less than ideal' delivery was acceptable.

It was highlighted that several Childsmile coordinators regularly requested that participation in the toothbrushing programme was made mandatory, as not having this government-led directive led to ongoing, sometimes difficult, negotiations between Childsmile staff and nurseries. However some participants suggested this was unlikely to be directed by the Scottish Government. At the time of these interviews, it was noted that a link between the programme and a Scottish Government education representative had not yet been established, although it was being pursued.

Participants discussed the support and monitoring carried out by Childsmile teams within nurseries. The Toothbrushing Standards state that *"Performance against the Standards is monitored in each establishment twice per school year by a member of the Childsmile team"* (Childsmile, 2019, p.1). However participants noted that 'monitoring visits' took place *at least* twice per year and emphasised that they should take place more often for establishments that required more support. An earlier version of the Toothbrushing Standards (published in 2011), stated that monitoring should take place in each establishment once per term (Childsmile, 2011) and some Childsmile teams continued to carry out monitoring visits more often than twice per year. It was suggested that further information on how Childsmile staff used monitoring checklists and carried out visits would be useful.

The Toothbrushing Standards also state that nursery staff supervising toothbrushing should be trained in effective toothbrushing and infection prevention and control procedures (Childsmile, 2019) with local Childsmile teams responsible for developing and delivering training to nursery staff supervising toothbrushing in their area. Participants thought that training for toothbrushing supervisors was important for successful programme delivery and they expected training to cover cross-infection (e.g. cleaning and storing equipment); the amount of toothpaste to be used; how to supervise children while brushing; and setting the programme in the wider context of Childsmile and children's oral health. It was noted that although the programme considered standardising this training previously, this was not taken forward to allow for training to be tailored to individual establishments' needs (e.g. the length of time they had been participating in the programme).

Participants were keen that the logic model's supporting activities reflected the toothbrushing resources that were supplied to establishments free-of-charge, via the national Core contract.

Interviews also touched on potential programme extensions, such as extending the age group of participating children (e.g. to those aged under three); and the potential for additional early learning and childcare settings to implement toothbrushing (e.g. childminders). For example, it was noted that funded nursery places for eligible two-year-olds (i.e. whose parents received particular welfare benefits or who were looked after or accommodated children) were available since August 2015 (Scottish Government, 2019). Childsmile teams in most health boards provided locally-funded resources to enable children under the age of three attending nurseries to participate in toothbrushing, including targeted two-year-olds with funded places and younger children attending private nurseries. While these may be considered as part of the Theory of Change in future, participants agreed that the main focus of this phase of the research was to obtain clarity on Theory of Change for current parts of the nursery supervised toothbrushing programme.

All suggested changes to the logic model's activities are shown in Table 7.

Table 7 Activities included in Logic Model One and Logic Model Two

Activities included in Logic Model One	Activities included in Logic Model Two
All nurseries provide access to toothbrushing to three- and four-year old children attending, on a daily basis	Ante-pre-school and pre-school children are offered the opportunity to brush their teeth in every day they attend nursery, in 100% of nurseries (local authority, voluntary, private and partner provider)
Education staff involved in supervising toothbrushing are trained by Childsmile staff; training covers effective toothbrushing & infection control procedures	Nursery staff involved in supervising toothbrushing are trained by Childsmile staff; training covers effective toothbrushing & infection control procedures
	Nursery staff supervise children while they are toothbrushing (i.e. dispense an appropriate amount of toothpaste for each child; observe children collecting toothpaste; observe children while they brush their teeth, ensuring toothbrushing takes place for at least two minutes; and ensuring children spit out the toothpaste afterwards)
	Nursery staff follow appropriate infection control procedures
Local Childsmile teams provide regular support to education staff to deliver toothbrushing; monitor delivery of toothbrushing in establishments (twice per year); and supply appropriate resources (toothbrushes & toothpaste)	Local Childsmile teams provide regular support to nursery staff to deliver toothbrushing and monitor delivery of toothbrushing in nurseries (at least twice per year).
	Local Childsmile teams supply toothbrushes and toothpaste to nurseries, free of charge (available via the national Core contract)

Activities included in Logic Model One	Activities included in Logic Model Two
Establish partnerships with Education (at the local authority level; with individual establishments; with individual staff members)	Local Childsmile teams establish partnerships with all nursery providers and staff
	Local Childsmile coordinators establish partnerships with local authority education departments
	Childsmile programme establishes partnerships with relevant national stakeholders (e.g. Scottish Government directorates for Children & Families, and Learning; Education Scotland; Care Inspectorate)

3.4.3.3 Short-, interim and long-term outcomes of the nursery supervised toothbrushing programme

Several participants highlighted that *"Children establish oral hygiene routines in nurseries"* was one of the more important programme outcomes; whereas participants placed less emphasis on *"Children use appropriate techniques and brush for two minutes"*. It was thought that expecting children participating in the programme to have good toothbrushing technique was unrealistic, as they were unlikely to have developed adequate manual dexterity at this age. Instead it was suggested that the outcome should state that *"children acquire techniques appropriate to their age and stage",* to reflect the programme's role in supporting skills acquisition.

Participants agreed that toothbrushing should be an integral part of health and wellbeing activities in nurseries, within the Curriculum for Excellence (Education Scotland, 2017b).

For the interim outcome *"More children in Scotland are exposed to appropriate levels of fluoride through brushing their teeth in nurseries"* it was thought that referring to increasing the numbers of children exposed to appropriate levels of fluoride was not accurate, as there would not be any further roll-out (e.g. to additional nurseries). Instead, participants suggested that this outcome should reflect that *"children in Scotland are exposed to appropriate levels of fluoride, on a regular basis, through toothbrushing"*.

In relation to the other suggested interim outcomes, participants thought that the programme aimed to make daily toothbrushing a norm for all children; several participants were keen that the Theory of Change reflected children acquiring toothbrushing skills; and all participants thought it was appropriate to include outcomes related to establishing oral hygiene routines outside of nurseries, such as use of the home oral health packs provided by Childsmile in conjunction with the programme.

All participants agreed that preventing dental decay in children in Scotland was the central purpose of all components of Childsmile. However one participant

suggested that preventing decay was both a short- and long-term outcome, in terms of preventing decay in the primary dentition in the short-term, and reducing decay in the permanent dentition (via daily toothbrushing) in the long-term. All participants thought that the outcomes *"Fewer children and families experience the negative effects of dental decay"* and *"Reduced cost of dental treatments"* were appropriate with no changes suggested.

In relation to addressing oral health inequalities among children, two participants thought this was not relevant, as the programme was offered universally to all children (regardless of their experience of deprivation). However other participants were clear that addressing oral health inequalities was a programme outcome as it was noted that children living in disadvantaged areas were less likely to brush their teeth at home, therefore would benefit most from having opportunities to participate in toothbrushing in nursery.

The suggested changes to the short-, interim and long-term outcomes are shown in Table 8, with the revised logic model (Logic Model Two) included in Figure 7.

Table 8 Outcomes included in Logic Model One and Logic Model Two

	Included in Logic Model One	Included in Logic Model Two	
Short-term outcomes	Children establish good oral hygiene routines in nurseries	Children establish good oral hygiene routines within nurseries	**No change**
	Children use appropriate toothbrushing techniques and brush their teeth for at least two minutes	Children acquire skills to use toothbrushing techniques appropriate to their age and stage and brush their teeth for at least two minutes	**Amended**
	Toothbrushing is an integral part of health & wellbeing activities in nurseries, with early years education professionals invested in the toothbrushing programme and effectively supporting children to maintain their oral health	Toothbrushing is an integral part of health & wellbeing activities in nurseries, with early years professionals invested in the toothbrushing programme and effectively supporting children to maintain their oral health	**No change**
Interim outcomes	More children are exposed to appropriate levels of fluoride through brushing their teeth in nurseries	Children are exposed to appropriate levels of fluoride on a regular basis through brushing their teeth in nurseries	**Amended**
	Children develop skills and motivation to maintain their oral health	Children brush their teeth more frequently outside of nurseries (e.g. at home) supported by the provision of oral health packs	**Amended**
Long-term outcomes	Prevent dental decay in children in Scotland	Prevent dental decay in the primary dentition of children in Scotland	**Amended**
	Fewer children (and their families) experience the negative effects of dental decay (e.g. pain, time off school/work, impact on quality of life etc)	Fewer children (and their families) experience the negative effects of dental decay (e.g. pain, time off school/work, impact on quality of life etc)	**No change**
	Reduced cost of dental treatments (e.g. dental extractions under general anaesthetic)	Reduced cost of dental treatments (e.g. dental extractions under general anaesthetic)	**No change**
	Address oral health inequalities among children	Address oral health inequalities among children	**No change**

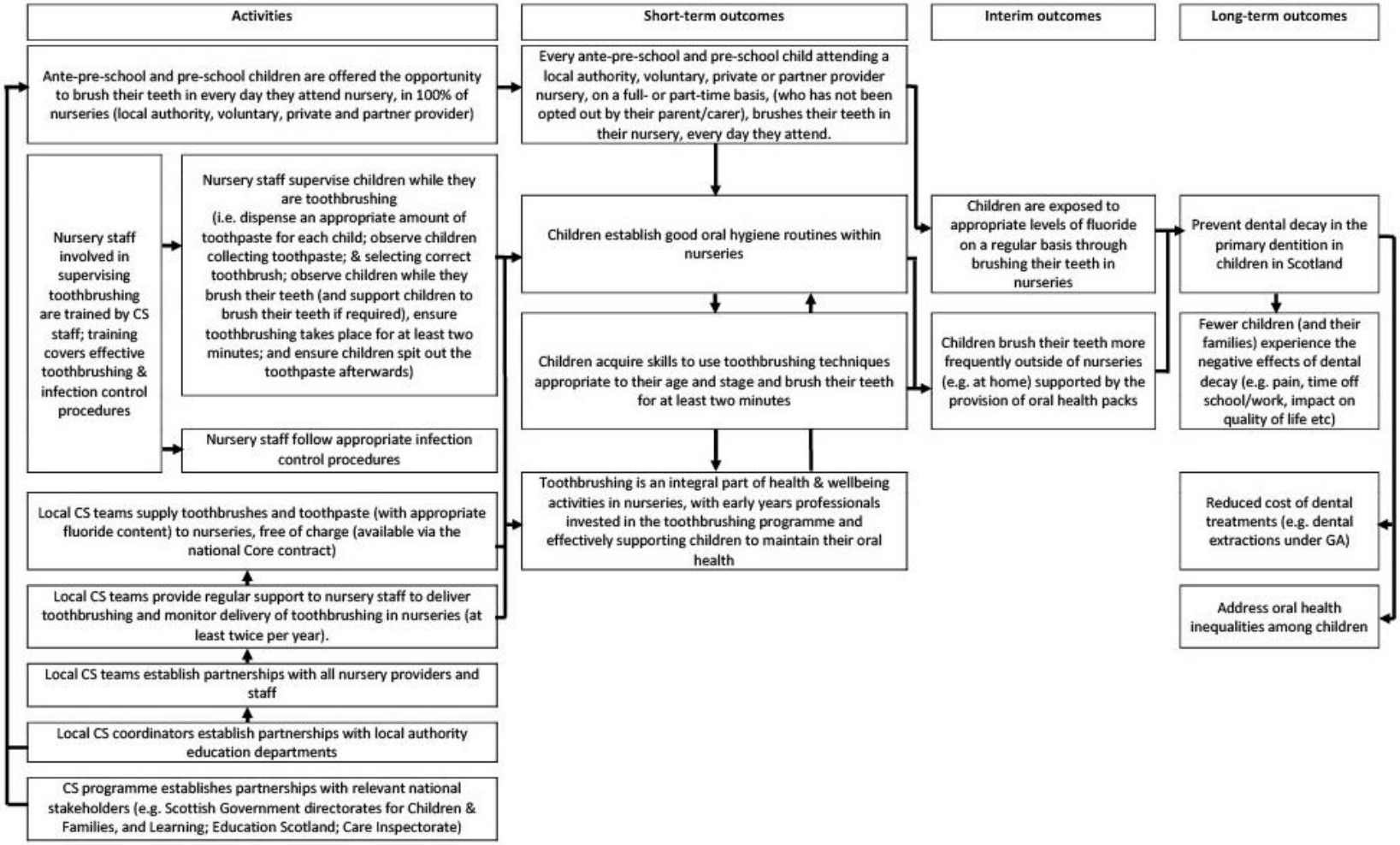


Figure 7 Further revised logic model showing Theory of Change for toothbrushing in nurseries (Logic Model Two)

3.4.4 Finalising the Theory of Change for the nursery supervised toothbrushing programme

As noted, the Theory of Change of the nursery supervised toothbrushing programme was finalised in consultation with the Childsmile Executive.

Stakeholders agreed that national partnership-working (i.e. with Scottish Government directorates) should be included in the logic model as it would support overall delivery, although further discussion with Scottish Government representatives was needed to progress this.

In relation to supervision, this is described in Logic Model Two as: “Nursery staff supervise children while they are toothbrushing (i.e. dispense an appropriate amount of toothpaste for each child; observe children collecting toothpaste; observe children while they brush their teeth, ensure toothbrushing takes place for at least two minutes; and ensure children spit out the toothpaste afterwards)”. Stakeholders thought this description was sufficient, aside from a suggestion that it should reflect that some children (particularly younger children or those with additional support needs) would require assistance to brush their teeth (instead of just being supervised).

In relation to toothbrushing outside of nurseries, stakeholders indicated that they expected providing oral health packs (with toothbrushes and toothpaste) to be used at home, via nurseries, would encourage children to toothbrush at home as this ensured they had the necessary resources to do so. However there remained uncertainty as to whether this would translate into increased toothbrushing at home and it was acknowledged that this would be difficult to measure.

It was suggested that the logic model should reflect the resources required to deliver the programme (i.e. time spent by Childsmile and nursery staff; and the toothbrushes, toothpaste and home oral health care packs provided by the programme). An additional column was added to the logic model to represent these inputs.

As noted, a number of points raised during discussions with stakeholders related to potential extensions to the programme (such as including children aged under three years, and rolling out to other early learning and childcare settings). Childsmile Executive members indicated that while discussions with the Scottish Government about these possible additions to the programme were ongoing, no agreement had been reached therefore these should not be considered part of current Theory of Change.

Data gathered during this discussion were used to produce a final version of the logic model (Logic Model Three, included in Figure 8). Logic Model Three was used in the next stage of the research to explore whether programme delivery matched the intended Theory of Change.

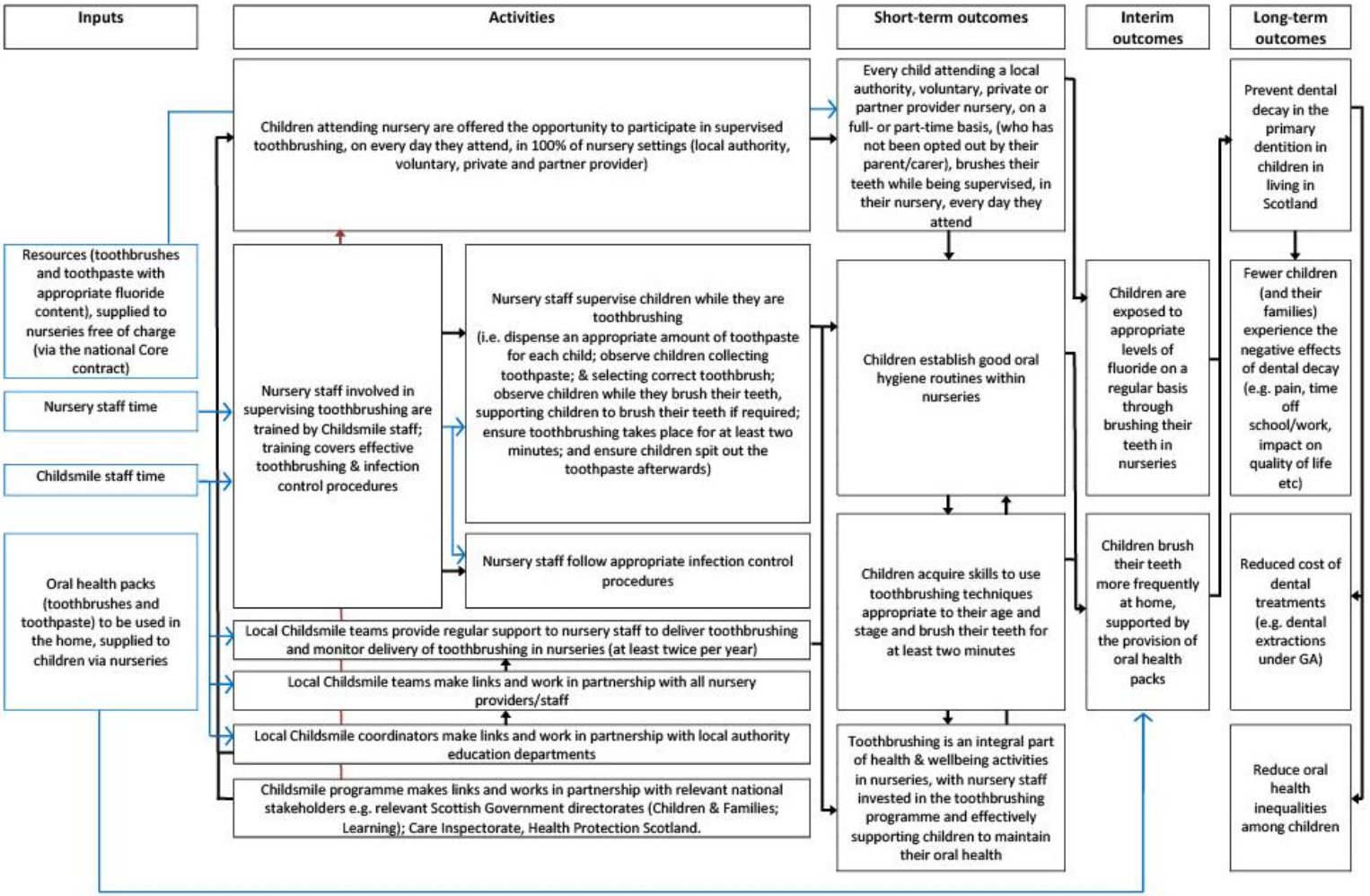


Figure 8 Final logic model showing Theory of Change for toothbrushing in nurseries, agreed with programme stakeholders (Logic Model Three)

3.5 Chapter summary

This chapter has set out the process undertaken to explore and agree a revised and updated Theory of Change for the nursery supervised toothbrushing programme, using documentary analysis and qualitative interviews with key stakeholders, and depicting this in a logic model. This allowed programme stakeholders' understanding and assumptions (which influence decision-making) to be identified and clarified, to reach consensus about what the activities and outcomes of the nursery supervised toothbrushing programme should be.

This resulted in further specification of the inputs and activities associated with the programme, including the provision of toothbrushing resources to nurseries to facilitate delivery; the time involved on the part of both nursery staff and Childsmile staff in supporting delivery; and detailed description of the steps involved in supervising toothbrushing within nurseries. There was also further definition of the outcomes expected from participation in the programme, including children's toothbrushing skills acquisition; exposure to appropriate levels of fluoride; and increasing the frequency of toothbrushing in the home.

Depicting these components in a logic model provides a practical, visual tool describing how the nursery supervised toothbrushing programme is intended to work. The following chapter will use the finalised logic model (shown in Figure 8) to investigate the extent to which delivery-in-reality matches the intended Theory of Change.

4 Assessing the fidelity of the implementation of the nursery supervised toothbrushing programme

The purpose of the previous chapter was to explore and agree the intended model of programme delivery with key stakeholders and develop a logic model depicting the Theory of Change of this programme component. The logic model (shown in Figure 8) describes what programme stakeholders thought the intended inputs, activities and outcomes (short-, medium- and long-term) of the nursery supervised toothbrushing programme should be.

Per criteria set out in the Medical Research Council guidance on developing and evaluating complex interventions (Skivington et al., 2021), the nursery supervised toothbrushing programme is a 'complex intervention', in terms of the number of components involved (e.g. Childsmile staff training nursery staff to deliver toothbrushing, including infection prevention and control procedures; and nursery staff establishing toothbrushing within routines in nurseries, encouraging children to participate and supervising children adequately); the skills required (e.g. among nursery staff supervising toothbrushing and among children participating in toothbrushing); the number of settings involved across Scotland; the need to engage with stakeholders at multiple levels (from local authority education departments to individual head teachers or nursery managers); and variations in delivery between different settings. It is known that complex interventions may not be implemented as intended, due to various moderating factors affecting implementation (Hasson, 2010) or adaptations made to fit with local contexts (Moore et al., 2015). It is important to assess variation in delivery, as not doing so risks erroneous conclusions being drawn about an intervention's effectiveness; that is, attempting to evaluate components that were not actually delivered in practice (such as assuming all nurseries provided an opportunity to toothbrush to all children present, every day, within the programme) also known as 'Type III' error (Dobson and Cook, 1980, Fixsen et al., 2019). Assessing implementation fidelity allows for better evaluation of how and why interventions work or not (Carroll et al., 2007).

The Medical Research Council guidance (Skivington et al., 2021) recommends process evaluation, which complements summative evaluation by identifying how interventions are delivered to target populations (Hasson, 2010) and assessing implementation fidelity (Haynes et al., 2016, Moore et al., 2015). Assessing implementation fidelity also provides opportunities to provide formative feedback to those involved in implementing interventions that lacked adherence to intended models, leading to improved implementation (Breitenstein et al., 2012).

Evaluation of Childsmile includes ongoing process evaluation of all programme components, which aims to document and describe delivery, assess whether the programme is being delivered as intended and identify where variations from the intended model posed risks to achieving outcomes; findings are shared regularly with programme stakeholders to inform formative programme improvement (Childsmile Central Evaluation and Research Team, 2017a).

4.1 Chapter aim and research questions

This chapter aims to assess the fidelity of the implementation of the nursery supervised toothbrushing programme in reality, in comparison with the intended model described in the previous chapter. This will be met by answering the following research questions:

1. Does delivery of the nursery supervised toothbrushing programme in reality match the intended model (as depicted in Logic Model Three shown in Figure 8, Chapter 3)?

    a. Which nursery characteristics are associated with 100% of children brushing (per the national survey of nurseries undertaken in 2019, to quantify participation in the nursery supervised toothbrushing programme)?

    b. How did delivery of the nursery supervised toothbrushing programme in reality differ from the intended model *prior* to the

Covid-19 pandemic (i.e. before March 2020); and *during* the Covid-19 pandemic (i.e. since March 2020)?

4.2 Ethical approval

As described in the previous chapter, this study was deemed to be 'service evaluation' by the West of Scotland Research Ethics Service (WOSRES) and did not require NHS ethical review. (WOSRES confirmation is included in Appendix 5.) Ethical approval for the overarching Childsmile service evaluation (which this study was part of) was provided by the University of Glasgow, College of Medical, Veterinary and Life Sciences (MVLS) Ethics Committee. (MVLS ethics committee approval documentation is provided in Appendix 5.)

4.3 Methods

A mixed-methods approach was utilised to answer this chapter's research questions which included: a cross-sectional survey of nurseries (to quantify participation in the programme); qualitative methods including interviews with programme stakeholders; and extracting data from ongoing Childsmile process evaluation methods. Figure 9 provides an overview and timeline of data collection for the methods utilised for this chapter.

Integrating data obtained through both quantitative and qualitative methods allows for a broader scope of evidence to be considered in answering research questions (Shorten and Smith, 2017). Quantitative methods allow for observable phenomena to be observed and measured (Rolfe, 2013); in the context of this research, quantitative methods are appropriate to investigate the extent to which nurseries and children participate in the programme. Utilising qualitative methods allows for exploration of social phenomena via participants' experiences and the meanings they ascribe to those experiences (Pope and Mays, 1995); within this research, qualitative methods provide rich description of programme delivery and allow for nuanced exploration of whether this took place as intended. Triangulating these data provided a more holistic assessment

of programme delivery-in-reality than would have been possible using a single method (Jick, 1979, Heale and Forbes, 2014, Flick, 2018).

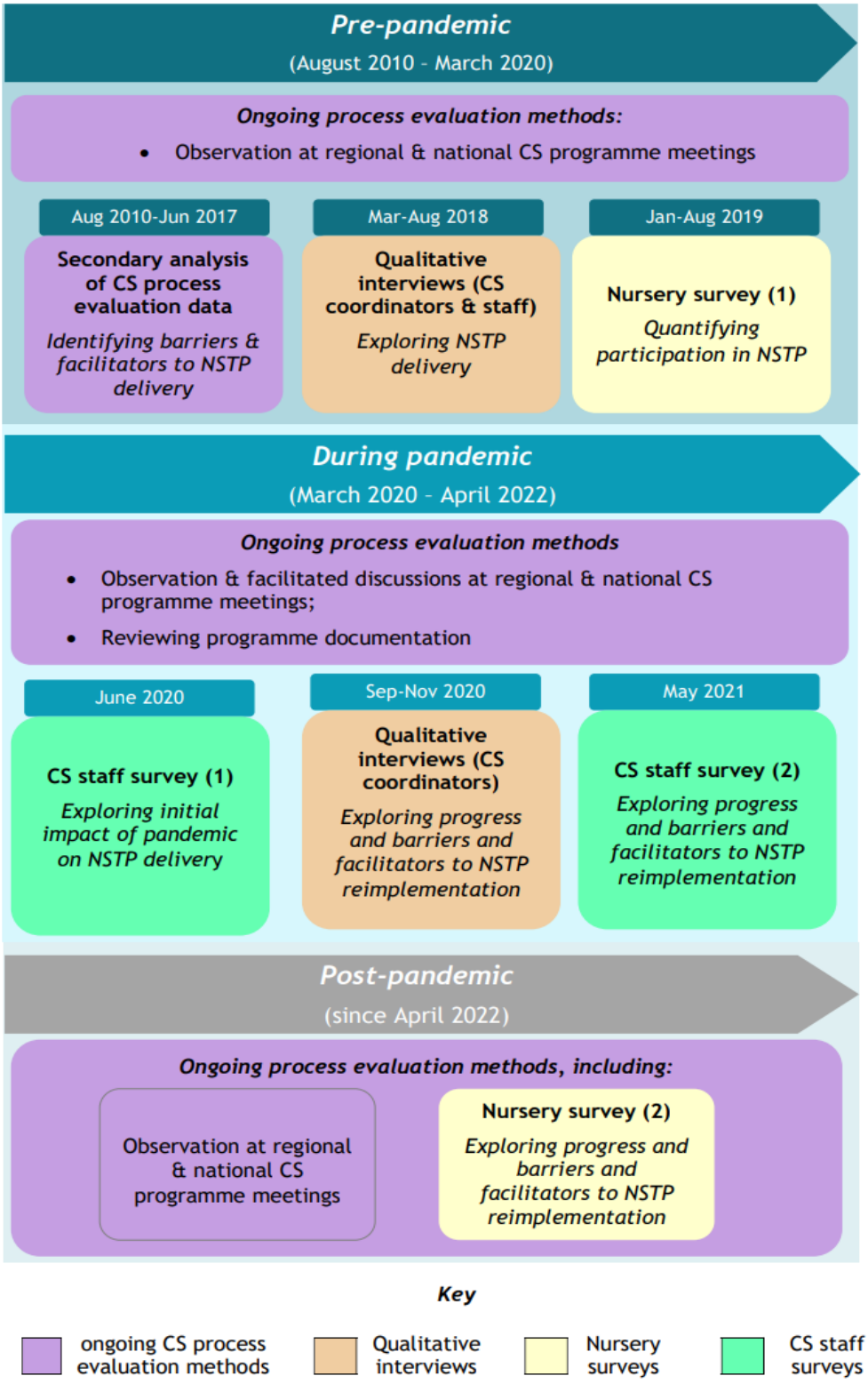


Figure 9 Overview and timeline of data collection supporting assessment of fidelity of implementation of the nursery supervised toothbrushing programme

4.4 Data collection procedures

4.4.1 National surveys of nurseries

4.4.1.1 Quantifying participation in the nursery supervised toothbrushing programme in 2019

A cross-sectional survey of all nurseries in Scotland participating in the programme (n = 2610) was undertaken between January and August 2019. The main aims of the survey were to a) establish nurseries' participation in the programme and b) quantify the extent to which nurseries carried out toothbrushing on a day-to-day basis.

Two data collection forms were developed by the principal researcher in consultation with the supervisory team (AS, AR) and the Childsmile Evaluation and Research steering group. 'Form one' was designed to gather information on whether all children were offered the opportunity to brush their teeth every day they attended nursery.

For each age group (under-twos, two-year-olds; and three-year-olds and over) nursery staff were asked to indicate 'disagree', 'not sure' or 'agree' in response to the question '*All children attending this nursery have the opportunity to brush their teeth every day they attend'* (or to indicate 'N/A' if that age group did not attend the nursery). If nursery staff answered 'disagree' or 'not sure' for any age group, they were asked to provide a free-text response to explain when and why children did not have the opportunity to brush each day they attended nursery. Finally, all respondents were asked to provide free-text responses to indicate the main barriers and facilitators to delivering the programme.

'Form two' was developed to obtain estimated numbers of children participating in toothbrushing in nursery during one day. For each age group (under-twos, two-year-olds; and three-year-olds and over) nursery staff were asked to provide the number of children who were expected to attend; were present; who brushed their teeth at nursery; and who were opted out of the toothbrushing programme, during the course of one 'audit' day. Forms one and two and

information for Childsmile staff and nursery staff to support completion are included in Appendix 9.

Lists of local authority, partner-providers and other private/voluntary nurseries located in each health board area were collated by local Childsmile coordinators and shared with the principal researcher in January 2019. These were used to identify baseline numbers of nurseries in each health board.

Data collection for form one was undertaken by dental health support workers (as noted in Chapter 1, section 1.4.1, dental health support workers are lay workers employed in health boards to support Childsmile delivery, including the supervised toothbrushing programme) during Toothbrushing Standards monitoring visits to nurseries (described in Chapter 1, section 1.4.2). Nursery staff were asked the questions detailed above by Childsmile staff and it was emphasised that these should be supportive discussions, with nursery staff encouraged to provide accurate, candid information about their experiences of delivering the toothbrushing programme.

Form two was completed by a member of nursery staff on the next working day following the Toothbrushing Standards monitoring visit (at which form one was completed), to provide numbers of children expected to attend, present, who brushed their teeth at nursery, and were opted out of the toothbrushing programme, reflecting one full day of nursery provision.

Data collection took place between 5th January to 15th August 2019, with completed forms collated by local Childsmile teams and sent to the administrator for the national Childsmile programme, based in Community Oral Health Section, University of Glasgow, for inputting to a Microsoft Excel workbook set up for this purpose. The workbook was stored on a secured drive; hard copies of data were stored in locked cabinets and then destroyed once inputted.

Nurseries returning survey data were categorised by the principal researcher according to the following characteristics: type of nursery (local authority; partner-provider; other private or voluntary); size of nursery (based on number

of children expected to attend on day of survey); range of age groups attending (only one age group; or multiple age groups); and area-based deprivation of nursery. Area-based deprivation of each nursery was identified using the 2020 (version 2) Scottish Index of Multiple Deprivation (SIMD). The SIMD is an area-based measure of relative socioeconomic deprivation where the population of Scotland is divided into 6976 small areas known as 'data zones' (each with 700-800 people) which are ranked according to levels of deprivation across seven domains (income; employment; education; health; access to services; crime; and housing) (Scottish Government, 2020g). Nursery postcodes were used to identify SIMD quintiles ('quintile' describes one-fifth of the population: SIMD 1 refers to the most deprived fifth of the population; and SIMD 5 refers to the least deprived fifth).

4.4.1.2 Post-pandemic survey of nurseries in 2022

A further survey of nurseries was carried out in May-June 2022 (as part of the Childsmile process evaluation) via Microsoft Forms. The purpose of the survey was to gather information on nurseries' progress towards reimplementing the toothbrushing programme as well as views on barriers and facilitators affecting reimplementation, following the reopening of educational establishments and subsequent relaxation of pandemic-related restrictions affecting educational settings. (See Chapter 1, section 1.5 for further description of the impact of the Covid-19 pandemic on programme delivery.)

Survey questions were developed by the principal researcher in consultation with Childsmile regional research team colleagues, with reference to form one used in the 2019 survey; respondents were asked indicate 'disagree', 'not sure' or 'agree' in response to the question '*All children attending this nursery have the opportunity to brush their teeth every day they attend*' (or to indicate 'N/A' if that age group did not attend the nursery), for each age group (under-twos, two-year-olds; and three-year-olds and over). Those answering 'disagree' or 'not sure' for any age group were asked to indicate the reason for this (with categories developed from analyses of the free-text responses gathered via the 2019 survey). Respondents were also asked to indicate any barriers and facilitators to programme delivery (with categories again developed from

analyses of free-text responses gathered via the 2019 survey). Finally, respondents were asked if there were any barriers to delivering the programme related to the Covid-19 pandemic specifically, with those agreeing this was the case asked to provide further details. (The survey questions are included in Appendix 10.)

Childsmile coordinators in all 14 Scottish health boards were asked to distribute the survey invitation and link to every nursery in their health board area by email. While Childsmile coordinators were asked to return information on numbers of nurseries sent the survey link, this was not provided in all cases, therefore it is not possible to report baseline numbers of nurseries in each health board area or indicate the survey response rate. Furthermore there were no responses received from any nurseries located in either NHS Fife or NHS Tayside areas, indicating that the survey invitation and link was not distributed in those areas. Responses were received from 654 nurseries in total (further information on the characteristics of nurseries returning data is included in Appendix 10).

Data collection took place between 25th May and 17th June 2022, after which point all responses received were downloaded from Microsoft Forms for analysis; these were stored on secure drives. Data from the 2019 and 2022 surveys are reported here to highlight any pertinent differences in delivery.

4.4.2 Drawing from ongoing Childsmile process evaluation methods

Qualitative data on programme implementation, and barriers, facilitators and contextual factors impacting on implementation, have been gathered consistently for the Childsmile process evaluation since 2010. These data were gathered from stakeholders directly involved in developing and implementing the programme, via: qualitative, semi-structured interviews and focus groups (which were digitally recorded using an encrypted recording device and transcribed, with recordings transferred to a secure drive and deleted permanently from the recording device); completion of data collection tools by Childsmile coordinators; and ongoing observation of programme meetings. The

principal researcher has been involved in designing and undertaking all aspects of the Childsmile process evaluation, in their role as Childsmile regional researcher, alongside colleagues from Childsmile Evaluation and Research and regional research teams. (Further detail on the methods, participants and timescales for the Childsmile process evaluation are included in Appendix 11.) Written consent has been obtained from participants for the Childsmile process evaluation on an ongoing basis.

4.4.2.1 Secondary analysis of data

The principal researcher undertook secondary analysis of process evaluation data collected between August 2010 and June 2017 to draw out barriers and facilitators to programme delivery identified by Childsmile programme stakeholders.

4.4.2.2 Observations and facilitated discussions at programme meetings

During the pandemic period, the principal researcher attended and observed 16 regional Childsmile coordinators meetings (attended by Childsmile coordinators or other representatives from all health boards) and ad hoc meetings with programme managers and other stakeholders, taking place between April 2020 and September 2021. These observations aimed to collect updates on progress towards programme reimplementation following the closures of education settings, as well as identifying factors influencing the reimplementation. Detailed notes were taken during meetings to capture information shared and themes discussed. Observations were supplemented by undertaking three facilitated discussions at regional Childsmile coordinator meetings in December 2020, involving 24 participants in total. Discussions were digitally recorded (using an encrypted recording device) and transferred to a secure drive; original recordings were then deleted permanently from the recording device. Recordings were transcribed by the principal researcher (with transcripts also stored on a secure drive) and hard copies of data were stored in a locked cabinet. Oral consent was obtained from participants present at these meetings (which took place online via the Microsoft Teams platform).

4.4.2.3 Review of programme documentation

Progress towards programme reimplementation during the pandemic was also tracked by reviewing the following documentation produced by the Childsmile programme during the period July 2020 to August 2021:

- COVID-19 Interim Childsmile Toothbrushing Standards in Nursery and School, version one (July 2020);
- Return of supervised daily toothbrushing in nursery and school settings: Frequently Asked Questions (September 2020);
- Remobilisation of the National Dental Inspection Programme and Childsmile activities in the academic year 2021: Paper for Scottish Directors of Education group (May 2021); and
- COVID-19 Interim Childsmile Toothbrushing Standards in Nursery and School, version two (August 2021).

4.4.3 Qualitative interviews with Childsmile coordinators and staff

The principal researcher carried out two tranches of qualitative, semi-structured interviews with Childsmile coordinators and staff, with the first tranche taking place between March and August 2018. This involved 24 respondents (Childsmile coordinators and other staff) representing all 14 health boards in Scotland. Participants were selected purposively for their role in planning and delivering the Childsmile programme in each local area, with efforts made to include representatives from every geographical health board to ensure context-specific factors associated with programme delivery were captured. Participants were contacted by email to provide information about the research and the purpose of the interviews (to develop an up-to-date picture of programme delivery and explore associated challenges and facilitators) and invited to participate. Interviews were structured around the logic model agreed with strategic programme stakeholders in the previous stage of the research (Logic Model Three), with respondents asked to comment on whether programme delivery in

their area matched the depicted Theory of Change. The interview schedule used to guide these discussions is included in Appendix 12. Interviews taking place during this tranche lasted between 25–50 minutes (averaging 35 minutes) and took place in participants' workplaces.

A second tranche of qualitative, semi-structured interviews was carried out by the principal researcher between September and November 2020, with 20 respondents (Childsmile coordinators) representing 11 out of 14 health boards in Scotland. As before, participants were selected purposively for their role in planning and delivering the Childsmile programme in each local area. While efforts were made to include representatives from every geographical health board, three invited participants declined to take part in an interview, due to their redeployment to other roles in their health boards during the Covid-19 pandemic. Participants invited to participate in interviews by email and were informed that the purpose of these interviews was to focus on progress towards reimplementing the programme and identify barriers and facilitators affecting reimplementation during the pandemic period. The interview topic guide is provided in Appendix 12. The duration of interviews in this tranche ranged from 40-105 minutes (averaging 60 minutes) and all interviews took place on Microsoft Teams aside from one which took place by telephone.

All interviews in both tranches were audio-recorded (using an encrypted recording device) and transcribed by the principal researcher (approximately 30 hours of audio recordings). Recordings were transferred to a secure drive then deleted permanently from the recording device. Transcripts were also stored on the secure drive. Participants in both tranches were provided brief information about the research and asked to provide written consent prior to participating in interviews (see Appendix 13).

4.4.4 Surveys of Childsmile coordinators and teams

A survey of Childsmile teams (coordinators and their staff) was carried out in June 2020, using Microsoft Forms, to gather information on the initial impact of the Covid-19 pandemic on programme delivery. (The survey questions are

included in Appendix 14.) Twenty-seven responses were received, representing 13 (out of 14) health boards in Scotland.

A follow-up survey of Childsmile teams was carried out in May 2021, using Microsoft Forms, to obtain information on progress towards programme reimplementation (survey questions are included in Appendix 14). Seventeen responses were received, representing 13 (out of 14) Scottish health boards.

For both surveys, responses were downloaded from the Microsoft Forms platform and stored on a secure drive.

4.5 Analyses and reporting

4.5.1 Quantitative data analysis

Quantitative data gathered through the surveys of nurseries described above were reviewed and cleaned by the principal researcher to identify incomplete or missing data and remove typographical errors. Categories describing various characteristics of nurseries were specified: Percentage of children brushing on the day of the survey (0%; >0% to <100%; 100%); Type of nursery (local authority; partner-provider; other private or voluntary); Size of nursery (based on number of children expected to attend on day of survey); Range of age groups attending (only one age group; or multiple age groups); Area-based deprivation of nursery (based on SIMD quintile identified using nursery postcodes); and health board area in which the nursery was located.

These data were analysed using IBM SPSS (version 28). Simple tabulations and frequencies were calculated for the high-level overview of numbers of nurseries and children participating in toothbrushing. Further analyses relating to factors associated with rates of toothbrushing in nurseries were carried out using cross-tabulations and Chi-Squared Tests of Independence. Please note that due to very large sample sizes, any null hypothesis test is likely to find very small differences as statistically significant. These differences might not necessarily be meaningful or important, therefore the percentage differences are presented with commentary on the size of these differences, as well as presenting the Chi-

squared values and associated p-values. These data are reported in section 4.6.1 in this chapter.

4.5.2 Qualitative data

For all qualitative data gathered (via qualitative interviews, surveys of nurseries and Childsmile staff and ongoing process evaluation methods, as described above) the principal researcher carried out an initial stage of inductive coding, which involved reading and interpreting the raw text of the transcripts and other sources as detailed, to identify themes emerging from the data that described programme delivery and factors affecting its implementation. Codes and themes were developed in consultation with the supervisory team (AR, AS). Coding was undertaken using QSR International NVivo 10 qualitative data management software. Following this initial inductive coding, the principal researcher carried out further coding using the inputs, activities and outcomes from the nursery supervised toothbrushing programme logic model as a basic framework to organise data to draw out key themes relating to how delivery in reality related to the intended model, and factors associated with being able to implement the programme as intended or not. These data are reported in section 4.7 in this chapter, in relation to each activity shown in the logic model (Logic Model Three). Contextual information, obtained from observations undertaken for the Childsmile process evaluation, is provided where necessary to support interpretation of respondents' views.

Illustrative quotes from respondents are included to support specific findings where relevant. To ensure anonymity, each respondent was assigned a number and respondent type (i.e. 'operational' for those involved in delivery on-the-ground, such as Childsmile coordinators and other Childsmile staff; or 'strategic' for those involved in strategic programme management at the national level, such as Childsmile Executive members). Health board areas for operational respondents and nurseries were assigned a letter randomly and specified alongside quotes. Sources of data (i.e. interview, survey, programme meeting or other process evaluation data collection) and the month and year of data collection are also noted alongside quotes.

4.6 Results

These results are reported in two sections: firstly, findings from quantitative data analyses drawn from the survey of nurseries undertaken in 2019 to quantify participation in the programme are reported; followed by findings from the qualitative data collected via the methods described above, on the extent to which respondents viewed the programme was being delivered as shown in the logic model.

4.6.1 Quantifying participation in the nursery supervised toothbrushing programme

The first activity shown in the logic model (Logic Model Three) indicates that the central aim of the programme is to provide all children attending nursery the opportunity to participate in supervised toothbrushing, on every day they attend, in 100% of nursery settings. Data collected via the survey of nurseries were used to assess the fidelity of delivery on-the-ground, in comparison to what was intended as shown in Logic Model Three.

4.6.1.1 Data completeness

As noted in section 4.4.1.1, baseline numbers of nurseries were obtained from lists collated by Childsmile coordinators in each health board in January 2019. This identified 2610 nurseries operating across Scotland, comprised of: 1550 (59%) local authority nurseries; 822 (31%) partner-provider nurseries (i.e. private or voluntary sector nurseries working in partnership with local authorities to provide funded places to ante-pre- and pre-school children and eligible two-year-olds); and 238 (9%) other private or voluntary sector nurseries (i.e. those who do not offer funded places as per partner-providers).

Partial or full data were received from 2508 nurseries (96.1% of all nurseries in Scotland). As noted, two separate data collection forms were developed for this exercise. Overall, fully completed data (i.e. with no fields missing or excluded

for any age group) were received from 2112 nurseries (80.9% of all nurseries) for form one[4]; and 2249 nurseries (86.2% of all nurseries) for form two. For both forms one and two, there were 2063 nurseries (79.0% of all nurseries) that provided fully completed data.

For nurseries providing partial data (such as only completing form one or form two, or not completing individual questions on either form) data from these partial returns were included in analyses where appropriate. For example, if a nursery omitted data on numbers of children aged three or over brushing their teeth, data for this age group would be excluded from analyses; however, if the same nursery provided completed data for the other age groups, these data would be included. For form two, where individual returns omitted data for one or more of the questions [5] for a particular age group, all corresponding data for that age group were excluded. Table 9 gives an overview of completeness of form two data for each age group.

Table 9 Completeness of toothbrushing survey data: Form 2

Age group	No. of potential responses [6]	Completed responses received and included in analyses	
	N	*n*	*% of N*
Under-twos	813	714	87.8
Two-year-olds	1305	1182	90.6
Three-year-olds and over	2583	2477	95.9

[4] Further information on data received from Form 1 is included in Appendix 8.

[5] 1. *How many children are expected to attend on the day of the count?*;
2. *How many children are present on the day of the count?*;
3. *How many children brushed on the day of the count?*;
4. *How many children present on the day of the count were opted out of toothbrushing?*

[6] As before, this refers to the number of nurseries where it was not indicated that they did not have children of the age group attending. Again, this includes nurseries that did not return any data and some of these may not have children of one or more age groups attending.

4.6.1.2 Characteristics of nurseries returning data

As noted, nurseries were categorised according to their type (local authority; partner-provider; other private or voluntary); size (based on number of children expected to attend on day of survey); range of age groups attending (only one age group; or multiple age groups); and area-based deprivation. Table 10 shows numbers and percentages of nurseries in each category.

Table 10 Characteristics of nurseries returning data

Category		N	% of all nurseries returning data (n=2508)
Type of nursery	Local authority	1500	59.8%
	Partner-provider	786	31.3%
	Other private / voluntary	222	8.9%
Age groups attending nursery	One only [7]	1380	55.0%
	More than one [8]	1128	45.0%
Size of nursery (number of children attending)	Small (one to 25 children)	786	31.3%
	Medium (26-49 children)	769	30.7%
	Large (50-75 children)	504	20.1%
	Very large (76+ children)	449	17.9%
Area-based deprivation (SIMD-fifth)	SIMD 1 (most deprived)	488	19.5%
	SIMD 2	516	20.6%
	SIMD 3	613	24.4%
	SIMD 4	530	21.1%
	SIMD 5 (least deprived)	356	14.2%
	not known	5	0.2%

[7] Of those nurseries with only one age group attending, 98.8% (1363) had children aged three-years-old and over only attending, with 0.7% (nine) of nurseries having only two-year-olds attending; and 0.6% (eight) with only under-twos attending.

[8] 55.6% (630) of those had all three age groups (under-twos; two-year-olds; and three-year-olds and over) attending; 40.8% (460) had both two-year-olds and three-year-olds and over attending; 1.7% (19) had both under-twos and two-year-olds attending; and 1.7% (19) had both under-twos and three-year-olds and over attending.

In total, 2508 nurseries reported on 101,502 children who were present and eligible to participate in the programme, on the day of the survey. Of these children, 81.6% (82,860) were three-years-old or over, 11.9% (12,086) were two-year-olds, and 6.5 % (6556) were under-twos. There was 0.4% (376) of children present who were opted out of the programme by their parents/carers (38 under-twos, 22 two-year –olds and 316 three-year-olds and over). For all age groups, the distribution of children present and eligible to participate across health boards was broadly proportional to the population distribution as shown in National Records of Scotland mid-year population estimates by age group for 2019, as at 30 June 2019 (National Records of Scotland, 2020).

4.6.1.3 Number of children brushing on the day of survey

Table 11 shows that, for all ages, 93,596 children (92.2% of eligible children present) were reported to have brushed their teeth in nursery on the day of the survey, across Scotland. Between health boards, this ranged from 81.9% (NHS Fife) to 98.5% (in NHS Borders) of eligible children present. Taking each age group in turn, the results showed that, on the day of the survey across Scotland:

- 76,468 three-year-olds and over (92.3% of those present) were reported to have brushed their teeth; this ranged from 81.0% (NHS Fife) to 99.2% (NHS Borders) between health boards.

- 11,201 two-year olds (92.7% of those present) were reported to have brushed their teeth, which ranged from 83.7% (NHS Grampian) to 100% (NHS Borders).

- 5927 under-twos (90.4% of those present) were reported to have brushed their teeth; ranging from 47.5% (NHS Grampian) to 99.5% (NHS A&A).

Table 11 Nursery toothbrushing survey results: Eligible children present and brushing by health board

	Eligible children present on the day				Children who brushed on the day							
Age group	*Under-twos*	*Two-year-olds*	*Three-year-olds and over*	*All ages*	*Under-twos*		*Two-year-olds*		*Three-year-olds and over*		*All ages*	
Health board	N	N	N	N	n	% of N	n	% of N	n	% of N	n	% of N
AA	197	662	6172	7031	196	99.5	650	98.2	6007	97.3	6853	97.5
B	69	185	1593	1847	53	76.8	185	100	1581	99.2	1819	98.5
DG	32	108	1895	2035	26	81.3	98	90.7	1787	94.3	1911	93.9
F	300	743	6053	7096	259	86.3	649	87.3	4903	81.0	5811	81.9
FV	325	745	4986	6056	298	91.7	651	87.4	4135	82.9	5084	83.9
G	139	613	9379	10,131	66	47.5	513	83.7	8387	89.4	8966	88.5
GGC	2087	3406	14,058	19,551	1993	95.5	3216	94.4	12,816	91.2	18,025	92.2
H	130	329	4943	5402	127	97.7	301	91.5	4623	93.5	5051	93.5
La	771	1643	11,066	13,480	693	89.9	1464	89.1	10,634	96.1	12,791	94.9
Lo	1950	2570	15,054	19,574	1747	89.6	274	96.3	14,106	93.7	18,327	93.6
T	545	1033	6489	8067	464	85.1	954	92.4	6378	98.3	7796	96.6
Islands [9]	11 [10]	49	1172	1232	5	45.5	46	93.9	1111	94.8	1162	94.3
Sco	**6556**	**12,086**	**82,860**	**101,502**	**5927**	**90.4**	**11,201**	**92.7**	**76,468**	**92.3**	**93,596**	**92.2**

[9] Data for the three Scottish island health boards (Orkney, Shetland and Western Isles) were aggregated due to small numbers of nurseries and similarities in populations and geography.

[10] Of the three island health boards, there were only nurseries in Western Isles that identified children under the age of 2 were eligible and present on the day.

Table 12 Minimum, quartile one, median, quartile three and maximum percentages of children brushing on day of the survey, by age group and health board

Health Board	Nurseries reporting on children present on the day who brushed their teeth																							
	Under-twos						Two-year-olds						Three-year-olds and over						All ages					
	Min	Q1	Med	Q3	Max	IQR	Min	Q1	Med	Q3	Max	IQR	Min	Q1	Med	Q3	Max	IQR	Min	Q1	Med	Q3	Max	IQR
AA	83.3	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0
B	0	100	100	100	100	0	100	100	100	100	100	0	74.2	100	100	100	100	0	74.2	100	100	100	100	0
DG	25.0	70.5	100	100	100	29.6	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0
F	0	70.2	100	100	100	29.8	0	93.8	100	100	100	6.2	0	75.4	95.9	100	100	24.6	0	75.0	93.4	100	100	25.0
FV	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0	0	92.4	100	100	100	7.7
G	0	0	100	100	100	100	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0
GGC	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0
H	40.0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0
La	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0
Lo	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0	0	98.4	100	100	100	1.6
T	0	100	100	100	100	0	0	100	100	100	100	0	47.1	100	100	100	100	0	43.3	100	100	100	100	0
Islands	0	0	0	25.0	100	25.0	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0
Sco	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0	0	100	100	100	100	0

Table 12 shows that for all ages, the minimum value of percentage of children brushing on the day recorded was 0% in all health boards, apart from NHS Borders (74.2%) and NHS Tayside (43.3%). The first quartile value was 100% for all health boards apart from NHS Fife (75.0%), NHS Forth Valley (92.4%) and NHS Lothian (98.4%); and the 3rd quartile and maximum values were 100% for all health boards;

Among under-twos, the minimum values recorded were 83.3% for NHS A&A, 40.0% for NHS Highland, 25.0% for NHS D&G and 0% for all over health boards. The first quartile value was 0% for NHS Grampian and 100% for all health boards except NHS D&G (70.4%) and NHS Fife (70.2%); and the median, third quartile and maximum values were 100% for all health boards

For two-year-olds, the minimum value recorded was 0% for all health board except NHS Borders (100%). The first quartile value was 100% for all health boards except NHS Fife (93.8%). The median, third quartile and maximum values were 100% for all health boards

For three-year-olds and over, the minimum value was 74.2% for NHS Borders, 47.1% for NHS Tayside, and 0% for the rest of the health boards. The first quartile value was 100% for all health boards except NHS Fife (75.4%); and the median value was 100% for all health boards except NHS Fife (95.9%). The maximum value was 100% for all health boards

4.6.1.4 Brushing status of nurseries

Table 13 Nursery toothbrushing survey results: Nurseries reporting 0% and 100% of children brushing, by health board

Age group	Nurseries reporting that 0% of children present brushed their teeth						Nurseries reporting that 100% of children present brushed their teeth					
	Under-twos		Two-year-olds		Three-year-olds and over		Under-twos		Two-year-olds		Three-year-olds and over	
Health board	N	% of R [11]	N	% of R	N	% of R	N	% of R	N	% of R	N	% of R
AA	0	0	1	1.6	1	0.7	22	95.7	58	92.1	131	86.8
B	1	11.1	0	0	0	0	7	77.8	28	100	68	93.2
DG	0	0	3	9.7	1	1.3	4	57.1	25	80.6	64	81.0
F	5	15.2	7	9.7	6	3.8	23	69.7	53	73.6	72	46.2
FV	4	9.3	11	15.1	8	5.9	37	86.0	56	76.7	107	79.3
G	6	31.6	10	12.5	9	3.0	11	57.9	67	83.8	248	81.8
GGC	4	1.9	5	1.9	9	2.5	181	87.9	239	93.0	303	82.6
H	0	0	2	5.6	13	5.1	13	92.9	32	88.9	205	80.4
La	5	6.3	6	4.9	2	0.7	68	86.1	107	87.7	222	82.5
Lo	18	10.5	4	1.9	13	3.2	135	78.9	190	89.2	318	78.5
T	11	16.9	9	7.4	0	0	50	76.9	107	87.7	184	88.5
Islands	3	75.0	2	9.5	3	4.3	1	25.0	18	85.7	59	84.3
Sco	**57**	**8.5**	**60**	**5.4**	**65**	**2.6**	**552**	**82.0**	**980**	**87.7**	**1981**	**80.2**

[11] 'R' is the number of nurseries that returned data for each age group.

Table 13 shows that, across Scotland, 80.2% (1981) of nurseries with three-year-olds and over, 87.7% (980) of nurseries with two-year-olds, and 82.0% (552) of nurseries with under-twos attending, reported that 100% of children present brushed their teeth on the day of the survey. Among nurseries with three-year-olds and over attending, this ranged from 46.2% (72) of nurseries with this age group attending in NHS Fife, to 93.2% (68) of nurseries with this age group attending in NHS Borders. For nurseries with two-year-olds attending, this ranged from 73.6% (53) of nurseries with two-year-olds attending in NHS Fife to 100% (28) of nurseries with this age group in NHS Borders; and for under-twos, this ranged from 57.1% (4) of nurseries with under-twos attending in NHS D&G[12], to 95.7% (22) of nurseries with this age group attending in NHS A&A.

Table 13 also shows that 2.6% (65) of nurseries with three-year-olds and over, 5.4% (60) of nurseries with two-year-olds, and 8.5% (57) of nurseries with under-twos attending, reported that none of the children present brushed their teeth on the day of the survey across Scotland.

4.6.1.5 Nursery characteristics associated with 100% of children brushing

As set out in Table 10 (section 4.6.1.2) nurseries returning data were categorized according to a number of characteristics. These were used to undertake further analysis to identify whether any of these characteristics were associated with reported rates of brushing within nurseries, to help direct efforts towards those nurseries most in need of support. These included the type of nursery (i.e. run by local authority, private partner-provider, or other private or voluntary sector); nursery size (in terms of number of children present on the day of the survey); range of age groups attending; area-based deprivation of nursery; and geographical health board where the nursery is located.

Nursery type: Three categories of nursery type were identified: those operated by local authorities; partner-provider nurseries (privately operated

[12] While 25.0% of nurseries with under-twos attending reported 100% of children present brushed in the island health boards, this related to one nursery only, as there were just four nurseries with this age group attending (all in NHS Western Isles).

establishments contracted by local authorities to provide early learning and childcare); and other private or voluntary sector nurseries (not working in partnership with local authorities).

Table 14 Number and percentage of each nursery type, by reported toothbrushing rate

Reported rate of children brushing on day of survey	Nursery type					
	Local authority		Partner-provider		Other private/voluntary	
	N	%	N	%	N	%
100% of children brushing	1118	74.5	604	76.8	168	75.7
>0% and <100% of children brushing	338	22.5	177	22.5	47	21.2
0% of children brushing	44	2.9	5	0.6	7	3.2
Total	**1500**	**100**	**786**	**100**	**222**	**100**

Table 14 shows there was very little difference between nursery type and reported toothbrushing rates, with 74.5% (1118) of local authority nurseries reporting that 100% of children brushed on the day of the survey, compared to 76.8% (604) of partner-provider nurseries and 75.7% (168) of other private/voluntary nurseries. Due to the large sample sizes, quite small differences between groups are likely to be statistically significant, but in this case, these differences between groups were not considered to be of importance.

Analysis of post-pandemic survey data showed a difference in rates of brushing with all age groups attending between nursery types: 70.6% (308) of local authority nurseries compared with 54.8% (119) of private/voluntary nurseries.

Nursery size (numbers of children attending): Nurseries were categorised according to the number of children expected to attend on the day of the survey. Four categories were identified: small (one to 25 children); medium (26-49 children); large (50-75 children); and very large (76+ children).

Table 15 Number and percentage of each nursery size, by reported toothbrushing rate

Reported rate of children brushing on day of survey	Nursery size							
	Small (one to 25 children)		Medium (26-49 children)		Large (50-75 children)		Very large (76+ children)	
	N	%	N	%	N	%	N	%
100% of children brushing	625	79.5%	579	75.3%	366	72.6%	320	71.2%
>0% and <100% of children brushing	142	18.1%	173	22.5%	125	24.8%	122	27.2%
0% of children brushing	18	2.3%	17	2.2%	13	2.6%	8	1.8%
Total	**786**	**100**	**769**	**100**	**504**	**100**	**449**	**100**

There appeared to be a decreasing trend in the percentage of nurseries with 100% of children brushing on the survey day as the size of the nursery increased with almost 10% fewer of very large nurseries managing to brush 100% of attending children's teeth compared to the small nurseries (79.5% for 'small' nurseries to 71.2% of 'very large' nurseries) (χ^2 = 16.440 (6), p= .012). (Post-pandemic data on numbers of children attending nurseries were not available from the nursery survey.)

Range of age groups attending: Nurseries were divided into two categories: those with only one age group attending (either under-twos, two-year-olds, or three-year-olds and over); or those with more than one age group (any combination of the age groups noted above).

Table 16 Number and percentage of each age group attending, by reported toothbrushing rate

Reported rate of children brushing on day of survey	Age groups attending			
	Only one age group attending		More than one age group attending	
	N	%	N	%
100% brushing	1066	77.2	824	73.0
>0% / <100% brushing	273	19.8	289	25.6
0% brushing	41	3.0	15	1.3
Total	**1380**	**100**	**1128**	**100**

Table 16 shows that there was a difference of +4% in the reported rates of toothbrushing between nurseries with only one age group attending, and those with more than one age group attending. Among those with only one age group attending, 77.2% (1066) of nurseries reported that 100% of children brushed on the day of the count, while 73.0% (824) of nurseries with more than one age group attending reported 100% of children brushed (χ^2 = 18.378 (2), p= <.001).

Area-based deprivation of nursery: As noted, nursery postcodes were used to identify the SIMD-fifth that each nursery was located in.

Table 17 Number and percentage of each nursery SIMD-fifths, by reported toothbrushing rate

Reported rate of children brushing on day of survey	SIMD-fifth											
	1 (most deprived)		2		3		4		5 (least deprived)		unknown	
	N	%	N	%	N	%	N	%	N	%	N	%
100% of children brushing	367	75.2	369	71.5	473	77.2	420	79.2	259	72.8	2	40.0
>0% and <100% of children brushing	113	23.2	133	25.8	124	20.2	95	17.9	94	26.4	3	60.0
0% of children brushing	8	1.6	14	2.7	16	2.6	15	2.8	3	0.8	0	0
Total	**488**	**100**	**516**	**100**	**613**	**100**	**530**	**100**	**356**	**100**	**5**	**100**

Table 17 shows that there was little variation and no real socio-economic trend in the proportions of nurseries reporting 100% of children brushing between SIMD-fifths: the highest percentage of nurseries with 100% of children brushing were located in SIMD 4 (79.2%) while the lowest was in SIMD 2 (71.5%). However post-pandemic data indicated that there was variation between SIMD-fifths in relation to the percentage of nurseries agreeing that toothbrushing was taking place with all age groups attending: 79.2% (99) of nurseries in SIMD 1 indicated this was the case, compared with 51.4% (56) of nurseries in SIMD 5.

Health board in which nursery is located:

Table 18 Number and percentage of nurseries by health board, by reported toothbrushing rate

Reported rate of children brushing on day of survey	Health Board											
	AA	**B**	**DG**	**F**	**FV**	**G**	**GGC**	**H**	**La**	**Lo**	**T**	**Islands**
	N (%)	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**
100% of children brushing	131 (86.2)	59 (80.8)	55 (67.9)	88 (54.0)	99 (72.8)	243 (78.6)	284 (75.7)	207 (80.5)	202 (74.8)	304 (73.6)	164 (78.5)	54 (77.1)
>0% and <100% of children brushing	20 (13.2)	14 (19.2)	23 (28.4)	68 (41.7)	34 (25.0)	60 (19.4)	80 (21.3)	40 (15.6)	65 (24.1)	100 (24.2)	44 (21.1)	14 (20.0)
0% of children brushing	1 (0.7)	0 (0)	3 (3.7)	7 (4.3)	3 (2.2)	6 (1.9)	11 (2.9)	10 (3.9)	3 (1.1)	9 (2.2)	1 (0.5)	2 (2.9)
Total	**152 (100)**	**73 (100)**	**81 (100)**	**163 (100)**	**136 (100)**	**309 (100)**	**375 (100)**	**257 (100)**	**270 (100)**	**413 (100)**	**209 (100)**	**70 (100)**

Table 18 showed that there was variation in the proportions of nurseries reporting 100% of children brushing between health boards: the health board with the highest percentage of nurseries with 100% of children brushing was NHS A&A (86.2%) while the lowest was NHS Fife (54.0%). Analysis of post-pandemic survey data also indicated variation between health boards in the percentage of nurseries agreeing that toothbrushing was taking place with all age groups attending, from 88.9% (24) in NHS Borders to 48.3% (56) in NHS Grampian.

4.6.1.6 Nurseries providing toothbrushing every day

As noted, form one (Appendix 9) gathered information on whether all children were offered the opportunity to brush their teeth, every day they attended, as well as reasons why this did not take place. Nurseries were asked to indicate whether they agreed, disagreed, or were unsure, for each of the three age groups, in response to the question *"To what extent do you agree with the statement 'All children attending this nursery have the opportunity to brush their teeth every day they attend'";* these data are presented in Table 19 by age group and health board.

Table 19 Nurseries' responses to whether children were given opportunity to brush every day they attended, by age group and health board

Health board	AGREE						DISAGREE						NOT SURE					
	Under-twos		Two-year-olds		Three-year-olds and over		Under-twos		Two-year-olds		Three-year-olds and over		Under-twos		Two-year-olds		Three-year-olds and over	
	N	% of R[13]	N	% of R	N	% of R	N	% of R	N	% of R	N	% of R	N	% of R	N	% of R	N	% of R
AA	20	71.4	65	90.3	141	93.4	2	7.1	0	0	3	2.0	6	21.4	7	9.7	7	4.6
B	10	83.3	29	93.5	72	98.6	2	16.7	2	6.5	1	1.4	0	0	0	0	0	0
DG	7	87.5	28	75.7	62	77.5	1	12.5	4	10.8	8	10.0	0	0	5	13.5	10	12.5
F	36	90.0	63	77.8	109	67.7	1	2.5	9	11.1	44	27.3	0	0	0	0	5	3.1
FV	39	88.6	63	84.0	109	80.7	5	11.4	12	16.0	25	18.5	0	0	0	0	1	0.7
G	17	53.1	77	75.5	248	80.0	10	31.3	17	16.7	48	15.5	2	6.3	2	2.0	11	3.5
GGC	198	68.3	245	71.6	331	73.7	15	5.2	20	5.8	31	6.9	2	0.7	1	0.3	5	1.1
H	18	100	47	90.4	236	90.4	0	0	4	7.7	15	5.7	0	0	1	1.9	10	3.8
La	77	84.6	129	90.8	258	93.8	7	7.7	9	6.3	11	4.0	5	5.5	2	1.4	4	1.5
Lo	156	87.6	208	94.5	362	88.7	15	8.4	8	3.6	35	8.6	6	3.4	4	1.8	11	2.7
T	56	83.6	112	88.9	188	90.4	7	10.4	5	4.0	9	4.3	1	1.5	9	7.1	11	5.3
Islands	2	50.0	21	84.0	65	90.3	0	0	1	4.0	4	5.6	2	50.0	2	8.0	2	2.8
Sco	**636**	**78.2**	**1087**	**83.3**	**2181**	**84.4**	**65**	**8.0**	**91**	**7.0**	**234**	**9.1**	**24**	**3.0**	**33**	**2.5**	**77**	**3.0**

[13] 'R' is the number of nurseries that returned data for each age group.

Table 19 shows that, across Scotland, 84.4% (2181) of nurseries with three-year-olds and over, 83.3% (1087) of nurseries with two-year-olds, and 78.2% (636) of nurseries with under-twos attending agreed that children had the opportunity to brush their teeth every day they attended nursery. Among nurseries with three-year-olds and over attending, this ranged from 98.6% (72) of nurseries in NHS Borders to 67.7% (109) of nurseries in NHS Fife. For nurseries with two-year-olds attending, this ranged from 94.5% (208) of nurseries in NHS Lothian to 71.6% (245) of nurseries in NHS GGC; and for nurseries with under-twos attending, this ranged from 100% (18) of nurseries in NHS Highland to 53.1% (17) of nurseries in NHS Grampian[14].

[14] While there were 50.0% of nurseries in the island health boards with under-twos attending that indicated 'agree', there were only four nurseries with this age group attending (all in NHS Western Isles).

Table 20 Number and percentage of nurseries indicating agree, disagree or not sure in response to whether children have the opportunity to brush every day they attend nursery, by reported toothbrushing rate

Age group	Under-twos						Two-year-olds						Three-year-olds and over					
"Do children have the opportunity to brush every day they attend?"	*Agree*		*Disagree*		*Not sure*		*Agree*		*Disagree*		*Not sure*		*Agree*		*Disagree*		*Not sure*	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
nurseries with 100% of children brushing	522	83.4	11	21.2	12	52.2	917	86.3	28	36.4	21	70.0	1810	83.5	114	48.9	49	63.6
nurseries with >0% & <100% of children brushing	55	8.8	8	15.4	3	13.0	73	6.9	9	11.7	2	6.7	326	15.0	77	33.0	21	27.3
nurseries with 0% of children brushing	22	3.5	24	46.2	7	30.4	22	2.1	33	42.9	3	10.0	18	0.8	40	17.2	7	9.1
N/A [15]	27	4.3	9	17.3	1	4.3	51	4.8	7	9.1	4	13.3	13	0.6	2	0.9	0	0
Total	**626**	**100**	**52**	**100**	**23**	**100**	**1063**	**100**	**77**	**100**	**30**	**100**	**2167**	**100**	**233**	**100**	**77**	**100**

Table 20 shows that, among all nurseries across Scotland agreeing that children had the opportunity to brush every time they attended (recorded via form one of the survey), the percentages of those reporting that 100% of children in each age group brushed on the day of the survey (recorded via form two) were: 83.5% (1810) (for nurseries with children aged three-years-old and over attending); 86.3% (917) (for nurseries with two-year-olds attending); and 83.4% (522) (for nurseries with under-twos attending).

[15] Not applicable as no children of this age group attended on day of survey OR data was not completed / returned.

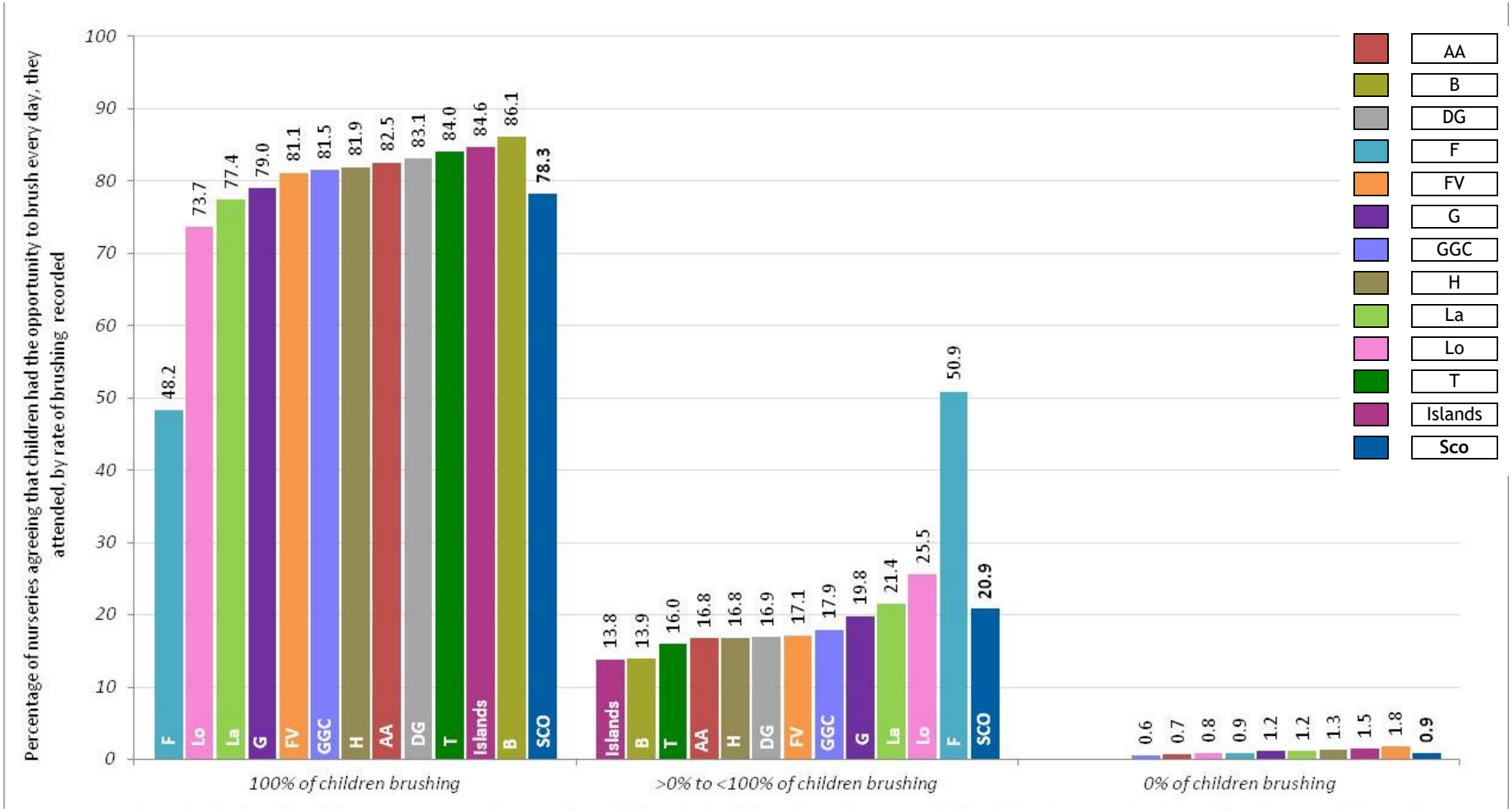


Figure 10 Reported rates of brushing among nurseries agreeing children have the opportunity to brush every day they attend nursery, by health board

Figure 10 shows that, among nurseries agreeing that children had the opportunity to brush every time they attended (as recorded via Form 1) the percentages of those reporting that 100% of children (across all age groups) brushed on the day of the survey (recorded via Form 2) was 78.3% (1731) across Scotland. This ranged from: 48.2% (55) in NHS Fife to 86.1% (62) in NHS Borders. Only 19 nurseries across Scotland agreeing that children had the opportunity to brush every time they attended recorded that 0% of children brushed (0.9%).

4.6.2 Summary of results from national survey of nurseries: Quantifying participation in the nursery supervised toothbrushing programme in 2019

This section has reported the results of the quantitative data analyses of the national survey of nurseries undertaken in 2019. This showed that, among eligible children (of all ages) attending nursery on the day of the survey, 92.2% brushed their teeth (90.4% of under-twos, 92.7% of two-year-olds, and 92.3% of three-year-olds and over). Across Scotland, 82.0% of nurseries reported that 100% of under-twos, 87.7% of nurseries reported that 100% of two-year-olds, and 80.2% of nurseries reported that 100% of three-year-olds and over, brushed their teeth on the day of the survey.

Nursery characteristics found to be associated significantly with 100% of children brushing were the size of the nursery (in terms of numbers of children attending), the range of age groups attending and the health board in which the nursery was based. There was a decreasing trend in proportions of nurseries reporting 100% of children brushing, with almost 10% fewer ‘very large’ nurseries (attended by 76 or more children) reporting that 100% of children brushed (71.2%), compared with 79.5% of ‘small’ nurseries (attended by one to 25 children). Nurseries were more likely to have 100% of children brushing where there was only one age group attending (77.2% of these nurseries reported 100% of children brushing) compared with those with more than one age group attending (73.0%).

There was also wide variation in proportions of nurseries reporting 100% of children brushing between health boards (ranging from 86.2% of nurseries in NHS Ayrshire & Arran, to 54.0% of nurseries in NHS Fife).

However the results found little difference in brushing rates between different nursery types (74.5% of local authority nurseries, 76.8% of partner provider nurseries and 75.7% of other private/voluntary nurseries reported that 100% of children brushed). There was also little variation and no socioeconomic trend in proportions of nurseries reporting 100% of children brushing between SIMD-fifths.

While the overall percentage of children brushing (92.2%) indicates fairly high participation, there remained large numbers of children who did not have the opportunity to brush, despite the prompt provided by the survey to do so. There were also differences apparent in brushing rates between the various categories of nurseries, indicating that children attending nurseries within particular categories (i.e. those with higher numbers of children attending or more than one age group attending) or geographical (health board) areas may be less likely to have the opportunity to participate in the toothbrushing programme every day.

4.7 Stakeholders' views on fidelity to the nursery supervised toothbrushing logic model

The previous section of this chapter reported the results of an exercise to quantify children's participation in the toothbrushing programme in the period before the pandemic, with a view to assessing whether children were being offered the opportunity to brush their teeth every time they attended nursery; this related to the first activity shown in Logic Model Three. This section explores views on the extent to which the programme was delivered as intended in the periods before, during and post-pandemic, through analysis of all qualitative data collected from programme stakeholders (who are categorised by role type: programme managers; Childsmile coordinators; dental health support workers; and nursery staff), taking each activity included in Logic Model Three in turn. For the first activity - *"Children attending nursery are offered the opportunity to participate in supervised toothbrushing, on every day they attend, in 100% of nurseries"* – convergence between the quantitative survey data (reported in the previous section) and these qualitative data, on the extent to which this activity was delivered as intended, is examined.

Logic Model Three is included in Figure 11 below, for reference. (Data collection procedures are described in section 4.4.) Where the data reported were provided by participants from one role type only, this is specified; where more than one role type is represented in the data reported, this is denoted using more generic terms (e.g. 'Childsmile staff' or 'programme stakeholders').

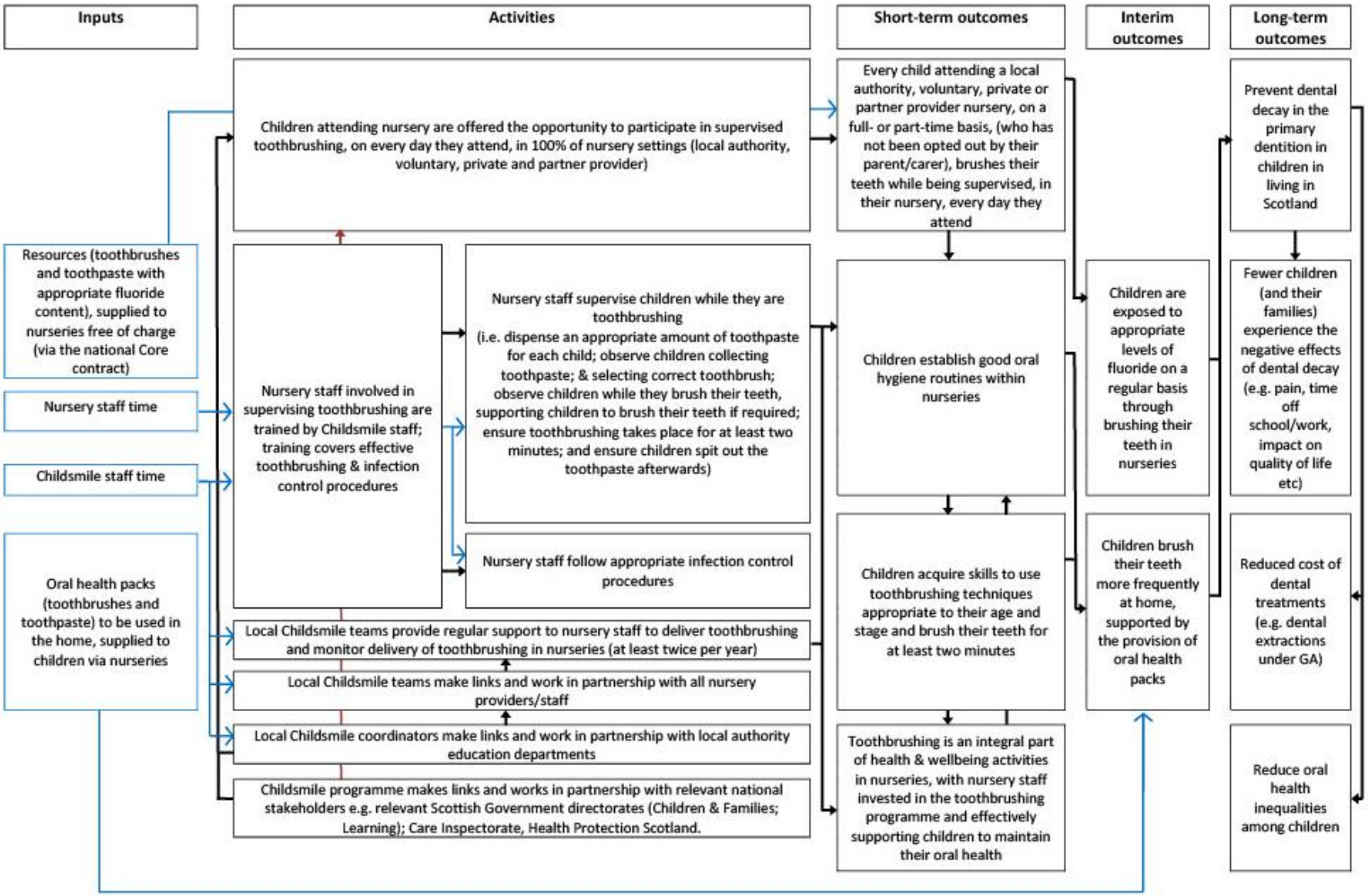


Figure 11 Final logic model showing Theory of Change for toothbrushing in nurseries, agreed with programme stakeholders (Logic Model Three)

4.7.1 Logic model activity one: Children attending nursery are offered the opportunity to participate in supervised toothbrushing, on every day they attend, in 100% of nurseries (local authority, voluntary, private and partner-providers)

Programme stakeholders indicated that offering toothbrushing universally, to all children attending nurseries, was central to the Childsmile programme and thought that daily toothbrushing should be established as a norm for all children:

> *It really is the backbone of Childsmile. The solid, number one message we're giving is that toothbrushing is really high priority. ...We're saying, 'toothbrushing is for all, it should be for all'.*
>
> (Respondent 4 [operational], interview, July 2018)

Before the pandemic, several Childsmile coordinators reported a good level of participation among nurseries and in eight out of 14 health boards it was thought that the programme was mature:

> *I think it is going very well. At this stage in the programme it is very well embedded in nurseries now.*
>
> (Respondent 26 [operational], interview, March 2018)

For example, one Childsmile coordinator commented that support from the local authority in their area increased their confidence that toothbrushing was offered to all children, every day:

> *Generally in nurseries, it has been going on for so long that it actually, it is just part of their daily routines and part of the curriculum for them.*
>
> (Respondent 17 [operational], interview, August 2018)

Another Childsmile coordinator noted that while toothbrushing might occasionally not take place, this was rare and daily toothbrushing would be quickly reinstated:

> *If there's different things, special things, coming up, or staff shortages or a change within the establishment you can get, maybe for a short period of time, things don't work as well as they did before, but then they get back on track again.*
>
> (Respondent 31 [operational], interview, August 2018)

However, these views did not triangulate with historic process evaluation data, wherein the majority of respondents did not believe that this activity was delivered as intended; secondary analysis of process evaluation data found that respondents in eight out of 14 health boards (from all parts of Scotland) reported that toothbrushing did not take place in all nurseries every day.

'Participation' was sometimes deconstructed. Although nursery staff might identify their establishment as 'participating' in the programme, it was unlikely that all children were offered the opportunity to brush every day:

> *If we were to fool ourselves and think that 100% meant 100% of the children brushed their teeth every day we'd be completely mistaken. It's nothing like that amount.*
>
> (Respondent 25 [operational], process evaluation, August 2013)

It was also noted that some nursery staff themselves admitted to Childsmile staff that those undertaking programme monitoring might get a false impression:

> *You go out to see them and they say 'oh right, well we only really brush when you're here'.*
>
> (Respondent 10 [operational], process evaluation, May 2012)

Similarly, one Childsmile coordinator reflects here on the potential for being misled:

> *You can say to them 'right, okay, are you brushing all the time?', they'll either have one of two responses: they'll lie to you or they will tell you the truth 'well we're not always doing it' or 'we do it when you come' ... you can give them the advice, you can tell them what you expect out of them but you can't force them to do it.*
>
> (Respondent 10 [operational], process evaluation, May 2012)

This Childsmile coordinator continues the theme of being 'told what staff think they want to hear':

> *We like to think this is how things are run. But short of being in the nurseries every day ... they tell us what they think we want to hear when we're in monitoring...we set these things up and we hope that they're following things and they're doing it daily* ...[but] *you look at the brushes and you think, they've not been used this year, they're brand new.*
>
> (Respondent 24 [operational], interview, August 2018)

These views suggest that the survey data reported in the previous section may have over-estimated nurseries' participation in toothbrushing every day, given these perceptions that nursery staff may not have felt able to tell Childsmile staff if they were not delivering the programme as intended.

At the beginning of the pandemic, nurseries and schools throughout Scotland were closed March to August 2020 and January to February 2021, therefore the programme was not delivered during these periods (actually, Childsmile coordinators in nine out of 14 health boards indicated that toothbrushing ceased in at least some establishments prior to the official closures in March 2020, due to cross-infection concerns). It was acknowledged that there were uncertainties and anxieties at that point in the pandemic, with the situation changing rapidly which hindered communication between Childsmile teams and nurseries:

> *Head teachers took decision to stop prior to any guidance given out...*[nursery] *staff stopped as lots of information (unverified at the time) was raising concerns.*
>
> (Respondent 7 [operational], survey, July 2020)

In one health board the Childsmile team advised establishments that were anxious about toothbrushing at that time to suspend the programme:

> *Prior to lockdown we were getting phone calls about safety, concerns about contamination. Any establishment that contacted us with any level of uncertainty, we advised them to stop brushing...* [consultant in dental public health] *was supportive that we wouldn't expect people to be participating if there was any doubt.*
>
> (Respondent 4 [operational], interview, October 2020)

In relation to programme reimplementation during the pandemic period, for several months after educational establishments reopened in August 2020, very few Childsmile coordinators identified that toothbrushing had resumed. It was reported that Childsmile coordinators were beginning to communicate with local authority education departments about restarting toothbrushing, but that progress was generally slow (see Chapter 5).

While the numbers of nurseries reported to be participating in the toothbrushing programme increased towards the end of 2020, further closures of educational establishments curtailed the progress made:

> *We had a huge 'Yes, we'd love to do it', 60, 70 nurseries, and we ended up with 14 that we managed to get set up, pre-lockdown, at Christmas. Then they all stopped after Christmas, when we went into lockdown.*
>
> (Respondent 13 [operational], programme meeting, March 2021)

It was noted that staff in nurseries appeared to be more cautious in relation to resuming toothbrushing after reopening in February 2021:

> *After the first lockdown we had about 30-odd establishments that started brushing in school and nursery and there were more coming on board and our toothbrushing training was going well, but with this second lockdown schools are much more anxious...We've got two that have restarted. We're having many more questions about if it's appropriate to do.*
>
> (Respondent 7 [operational], programme meeting, March 2021)

It was also reported that having Childsmile staff redeployed to other roles during the pandemic limited the progress that could be made with restarting the programme.

Several Childsmile coordinators reported that decisions made by local authority education departments had curtailed progress. For example, one Childsmile team had communicated with nurseries directly, with several expressing interest in resuming brushing; however, any progress was stopped due to the local authority Education Manager deciding it should not proceed. The extent to which all children were offered the opportunity to brush every time they attended, in nurseries that have resumed brushing during the pandemic, has not been assessed. Indeed, in one health board where good progress was made towards restarting toothbrushing in principle, the Childsmile coordinator highlighted that returning to the actuality of daily toothbrushing remained a challenge:

> *Establishing toothbrushing as a principle, and happening, feels OK; establishing daily toothbrushing is something that's a wee bit more challenging.*
>
> (Respondent 1 [operational], Health Board P, programme meeting, September 2021)

4.7.2 Logic model activity two: Nursery staff involved in supervising toothbrushing are trained by Childsmile staff; training covers effective toothbrushing & infection control procedures

The context for this activity is that all nursery staff involved in supervising children while toothbrushing should be trained in effective toothbrushing and infection prevention and control procedures, per the National Standards for Nursery and School Toothbrushing Programmes (Childsmile, 2019) with new staff trained prior to delivering the toothbrushing programme and existing staff receiving annual update training (Childsmile, 2016b). Childsmile coordinators in 10 out of 14 health boards reported that nursery staff were trained once per year in the pre-pandemic period, although it took place less often in the other four health boards. It was also noted that ensuring all nursery staff received update training was challenging, due to limited time available as well as low uptake among nursery staff. In two health boards, Childsmile staff had attempted to address this challenge by providing informal updates during monitoring visits, rather than delivering formal training. However one Childsmile coordinator thought that there was a need for a more robust method for cascading standardised information about programme delivery among all nursery staff involved:

> *We train the staff that are there on the day and then there's an agreement about cascading, but I think it would be far more robust if every single staff member had to complete an annual CPD.*
>
> (Respondent 4 [operational], interview, October 2020)

There was limited data gathered on training content, with most references relating to practical aspects and infection prevention and control, such as how to dispense toothpaste safely. One Childsmile coordinator thought it was important to provide the rationale for the nursery supervised toothbrushing programme:

> *Go over the reasons why we're doing toothbrushing, referring to NDIP...I do think that people that have had that background information do become more motivated...evidence about correlations between the toothbrushing and decay rates in Scotland.*
>
> (Respondent 10 [operational], interview, July 2018)

However, another Childsmile coordinator indicated that nursery staff were more interested in practical aspects of setting up and delivering the programme, than its background and evidence.

It was noted that detailed information on what should be included in training was not available, resulting in differences in the training delivered between health boards:

> *The National Standards say you carry out training once a year, but there's nothing anywhere to say what that training is. So in some areas it's really extensive, whereas others it's just the* [content of the] *National Standards.*
>
> (Respondent 35 [strategic], process evaluation, April 2012)

However, it was recognised that a 'one-size-fits-all' approach to training was not appropriate, given differing levels of experience in delivering the programme among nursery staff:

> *If it's a well-functioning establishment with a low staff turnover...telling them exactly the same thing you did in August last year, when the process itself is relatively straightforward, is maybe not the best use of everybody's time. What we've heard from coordinators is that they like to tailor it slightly, as required, which is why we've shied away from being too prescriptive about what it has to cover at every session.*
>
> (Respondent 22 [strategic], interview, January 2018)

During the pandemic, several Childsmile coordinators reported plans to train nursery staff on the revised procedures within the Toothbrushing Standards addendum although it was highlighted that day-to-day delivery was largely unchanged for those who used the dry brushing model previously. In some cases, training was targeted by perceived need as Childsmile coordinators thought that nursery staff experienced in delivering toothbrushing did not require intensive training before restarting the programme:

> *Some of the groups have been doing it for years and years and you can tell when a group is well-versed in doing it...*[Childsmile staff] *know their groups well enough to know who will need what level of training.*
>
> (Respondent 9 [operational], interview, October 2020)

There were restrictions on Childsmile staff visiting establishments in person at that time, leading to several Childsmile coordinators planning virtual training methods, including online training materials. However, other respondents thought that in-person training was required to demonstrate practical changes to delivery adequately:

> *To make sure that the establishments are brushing following the guidelines...we would need to do a demonstration practice and say 'right, show me how you do it now'...there has been a demonstration and observation and they've got Covid-compliant status.*
>
> (Respondent 31 [operational], interview, September 2020)

Up to May 2021, Childsmile coordinators in seven health boards reported that training had been delivered to nursery staff, although not all of those indicated that toothbrushing had resumed at that point.

4.7.3 Logic model activities three and four: Nursery staff supervise children while they are toothbrushing and follow appropriate infection control procedures

These activities are reported together as respondents considered following appropriate infection prevention and control procedures a central part of nursery staff's role in supervising children while brushing. Awareness of infection prevention and control procedures was of course heightened during the pandemic, due to concerns about potential transmission of Covid-19 from inadequately delivered toothbrushing in nurseries.

As reported in the previous chapter, strategic programme stakeholders held differing views on what supervising toothbrushing involved, in terms of close observation of children while brushing or following infection prevention and control procedures to provide a safe environment for toothbrushing. Childsmile coordinators also discussed what supervising toothbrushing entailed and why it was required, such as ensuring children used the correct toothbrush and amount of toothpaste and preventing cross-contamination. Childsmile coordinators agreed that nursery staff supervising brushing should be present to observe children brushing their teeth, to ensure that it took place for two minutes and that children were moving their toothbrushes around their mouths:

> *Are they moving the toothbrush around, are they doing it for two minutes? It's that side of it that's probably the hardest.*
>
> (Respondent 12 [operational], interview, August 2018)

Supervised toothbrushing was highlighted as vital for encouraging all children to brush their teeth and ensuring it took place for an adequate amount of time:

> [Children] *would not brush as long as they would if they had done that in a group setting previously...*[nursery staff] *weren't keeping tabs on who had brushed, if they came in and grabbed their brush, that's fine, but if they didn't they weren't chasing them up and that became a problem that maybe some children weren't brushing.*
>
> (Respondent 17 [operational], interview, August 2018)

The majority of Childsmile coordinators indicated that, to the best of their knowledge, toothbrushing would be supervised appropriately by nursery staff as they were trained and were told why supervision was required. For example, in one health board the Childsmile coordinator thought that having designated toothbrushing supervisors in each nursery helped ensure appropriate supervision:

> *We always emphasise the fact that it's got to be a supervised programme...there's always somebody designated for each individual class to make sure there's support there. So it's not really been an issue.*
>
> (Respondent 31 [operational], interview, July 2013)

However, dental health support workers in another health board suggested that toothbrushing was not always supervised adequately:

> *In a lot of nurseries, it's supposed to be supervised toothbrushing but it isn't always, the nursery staff can't accommodate that, you know 'here's your toothbrush, off you go'...that shouldn't happen, we know that, but you cannae be there every day.*
>
> (Respondent 36 [operational], January 2011)

Respondents agreed that supervision should not involve nursery staff brushing the child's teeth for them and that three- and four-year old children should brush their teeth themselves. It was acknowledged that while the programme was targeted at ante-pre-school and pre-school children (i.e. aged three-years-old and over), younger children participated in toothbrushing in some nurseries,

although it was suggested that this was beyond the immediate scope of the programme at that time. However another respondent thought that the expansion of funded nursery places to eligible two-year-olds required the programme to consider whether and how to include younger children in the programme:

> *When it started it was three- and four-year olds because they're the only ones that were funded... looking into the future then that's something we'll have to discuss, should we be expanding it to people getting those two-year-old places. ...But it does have implications with, perhaps, the way in which it is done, if we do this age group.*
>
> (Respondent 33 [strategic], interview, February 2018)

It was noted that the most recent version of the Toothbrushing Standards did not state a minimum age for participating in the programme and indicated that younger children and children with additional support needs may require direct assistance to brush their teeth. During the pandemic, Childsmile staff in one health board highlighted that the Toothbrushing Standards addendum did not include specific guidance for brushing with younger children who required assistance:

> *We know that Childsmile is age three to five, but we're encouraging brushing across all age ranges ... if you have a younger child who requires assistance, if staff are having to get quite close to that person, I just wondered about the risks of cross contamination*...[if] *you're brushing their teeth, there's sometimes the risk of spray.*
>
> (Respondent 32 [operational], programme meeting, September 2020)

Childsmile staff in two health boards also recognised that younger children would struggle to pick up and replace their own toothbrush from a rack (as required in the Toothbrushing Standards addendum).

4.7.4 Logic model activities five and six: Local Childsmile teams provide regular support to nursery staff to deliver toothbrushing and monitor delivery of toothbrushing in nursery settings (at least twice per year) and make links and work in partnership with all nursery providers and staff

Childsmile coordinators highlighted the role of Childsmile staff in supporting toothbrushing delivery in nurseries, such as working with nursery staff to address difficulties that arose:

> *You've seen it delivered in different ways, what's not working in one establishment, you could suggest something that might help them reorganise it.*
>
> (Respondent 31 [operational], interview, August 2018)

In one health board it was noted that Childsmile staff provided enhanced support to some nurseries, including visiting establishments in-person to carry out toothbrushing with children. Another Childsmile coordinator reported encouraging nursery staff to take the lead in implementing toothbrushing to fit within existing practices in the nursery, which was thought to have helped nursery staff to address barriers to toothbrushing themselves:

> *They look to us for solutions but we're not working there every day ...It has to come from them, how they want to work it rather than being told how to work it because that falls down.*
>
> (Respondent 21 [operational], interview, April 2018)

Where respondents identified that the programme was embedded into daily routines in nurseries, this was supported by having designated Childsmile staff communicating with establishments. In addition, one Childsmile coordinator noted that expectations for delivering the programme should be set out clearly for establishments:

> *'This is how we expect it to be delivered, here are the rules for toothbrushing, if you follow these we'll provide you with toothbrushes and racks'...if you're going to accept the free racks and free brushes, part of that is accepting the way it's to be conducted...there are certain standards that must be followed.*
>
> (Respondent 30 [operational], interview, March 2018)

Per the Toothbrushing Standards, Childsmile staff carried out monitoring visits in nurseries; these took place twice per year in the majority of health boards, with additional visits for nurseries experiencing issues with delivery and in a small number of health boards monitoring took place more than twice per year. Some respondents raised concerns about potential reduced frequency of visits to nurseries, due to wider capacity issues among Childsmile staff, while others noted that their team lacked capacity to provide ongoing support outside of monitoring visits.

Childsmile coordinators reported that monitoring visits entailed: observing and discussing nursery staff's delivery against the Toothbrushing Standards; replenishing toothbrushing resources; and inspecting equipment. Childsmile coordinators' views on whether monitoring should include observing children while they brushed varied, with some indicating this was not required:

> *The monitoring is of the supervision of the toothbrushing programme, not of the children doing the toothbrushing...I think it's seeing every location and monitoring them doing the supervision, possibly in a couple of classes randomly, but it's not about watching every child brush.*
>
> (Respondent 15 [operational], process evaluation, July 2013)

Other respondents thought observing children while brushing should be part of monitoring visits where possible:

> *Checking over the children, making sure they're brushing properly, you're making sure the members of staff have had their training and...adhering to all the protocols that you've went over with them.*
>
> (Respondent 34 [operational], process evaluation, January 2011)

Aside from monitoring visits, several respondents highlighted the importance of Childsmile staff providing other assistance to nursery staff, such as demonstrating how to supervise toothbrushing, supplying and setting up toothbrushes, racks and toothpaste, and preparing toothbrushing charts with children's names. One Childsmile coordinator thought that this support was essential:

> *Some people think that because toothbrushing has been happening we should be able to, theoretically, just leave the schools and nurseries to do that setting up process by themselves...my argument always was that you'd go back to do a monitoring visit and you would need to start off setting them up...you need to invest the time at the start of the new school year.*
>
> (Respondent 31 [operational], interview, August 2018)

During the pandemic, nurseries required practical, in-person support to demonstrate how to set-up and deliver the programme according to the Toothbrushing Standards addendum, for example to support their understanding and interpretation of what was written within the addendum. However it was identified that visiting restrictions in nurseries hindered Childsmile staff providing support to nursery staff.

Several Childsmile coordinators highlighted the need for regular communication with nurseries, particularly among those that had not yet restarted brushing, to maintain awareness of the programme and identify and alleviate any concerns:

> *We are contacting all the establishments...regularly, on a monthly basis, just to see if anybody's wanting to come on board, changed their minds.*
>
> (Respondent 13 [operational], programme meeting, December 2020)

Another Childsmile coordinator highlighted the programme's robust infection prevention and control procedures, established prior to the pandemic, when communicating with nursery staff:

> *They maybe overthink things a bit and actually when you go back to the cross infection control prior to Covid I think that's enough to reassure them as well, you know, that what they were doing prior to Covid was actually really good.*
>
> (Respondent 17 [operational], programme meeting, May 2021)

It was reported that few monitoring visits took place during the pandemic period, with several Childsmile coordinators identifying they had not yet planned how to carry out monitoring visits, although it was recognised that reinstating regular monitoring visits was required to ensure safe programme delivery:

> *There's no way that the programme could be just left to its own devices, I don't think that's appropriate cos it's not supporting the folks delivering it, and it's not in line with the guidance... it covers us too that we're still maintaining the quality of the programme.*
>
> (Respondent 9 [operational], interview, October 2020)

Nurseries in a few health boards resumed brushing without being aware of the Toothbrushing Standards addendum, resulting in some using potentially unsafe practices such as storing toothbrushing equipment in unventilated containers. Again, the need for Childsmile staff to visit nurseries in-person to ensure the programme was being delivered as intended was highlighted:

> *We really wanted to be in there supporting them. So it's kind of conversations over the phone at the moment and the ones that have started have said, yeah, they're getting on fine, but what is 'fine', really?*
>
> (Respondent 17 [operational], interview, September 2020)

4.7.5 Logic model activity seven: Local Childsmile coordinators make links and work in partnership with local authority education departments

Childsmile coordinators identified local authorities as key partners in implementing and delivering the nursery supervised toothbrushing programme, as local authorities in Scotland have a statutory duty to provide early learning and childcare for eligible children. Several Childsmile coordinators identified strong links with local authorities (specifically education departments), such as one Childsmile coordinator highlighting the support received from the local authority education department to encourage reluctant nurseries to participate in the toothbrushing programme:

> *It's not something that* [nurseries] *can choose to do or not do... what we got from the council was backing to say that toothbrushing is an integral part of the day, as is snack. So there is an expectation in* [area] *that all children will be toothbrushing.*
>
> (Respondent 17 [operational], interview, August 2018)

During the pandemic, Childsmile coordinators were expected to communicate with colleagues in local authority education departments about the Toothbrushing Standards addendum and make plans to restart the toothbrushing programme. However, several respondents acknowledged that local authorities were dealing with various guidance and requirements related to establishments reopening which limited their capacity to engage with Childsmile teams at that time. In one health board, Childsmile staff overseeing the toothbrushing programme suggested that someone with more seniority within the health board

should approach their local authority education counterparts in the first instance, to secure their initial engagement:

> *What we've had in the past, I think it probably had to come from someone like* [name], *that initial contact, I don't think to be honest that we're high enough up in the pecking order for them to take any notice of us.*
>
> (Respondent 29 [operational], programme meeting, September 2020)

While some local authorities responded positively to initial approaches by Childsmile coordinators and teams and supported restarting the programme, elsewhere it was reported that local authorities did not support it being restarted at that time. For example, one Childsmile coordinator made several approaches to the local authority before they were given the go-ahead to contact nurseries:

> [The local authority contact said] *it wouldn't happen any time soon because it's not a priority for anyone in education… with other policies and procedures having to come into play, that they didn't want to overload them with this ... 'It's just not a priority' were the words that were used.*
>
> (Respondent 6 [operational], interview, October 2020)

Several Childsmile coordinators reported contacting local authority colleagues regularly, to 'keep the nursery supervised toothbrushing programme on their radars'. While this led to the programme restarting in some areas by early 2021, other Childsmile coordinators noted they had made little progress towards restarting:

> *They're not wanting us at the moment…it's come from the top of Education, so we're kind of stuck.*
>
> (Respondent 18 [operational], programme meeting, December 2020)

Childsmile coordinators in two areas commented on the need to manage relationships with local authority colleagues carefully, as they didn't want to create barriers by pushing ahead too soon after nurseries reopened; for example:

> *I had a conversation with the lead for early years and the lead for education within* [local authority] *and they both felt very strongly that they didn't want to reintroduce toothbrushing* [yet]*…they felt that the staff were going to be overwhelmed with all of the new restrictions … I've got such a good relationship with early years and education, I didn't want to press anything.*
>
> (Respondent 4 [operational], interview, October 2020)

In five health boards, Childsmile coordinators reported that they had limited response to their communications with local authority colleagues; for example:

> *We've had nothing back from our health lead* [name] *who put all these things out for us originally, I've had nothing back from her, it's been incredibly quiet…There's been very little correspondence from anybody.*
>
> (Respondent 9 [operational], interview, October 2020)

While it was thought that disseminating communications regarding restarting the programme via local authority education departments added weight to the messages sent to nurseries, some Childsmile coordinators were unsure if messages were delivered or interpreted as intended. It was also reported that support from local authority education departments did not always translate into buy-in among establishment staff:

> *It doesn't matter what comes down from above, in nurseries and schools it's the head teachers that are the kings of their castles ...you go to the school and they go 'I'm no' doing it', you know, so I think we need to start slowly.*
>
> (Respondent 26 [operational], programme meeting, September 2020)

Wider contextual developments in relation to the pandemic and incidence of Covid-19 infections in different areas of Scotland affected progress towards the restart, such as one Childsmile coordinator reporting that progress made towards engaging with local authority colleagues had stalled once rates of Covid-19 infection increased towards the end of December 2020:

> *We've been emailing the early years education leads within the councils and not getting any responses to our emails, to ask about what the stance is on restarting the toothbrushing.*
>
> (Respondent 13 [operational], programme meeting, May 2021)

4.7.6 Logic model activities eight and nine: Childsmile programme makes links and works in partnership with relevant national stakeholders (e.g. Care Inspectorate, Health Protection Scotland); and Scottish Government Health and Social Care directorate (via Chief Dental Officer's office) facilitates partnerships between Childsmile and other Scottish Government directorates (e.g. Children & Families and Learning directorates)

Prior to the pandemic, respondents regularly shared feedback that the fact toothbrushing was not mandatory created difficulties with participation. Several respondents suggested national-level intervention (via the Scottish Government) was required to address this; for example, to:

> *Legislate that daily toothbrushing in nurseries...must happen.*
>
> (Respondent 15 [operational], process evaluation, March 2017)

This issue was also raised by several Childsmile coordinators in relation to efforts to restart the programme during the pandemic; for example:

> *That needs to come from government-level…it needs to be driven through as health policy, through education, rather than a local person asking 'do we want to do toothbrushing?' it's much more of a, 'this is the expectation because this is one of the factors that mitigates the widening health inequalities'.*
>
> (Respondent 9 [operational], interview, October 2020)

There were examples of partnership-working taking place between the Childsmile programme and national partners during the pandemic, such as developing guidance to support the restart of supervised toothbrushing in nurseries and schools (known as the Toothbrushing Standards addendum) in partnership with the Chief Dental Officer for Scotland, the Care Inspectorate and Health Protection Scotland (see Chapter 1, section 1.5 for further information).

Childsmile coordinators thought that involving these national organisations in developing the addendum had reassured colleagues in local authorities and individual establishments:

> *The minute you say you've got the Care Inspectorate, Health Protection Scotland, and the Antimicrobial guidance group, then people listen, because you're not just coming from Childsmile, you're coming from a wide range of professionals who have agreed this is a safe way.*
>
> (Respondent 7 [operational], interview, October 2020)

The requirement to only carry out dry brushing (per the first version of the Toothbrushing Standards addendum) was thought to be a barrier to

remobilisation, particularly where 'wet brushing' (i.e. at sinks) was predominant. Responding to Childsmile coordinators' requests for clarification on why dry brushing only was permitted, programme managers noted that the Toothbrushing Standards addendum was agreed with national partners to be the best available practice at that time, as there was no specific evidence available to guide decision-making about the safety of either dry or wet brushing models in the context of the Covid-19 pandemic:

> *There's no study that could give you the answer- the best guess, professional opinion, was that the dry brushing was the best way to go, and there was enough professional consensus about it at that time.*
>
> (Respondent 22 [strategic], programme meeting, August 2021)

However it was acknowledged that national partners were presented with the 'dry brushing only' model and asked if this was acceptable at that time, rather than being asked to consider both dry and wet models. As noted, the second version of the Toothbrushing Standards addendum did include both wet and dry models following consultation with Public Health Scotland's 'Covid-19 guidance cell'.

It was also reported that the Childsmile Executive worked with Scottish Government partners to address barriers to remobilisation during this period. For example, the Chief Dental Officer's office liaised with counterparts in the Scottish Government education directorate to facilitate the Childsmile Executive's access to the national Directors of Education group, to seek support for programme remobilisation in local authorities:

> *Scottish Government had asked us about remobilisation and* …[what was] *most challenging, and one of the things* …[was] *getting some support from Education…so we have produced a paper and we will send that off to the Directors of Education* [meeting].
>
> (Respondent 11 [strategic], programme meeting, May 2021)

It was reported that the Chair of the Directors of Education group fed back that the paper was circulated and no concerns were raised regarding proposed plans for restarting the Childsmile programme; however, Childsmile programme managers acknowledged that limited feedback from the group made it difficult to gauge their engagement with the information provided.

4.7.7 Impact of Covid-19 pandemic on intended outcomes of the nursery supervised toothbrushing programme

In relation to the impact of the pandemic on the nursery supervised toothbrushing programme, while data did not indicate that any outcomes within the logic model should be amended, several respondents highlighted that children's oral health would likely be impacted negatively due to the suspension of the programme during the pandemic, as it removed opportunities to establish toothbrushing routines or develop children's toothbrushing skills:

> *We know the toothbrushing has been so effective in improving the health of children's teeth, and we are concerned about the impact of any potential of not brushing over a period of time.*
>
> (Respondent 1 [operational], Health Board P, survey, June 2020)

It was also noted that wider disruption to dental services, including children not being seen in dental practices regularly, heightened the likely negative impact on children's oral health. Respondents highlighted that these potential negative outcomes for children's oral health emphasized the need for the programme to be restarted:

> *I think the toothbrushing programme will be even more important to mitigate the effects of that. ...rather than saying 'oh no, the toothbrushing's too difficult to achieve, we've all got to be so careful now', I don't think that's an argument really, I think we can and should be doing the toothbrushing programme.*
>
> (Respondent 9 [operational], interview, October 2020)

4.8 Chapter summary

Overall, this chapter has shown that there is evidence that each of the activities shown in the logic model have been delivered at least partially in the periods before, during and after the pandemic. However, the findings also suggest variations between health boards in the extent to which delivery-in-reality matches what was intended from the logic model. The Covid-19 pandemic disrupted programme delivery as nurseries closed for several months in 2020 and 2021, with processes involved in restarting the programme following those closures hampered by pandemic-related restrictions.

It is intended that children attending nursery should be offered the opportunity to participate in supervised toothbrushing, on every day they attend, in 100% of nurseries (activity one); however, this was found not to be the case in the pre-pandemic period, with 92.2% of eligible children (of all ages) brushing their teeth on the day of the survey. Some nursery characteristics were found to be associated with 100% of children brushing (namely, numbers of children attending; range of age groups attending; and health board location). However these data may over-estimate nurseries' participation, as qualitative findings indicated some Childsmile coordinators and staff perceived that toothbrushing did not take place with all children every day they attended in 100% of nurseries, and were uncertain about the extent to which toothbrushing was delivered every day.

It was found that local Childsmile teams trained nursery staff to deliver the programme (activity two), with variation between health boards in content and frequency of training; and the majority of Childsmile coordinators thought that appropriate supervision of toothbrushing took place in nurseries, following appropriate infection prevention and control procedures (activities three and four) as this was a core component of training provided to nursery staff. However, providing training annually was acknowledged to be challenging, due to numbers of nurseries and staff involved and time available for delivery; and while training content tended to focus on practical aspects of delivery, including infection prevention and control, this varied between health boards as there was no national, standardised training package.

Childsmile coordinators were satisfied that they and their teams supported nursery staff and monitored programme delivery (activities five & six), through demonstrating delivery, supplying equipment and addressing challenges that arose. Before the pandemic, programme delivery was monitored at least twice per year in the majority of health boards; however, it was often not possible to provide practical, in-person support due to pandemic-related restrictions, with few monitoring visits taking place in this period, although other methods of communication were used to maintain contact with nurseries.

Several Childsmile coordinators identified good links with local authority education departments (activity seven), particularly in the pre-pandemic period. During the pandemic, Childsmile coordinators were aware of the need to manage their relationships with local authority colleagues carefully; while some attempted communicating with local authority colleagues regarding restarting the nursery supervised toothbrushing programme, this had varying success. It was recognised that local authorities had many competing priorities at that time relating to pandemic-related guidance and restrictions.

Finally, in relation to partnership-working between the Childsmile programme and relevant national partners (activities eight and nine): in the pre-pandemic period it was identified that one of the major challenges was that nurseries' participation was not mandatory, with various respondents suggesting that intervention from the Scottish Government was required to address this; however, there has been no action taken on this to date. During the pandemic, there were several examples of successful partnership-working between the programme and national partners, including developing pandemic-related guidance for programme delivery, and it was thought that involving relevant national organisations had provided reassurance and increased credibility of the programme's guidance. However, the extent to which partnership working continued to take place was limited by the wider demands created by the pandemic and post-pandemic recovery activities.

This chapter has demonstrated that there are gaps between delivery-in-reality and what was intended within the Theory of Change in relation to several aspects of programme delivery. Following on from this, the next chapter

explores the barriers and facilitators to delivering the nursery supervised toothbrushing programme as intended.

5 Barriers and facilitators to implementing the nursery supervised toothbrushing programme

The previous chapter explored programme delivery in reality, compared to what was the intended model as shown in the nursery supervised toothbrushing programme logic model. This found that, while most activities were being delivered at least partially, there were gaps between what was intended and what was actually being delivered, including variation between health boards. This chapter will explore the overarching barriers to delivering the nursery supervised toothbrushing programme, as well as factors that facilitate its delivery, including issues arising during the Covid-19 pandemic. These findings will be used to identify appropriate implementation strategies to address the barriers and facilitators identified.

5.1 Chapter aim and research questions

Guided by the Consolidated Framework for Implementation Research (CFIR) (Damschroder et al., 2009), this chapter aims to present and summarise the main barriers and facilitators to delivering the nursery supervised toothbrushing programme as intended, which will inform the selection of appropriate implementation strategies to optimise programme delivery. The research questions were:

1. What are the main barriers and facilitators to implementing the nursery supervised toothbrushing programme as intended?

    a. Using an appropriate theoretical implementation framework, which factors are relevant in understanding the main barriers and facilitators to implementing the nursery supervised toothbrushing programme?

    b. How can the barriers and facilitators identified be used to select implementation strategies to optimise programme delivery?

5.2 Methods

A qualitative approach was used to explore the barriers and facilitators to programme delivery. Qualitative research is concerned with understanding how individuals and groups make sense of and interpret their experiences, within specific contexts (Bower and Scambler, 2007, Ravitch, 2020). Within the field of public health, Jack (2006) highlighted the role of qualitative research in providing insights into contextual factors influencing whether public health programmes are successful or not. Qualitative research also contributes to implementation science research: exploring participants' perceptions, experiences and beliefs, and contextual factors helps to identify barriers and facilitators to implementing interventions in 'real-world' settings (Tripp-Reimer and Doebbeling, 2004, Hamilton and Finley, 2019).

5.2.1 Data collection

Qualitative data gathered by the principal researcher from the same sources as in the previous chapter were used to answer this chapter's research questions (i.e. ongoing process evaluation methods; qualitative interviews with Childsmile coordinators and staff; nursery surveys; and surveys with Childsmile coordinators and staff). Table 21 recaps the data collection methods used; see also Figure 9 plus Sections 4.2 to 4.4 in Chapter 4 for more detailed description of the ethical considerations and methods included.

Table 21 Recap of methods used (Chapter 5)

Method	Description
Ongoing Childsmile process evaluation methods	The Childsmile process evaluation gathers ongoing qualitative data on programme implementation from programme stakeholders. (Appendix 11 provides details of process evaluation methods, participants and timescales.) Data used in this chapter included: • Secondary analysis of historic data (collected August 2010-June 2017); • Observations and facilitated discussions at programme meetings (taking place April 2020-September 2021); • Review of programme documentation produced by the Childsmile programme during July 2020-August 2021
Qualitative interviews with Childsmile coordinators and staff	Carried out by the principal researcher in two tranches, to explore programme delivery, challenges and facilitators: • Tranche one (March-August 2018): 24 respondents representing all 14 health boards; and • Tranche two (September-November 2020): 20 respondents representing 11 out of 14 health boards. (Interviews were audio-recorded and transcribed by the principal researcher; interview schedules are included in Appendix 12.)
Surveys of nurseries	Two surveys of nurseries were carried out: • The first survey was carried out January-August 2019, to quantify participation in the programme and gather data on barriers and facilitators to delivery; and • The second survey was undertaken May-June 2022, to gather information on nurseries' progress towards programme reimplementation in the post-pandemic period. (Survey questions are included in Appendices 9 & 10.)
Surveys of Childsmile coordinators and teams	Online surveys of Childsmile coordinators and teams were undertaken in June 2020 (on the initial impact of the pandemic on programme delivery) and May 2021 (on progress towards programme reimplementation). (Survey questions are included in Appendix 14.)

5.2.2 Qualitative data analysis

While data used to answer this chapter's research questions were gathered from the same sources as used in the previous chapter, analysis of these data differed for this chapter in that it focused on factors associated with programme implementation.

As described in Chapter 2 (Section 2.2.2.2), Thematic Analysis was used to analyse these qualitative data, following the approach set out by Braun and Clarke (2006). The principal researcher achieved initial familiarization with the data by transcribing approximately 30 hours of audio-recorded interviews and discussions and repeated readings of transcripts, meeting notes and relevant programme documents. This was followed by an phase of inductive coding (utilising QSR International NVivo 10 qualitative data management software), which involved reading and interpreting the raw text of transcripts and other sources detailed above, to observe and recognise patterns within the data and identify emerging themes describing factors affecting programme implementation. The principal research identified these codes in discussion with the supervisory team (AS, AR) to ensure appropriate interpretation of the data. Table 22 sets out the codes that emerged from this initial inductive coding exercise, which the principal researcher applied to the whole dataset (some of these were specific to the pandemic period while others were applicable to all time periods).

Table 22 Inductive codes applied to dataset

Stakeholders' buy-in, willingness, attitudes or perceptions towards the nursery supervised toothbrushing programme
Fitting toothbrushing into nursery schedules/routines
Compatibility of the nursery supervised toothbrushing programme with other guidance/policies
Supervising toothbrushing
Children's attendance patterns and numbers of children attending
Children's needs, abilities and responses to toothbrushing
Staffing and training (within nurseries and Childsmile teams)
Facilities and space available in nurseries
Toothbrushing equipment and resources provided
Support provided by Childsmile staff
Hygiene and infection prevention and control
Communication between various stakeholders, e.g. • nursery staff • local authority education departments • local Childsmile teams • national Childsmile programme • national organisations/partners
Content and interpretation of guidance on remobilising the nursery supervised toothbrushing programme
Planning and progress towards re-implementation of the nursery supervised toothbrushing programme
Wider contextual factors affecting implementation

The principal researcher then mapped these emergent codes to relevant CFIR domains and constructs (Damschroder et al., 2009), to identify which of these were relevant to programme implementation. (Detailed description of the CFIR is provided in Chapter 2, section 2.2.3.3.) Table 33 in Appendix 15 sets out how emergent codes were mapped to CFIR domains and constructs. The deductive codes provided by the CFIR domains and constructs were then applied to the whole dataset. Themes were then developed by examining coded data, through extracting data coded to various combinations of inductive and deductive codes, using the 'Queries' function within QSR NVivo 10, to identify which themes were

salient in relation to answering this chapter's research questions. Again, the principal researcher developed these themes in discussion with the supervisory team (AS, AR).

The remainder of this chapter reports the analysis undertaken; this is structured using the CFIR's domains and constructs as a framework for reporting these findings. As with Chapter 4, contextual information obtained from observations (undertaken for the Childsmile process evaluation) is used to support interpretation of respondents' views as required. Relevant quotes from respondents are included to illustrate findings where relevant. As described in Chapter 4, respondents' anonymity was preserved by assigning numbers and respondent types (i.e. 'operational' for Childsmile coordinators and other staff or 'strategic' for those involved in managing the programme nationally, such as Childsmile Executive members). Operational respondents' and nurseries' health board areas were assigned letters randomly which are specified alongside quotes, as is the data source (i.e. interview, survey, programme meeting or other process evaluation data collection) and month and year of data collection.

5.2.2.1 Selecting appropriate implementation strategies to optimise programme delivery

Once the range of relevant CFIR constructs were identified, the principal researcher mapped these to relevant ERIC strategies, using the CFIR-ERIC Implementation Strategy Matching Tool, which showed the percentage of participants from Waltz et al. (2019)'s study that selected each ERIC strategy as appropriate to address each CFIR construct. For this research, the highest rated ERIC strategies for each CFIR construct identified as relevant to the implementation of the nursery supervised toothbrushing programme were selected initially. These were reviewed to select the implementation strategies that were the most feasible and appropriate to apply to the programme. The results of this exercise were used to inform recommendations to optimise programme delivery.

5.3 Findings

Table 23 sets out the CFIR domains and constructs found to be relevant to programme implementation, in the periods before and during the Covid-19 pandemic (with the highlighted constructs identified as relevant during both periods). The CFIR was representative of the barriers and facilitators to implementing the nursery supervised toothbrushing programme, as the factors identified through this research mapped on to all five CFIR domains, and 14 of its 26 constructs (nine in the pre-pandemic period and 12 during the pandemic).

Seven constructs (from four domains) were identified as relevant in both pre- and during pandemic periods: complexity of the intervention; patient needs and resources; external policies and incentives; networks and communication; implementation climate; readiness for implementation; and individuals' knowledge and beliefs about the intervention. Interestingly, the 'Process of Implementation' domain emerged as relevant during the pandemic only, as the intervention was being re-implemented following its suspension, whereas before the pandemic the programme had been delivered for a long period of time, therefore respondents did not focus on the processes involved in implementation.

Table 23 Domains and constructs from the Consolidated Framework for Implementation Research identified as relevant to implementation of the nursery supervised toothbrushing programme

Domain		Construct	Identified as relevant to implementation:	
			pre-pandemic	during pandemic
1.	Intervention characteristics	Complexity	✓	✓
		Design quality & packaging	✓	
		Cost	✓	
		Evidence strength & quality		✓
		Adaptability		✓
2.	Outer setting	Patient needs & resources	✓	✓
		External policies & incentives	✓	✓
3.	Inner setting	Networks & communication	✓	✓
		Implementation climate	✓	✓
		Readiness for implementation	✓	✓
4.	Characteristics of individuals	Knowledge & beliefs about the intervention	✓	✓
5.	Process of implementation	Planning		✓
		Engaging		✓
		Executing		✓

5.3.1 Barriers and facilitators to delivering the nursery supervised toothbrushing programme

5.3.1.1 Domain 1: Intervention Characteristics (Complexity; Design Quality & Packaging; Cost)

In relation to the programme's complexity, this related to nursery staff's perceptions about fitting toothbrushing within overall nursery routines; supervising toothbrushing; and concerns relating to hygiene and cross-infection. Staff in several nurseries identified that toothbrushing was time-consuming which made it difficult to fit into routines. For example, one respondent commented that:

> *So many things are expected from practitioners with more being added and the big challenge is trying to fit everything in - especially on a daily basis. Sessions seem to pass so quickly and we are under pressure to include a multitude of tasks.*
>
> (Nursery, Area A, survey, 2019)

Other respondents commented that it was difficult to deliver toothbrushing alongside other things required within nursery sessions, including providing children with snacks or meals; outdoor learning sessions (with some nurseries identifying an expectation that children would be outdoors for 50% of the nursery session); physical activity; and activities related to children's transition to starting primary school.

Challenges associated with supervision included keeping track of which children had brushed their teeth during the nursery session; and being able to observe children while brushing their teeth to ensure it was being carried out correctly. Respondents also expressed concerns about cross-infection practices and the possibility that children may touch or use another child's toothbrush.

In terms of design quality and packaging, the toothbrushes provided to nurseries were available in five colours (red, yellow, orange, green and blue) with printed symbols on them (two themes - 'animals' and 'toys' – with 20 different symbols per theme) to aid children to identify their own toothbrush. Racks had corresponding symbols to enable children to store their toothbrush in the appropriate slot. Various respondents described the resources provided in positive terms, such as 'bright', 'attractive' or 'colourful' and specific aspects of these resources were highlighted positively, such as the use of symbols on brushes and racks which helped children to identify their own toothbrush and put it back into the correct slot on the rack:

> *The ease of children accessing their own toothbrushes and identifying which is theirs.*
>
> (Nursery, Area D, survey, 2019)

There were 200 possible colour/symbol combinations for the toothbrushes used in the programme; however, some respondents identified that their nursery was not provided enough 'unique' colour/symbol combinations in settings with large numbers of children attending:

> *Can be very difficult when you have three racks and all the symbols are the same, very easy to get brushes mixed up.*
>
> (Nursery, Area F, survey, 2019)

It was also suggested that some of the symbols on brushes were not clear, making it difficult for children to identify their own brush. Overall, while there were some barriers identified, the designed element of the programme (toothbrushes, toothpaste, racks etc.) mainly facilitated programme delivery. In addition to the regular supply and replenishment of toothbrushing resources, respondents highlighted that the fact that toothbrushes, toothpaste and racks were provided free-of-charge to nurseries was a major facilitator and that brushing would not take place if nurseries were required to fund these resources themselves.

5.3.1.2 Domain 2: Outer setting (Patient Needs & Resources; External Policies & Incentives)

Some children required additional support to participate in the programme. This included children with specific additional support needs, as well as resulting from children's developmental stage more generally. For example, several respondents indicated that children's behaviour was a general barrier to programme delivery, including their ability to follow instructions and perform the required actions.

Some respondents' concerns regarding hygiene and infection prevention and control were linked with children's support needs, as it was recognized that children who were unable to identify or select their own toothbrush independently required support to prevent the wrong brush being used:

> *Children are not able to follow a teeth cleaning routine independently to a degree that ensures hygiene/risk or cross infection procedures are 100% secure.*
>
> (Nursery, Area G, 2019)

In addition some children were reluctant or refused to participate in toothbrushing, which sometimes affected other children's willingness to participate. Some respondents provided reasons for children's refusal or reluctance, such as being uninterested in brushing or disliking the taste of the toothpaste used. It was recognised that children preferred participating in other activities in nursery which they were reluctant to stop to brush their teeth:

> *The biggest challenge is tearing the children away from playing to come brush their teeth.*
>
> (Nursery, Area A, survey, 2019)

Where children were reluctant to participate, several respondents commented that they would not 'force' them to participate and that children were able to choose not to brush:

> *Children now have option to say 'no' to an activity, even if beneficial.*
>
> (Nursery, Area J, survey, 2019)

This was linked to 'free play' policies in nurseries, which in some cases were interpreted to mean that nursery staff were unable to direct children to participate in particular activities, including toothbrushing:

> *Outside play does not encourage children to come in and brush teeth.* [We are] *not to stop children from engaged play.*
>
> (Nursery, Area E, survey, 2019)

However, children's responses to toothbrushing, specifically in terms of social learning from peer interaction and achievement motivation, also appear as facilitatory:

> *It allows children self motivation and independence and they encourage each through copying others.*
>
> (Nursery, Area F, survey, 2019)

Childsmile coordinators in a number of health boards identified that local authority policies related to early learning and childcare provision impacted on toothbrushing delivery, specifically in relation to Scottish Government guidance requiring early learning and childcare services to be child-centred and responsive to children's interests and demands (Scottish Government, 2014a)[16]; and the national play strategy which called for 'free play', (motivated intrinsically, chosen by the child) to be central to early learning and childcare environments (Scottish Government, 2013b). There was evidence that nursery staff interpreted these policies as preventing them from directing children to participate in group-based activities, including toothbrushing:

> *Not being allowed to interrupt children play makes it difficult to slot in toothbrushing.*
>
> (Nursery, Area J, survey, 2019)

This extended to respondents referring to guidance they had received via the Care Inspectorate (the body which regulates and inspects care services in Scotland) regarding the requirement for free play:

> *Inspection highlighted taking children away from free play for brushing* [is] *no longer allowed.*
>
> (Nursery, Area C, survey, 2019)

[16] Any policies referred to by respondents are referenced within this section, as appropriate.

These changes in early years delivery were thought to result in less structured nursery sessions:

> *The nursery structure isn't as it was when the toothbrushing programme started... the whole nursery structure itself* [has changed]. *That is what's having an impact on the programme. It's a huge culture change within the nursery...in the past it was much easier to see that it was happening because of the way the nurseries were structured and we have lost that structure…the kids are coming in and out all the time and it's almost like there isn't a good time of day when you can have them all brushing...it is a headache beyond belief as far as the brushing programme is concerned.*
>
> (Respondent 8 [operational], interview, June 2018)

While nurseries previously had a set time for providing snacks each day, with most carrying out toothbrushing directly after snack-time, there was 'rolling' snack-time now available for the duration of the session, with children choosing if and when to have this. This meant there was no longer a set time for snack or toothbrushing and limited opportunities to bring children together to carry out group activities. While nurseries intended to offer 'rolling' toothbrushing (i.e. toothbrushing would be available for the duration of the session and children would brush their teeth after snack, whenever that might be) Childsmile coordinators did not think that this was working as it should:

> *Some of the nurseries now have this play-focus, they're not in groups and things like that. That's becoming a bit of a barrier...nurseries are maybe just using it as an excuse to stop. The rolling snack is a part of that. But they tend to offer toothbrushing at the same time but...supervision will not be great because that one person is also supervising the snack and supervising the toothbrushing.*
>
> (Respondent 12 [operational], interview, August 2018)

Another Childsmile coordinator commented that allowing children to choose which activities to participate in made it less likely they would participate in toothbrushing:

> *Definitely every child doesn't get the opportunity, just because of the way it runs in [health board]. Where it seems to have a natural flow from snack, but not every child comes for snack...it's the children that have not had their snack, they don't seem to be encouraging them.*
>
> (Respondent 19 [operational], interview, April 2018)

In addition to the introduction of 'free play' into nurseries, other changes to early learning and childcare delivery (in terms of availability of sessions and children's attendance patterns) impacted on the programme. When the programme was first implemented, children (aged three and four) were entitled to 475 hours of early learning and childcare per year, mainly delivered via sessions on set days and times (e.g. five mornings or five afternoons per week). The Children and Young People's Act (Scotland) 2014 required local authorities to increase early learning and childcare provision to 600 hours per year for eligible children (all three- and four-year olds and two-year olds whose parents/carers receive certain welfare benefits) (Scottish Government, 2014b). Alongside increasing the mandatory hours of early learning and childcare, local authorities have a statutory duty to increase the choice and flexibility of early learning and childcare provision and it is expected that increasing to 1140 hours of early learning and childcare per year will prompt further changes to nurseries' opening hours, year-round (instead of term-time) provision, and children's use of multiple early learning and childcare providers (Scottish Government, 2018a). Various attendance patterns were available in local authority nurseries: some offered full day sessions while others retained five morning or afternoon sessions; some had children attending on set days, with fixed session start and finish times, while others had introduced flexible provision whereby individual children could potentially have different attendance patterns:

> *Now it just seems to be totally random that someone comes in for two hours one day, seven hours on another day... you look at the attendance sheet and it's just a mosaic of, one child's in ten 'til two, another is in nine 'til three, on different days as well...it is very difficult to know who is in when.*
>
> (Respondent 9 [operational], interview, June 2018)

Some Childsmile coordinators identified that flexible attendance in nurseries had a negative impact as children might not be present at a time when toothbrushing was available in the establishment:

> *There are a lot of children only engaging in nurseries one or two days a week or they're in at times they're not necessarily being exposed to the toothbrushing programme, or because they're coming and going throughout the day it's not happening.*
>
> (Respondent 10 [operational], interview, March 2018)

Indeed, it was suggested that the changed structure and flexibility of early learning and childcare provision meant it was very different to when the programme was first introduced, with some Childsmile coordinators commenting that the toothbrushing programme no longer fitted into the structures it was originally designed for.

It was further noted that emphasis given to outdoor play within early learning and childcare provision meant toothbrushing did not take place as children were not present within the nursery building:

> *They've got all these competing directives...*[such as] *they have that directive about how much time they need to be spending outside.*
>
> (Respondent 10 [operational], interview, July 2018)

It should be noted that some considered toothbrushing to be distinct from activities covered under free play, leading to toothbrushing continuing to take place in nurseries as a structured activity which children were prompted to do:

> *It's not like choosing to go and play in the sand or wet play and whatever it might be, it's part of the nursery day, like washing your hands when you've been to the toilet. It's not really an 'activity'.*
>
> (Respondent 24 [operational], interview, August 2018)

Another facet of this construct relates to the fact that toothbrushing is not a mandatory part of early learning and childcare provision; while Childsmile staff were able to advise and support nurseries about delivering the programme, they were unable to influence nurseries' engagement or day-to-day delivery:

> *Because it's a recommendation as opposed to a requirement, we've always struggled with that. If it had been a directive…that would have been it, but as long as there's that grey area of having an option, they will pull that out their holster, 'well we don't have to do this'.*
>
> (Respondent 24 [operational], interview, August 2018)

Without external influence to push nurseries to participate, some Childsmile coordinators thought they were unlikely to ever reach participation targets, as they continued to face resistance and had exhausted attempts to bring establishments on board:

> *There comes a point where there's nothing else I can do. I've spoken to the head teacher, they've said 'no'...I don't have any authority.*
>
> (Respondent 24 [operational], process evaluation, May 2012)

Indeed, some respondents thought that nursery supervised toothbrushing programme delivery should be on a par with other directives in educational establishments, such as duration of physical activity, and that this required direction from the Scottish Government:

> *Make it mandatory, everybody toothbrushing, yes. I think that is an awesome idea and I would love that to happen. ...it would happen more, it would be more part of the day because it would be seen alongside physical activity et cetera. We've all been desperate to ask for that for a long, long time.*
>
> (Respondent 15 [operational], interview, August 2018)

However other respondents acknowledged that there might remain nursery staff who resisted delivering the programme regardless of national directives:

> *Even if you make it mandatory it will still be an issue for those that don't see the purpose or the point and will always make it difficult.*
>
> (Respondent 18, [operational], interview, August 2018)

5.3.1.3 Domain 3: Networks and Communications; Inner Setting (Implementation Climate; Readiness for Implementation)

Some respondents reported that communication between nursery staff and Childsmile staff was challenging; this included uncertainty among Childsmile staff regarding some nurseries' participation, despite their assurances that they provided toothbrushing every day:

> *They say they do it five days a week, but our staff know they're not doing it five days a week as they would have been asking for a lot more toothpaste, you can see the evidence of the toothbrushes that are brand new. They don't realise we can tell.*
>
> (Respondent 6 [operational], interview, June 2018)

In relation to communication taking place between local Childsmile teams and local authority education departments, some Childsmile coordinators enlisted support from local authority colleagues to engage with non-participating nurseries, although one Childsmile coordinator cautioned that involving local

authority education departments to address issues sometimes had a negative impact:

> *It can work where it just puts their hackles right up, 'you've been away telling on me'.*
>
> (Respondent 24 [operational], interview, August 2018)

It was also identified that support from a local authority education department did not always translate to cooperation from individual nurseries:

> *We have the council on our side, emails have gone out, had meetings with the early years development officers, that's all happened but still* [nurseries] *just don't do it.*
>
> (Respondent 20 [operational], interview, April 2018)

Several other respondents indicated that their links with local authority education departments were lacking:

> *That's one of the barriers we find, the buy-in and understanding of the programme and how that's filtered down, and if it isn't, it's a non-starter. So I think that we do need to get the* [local authority] *representatives involved in the top level so that it's passed down through Education.*
>
> (Respondent 9 [operational], interview, June 2018)

However, several Childsmile coordinators highlighted local authorities as key partners in implementing and delivering the programme. Various Childsmile coordinators reported strong links with local authority education departments and in some cases sat on local early years groups alongside local authority partners. Some respondents highlighted that they received support from local authorities when working with nurseries reluctant to deliver toothbrushing, including examples of local authority education departments communicating to

establishments that there was an expectation that they participated in the programme:

> *The Director of Education*...[emailed establishments to say] *'if you're offered to take part in this programme, you should be doing it. If you're not, come and see me'... we've began a round, again, of these reluctant places and we're starting to steadily get them on board. So I think it's worked.*
>
> (Respondent 24 [operational], process evaluation, May 2012)

Within the CFIR, the 'Implementation Climate' construct refers to an organisation's capacity to make changes and adopt an intervention, including receptivity among those involved in implementing the intervention and the extent to which an intervention is compatible with existing workflows and systems. (This construct overlaps with the 'Complexity' construct in the 'Intervention Characteristics' domain.) The extent to which delivering the programme fitted within nurseries' schedules and routines emerged as a major theme, as it was identified that there were lots of activities delivered during nursery sessions in addition to toothbrushing:

> *There are more and more that we are expected to fit into the nursery hours and it is just not possible at times to do everything.*
>
> (Nursery, Area A, survey, 2019)

In some cases it appeared that those identifying challenges with fitting toothbrushing into routines placed higher priority on other activities, e.g.:

> *Unfortunately teeth brushing is the first thing to be dropped when we are busy and in all honesty this happens more often than not.*
>
> (Nursery, Area A, survey, 2019)

Children arriving or leaving nursery at different times impacted on finding an appropriate time for toothbrushing to take place. In some nurseries it was noted

that toothbrushing took place at a fixed time during each session, with no flexibility to accommodate children who were not present at that point (for example, due to arriving later or leaving earlier) to participate in brushing.

While various respondents identified that fitting toothbrushing into nursery routines was challenging, there were many other respondents who found that toothbrushing was a well-established part of their nursery routines, including those that noted it fitted with other aspects of the nursery curriculum. It was highlighted that it required effort to establish toothbrushing within nurseries' routines soon after the start of the academic year, with several respondents commenting that routines were put in place *"early on"*. It was also noted that having both staff and children who were familiar with the routine facilitated toothbrushing:

> *Do it the same time every day so children learn very quickly and because they know routine so well it is easy to include as part of our day.*
>
> (Nursery, Area A, survey, 2019)

Having children who attended at the same time helped to fit toothbrushing into routines; and having smaller numbers of children attending was thought to help maintain regular routines within nurseries and provide adequate supervision to children while brushing, in comparison with nurseries with larger numbers of children:

> *We have quite a lot of smaller establishments...they're the ones that do it well because there aren't so many children. With the bigger ones it might be that they have several* [toothbrushing racks] *and they select each group to go at a separate time.*
>
> (Respondent 4 [operational], interview, July 2018)

The 'Readiness for Implementation' construct relates to availability and access to resources, knowledge and information to support implementation and delivery of interventions. As noted in relation to other constructs, factors including time

constraints and large numbers of children attending posed challenges to delivering toothbrushing every day and supervising toothbrushing adequately. Having sufficient staffing within nurseries was a necessary resource to deliver the programme:

> *Having one staff member keeping on top of managing the toothbrushing in terms of organisation, supported by the rest of the staff team, ensuring they carry out toothbrushing.*
>
> (Nursery, Area F, survey, 2019)

It was identified that parents/carers volunteered to support the programme in some nurseries, which facilitated delivery; however, it was also noted that relying on parents/carers (rather than nursery staff) to deliver the programme meant toothbrushing might not happen if volunteers were unavailable.

There were barriers related to facilities and space available in nurseries, such as a lack of sinks or issues with the location of sinks in the settings. Limited space required careful scheduling of activities in some nurseries where it was not possible to deliver toothbrushing alongside another activity simultaneously. Conversely, other nursery staff identified that having appropriate facilities and space available in nurseries facilitated programme delivery, such as having sufficient, accessible sinks and adequate storage space for toothbrushing resources.

Having toothbrushing resources (toothbrushes, toothpaste or racks) supplied to nurseries by the Childsmile programme was said to be an important facilitator to programme delivery. A small number of respondents identified issues with the toothbrushing equipment supplied, such as not receiving sufficient toothbrushing resources which made replacing dropped or damaged toothbrushes difficult, for example. However, the vast majority of respondents commented that they received an adequate supply of toothbrushing resources.

Feedback from a number of Childsmile coordinators highlighted their teams' approaches to ensuring that nursery staff were equipped with sufficient knowledge and information to implement the programme successfully. For

example, one Childsmile coordinator noted that encouraging nursery staff to take the lead in implementing the programme in their own settings, to ensure that it fitted with existing practices, had proved successful in engaging establishments to address barriers to toothbrushing themselves, while another highlighted that clearly setting out the expectations for nursery staff facilitated their engagement.

Nursery staff said that training provided by local Childsmile teams supported them to deliver the programme. Furthermore, it was thought that Childsmile staff visiting nurseries to provide information about toothbrushing to children facilitated their participation:

> *Talks to the children help all the staff to show the children the correct way to clean teeth and teach them the importance of good dental hygiene.*
>
> (Nursery, Area F, survey, 2019)

5.3.1.4 Domain 4: Characteristics of Individuals (Knowledge & Beliefs about the Intervention)

Damschroder et al. (2009) recognised that the characteristics of individuals implementing interventions (including their attitudes towards, and value placed on, the intervention being implemented) influenced implementation, both positively and negatively. Feedback from Childsmile coordinators and staff indicated that one of the main barriers they faced was negative attitudes among nursery staff, with Childsmile coordinators in the majority of health boards identifying barriers with some nursery staff's engagement with the programme. While it was acknowledged that substantial numbers of nursery staff supported the programme, it was thought that programme delivery often fell to those well-engaged staff.

With respect to those who viewed the nursery supervised toothbrushing programme negatively, there appeared to be difficulty in influencing those views. The impact of negative attitudes among influential nursery staff was also

highlighted; for example, if head teachers or nursery managers did not value the programme, the rest of the staff were often less engaged with it:

> *As soon as you mention toothbrushing, they just will not take you on, they'll just disappear... some of them, if it's their turn to do the toothbrushing, they just don't do it because they don't want to do it, they don't see the point in it...and so it just doesn't happen.*
>
> (Respondent 9 [operational], interview, June 2018)

One Childsmile coordinator commented that their staff's conversations with nursery staff about toothbrushing were often negative and ongoing work to manage and maintain relationships and encourage participation was required. Nursery staff also expressed negative views about toothbrushing not being part of their role:

> *They won't take part in toothbrushing because 'it's not their responsibility', 'do you want me to start brushing their hair next or cutting their toe nails?' is basically the reaction.*
>
> (Respondent 17 [operational], process evaluation, July 2013)

A lack of buy-in or negative views towards the programme were also apparent among some nursery staff respondents:

> *I also don't believe it is our job and we are concentrating on lots of things at nursery... I believe the work should be done at home and more support there.*
>
> (Nursery, Area A, survey, 2019)

Another factor related to this construct was that some nursery staff appeared to experience feelings of disgust or discomfort regarding toothbrushing:

> *You can tell they're just absolutely revolted by the whole process...we take it for granted because we're quite happy handing out toothpaste and dealing with children spitting…but they find the whole thing so unsavoury.*
>
> (Respondent 9 [operational], process evaluation, July 2013)

This was linked with some nursery staff feeling uneasy about hygiene and infection prevention and control factors associated with toothbrushing, including aspects of toothbrushing not taking place at a sink; one respondent commented that *"Spitting into a paper towel is not hygienic"* (Nursery, Area M, survey, 2019). However, on the whole, there were few comments made about hygiene and infection prevention and control by respondents during the pre-pandemic period.

5.3.2 Barriers and facilitators to delivering the nursery supervised toothbrushing programme during / after Covid-19 pandemic (since March 2020)

The previous section explored barriers and facilitators to nursery supervised toothbrushing programme delivery in the period prior to the Covid-19 pandemic in relation to relevant CFIR domains and constructs. This section revisits these barriers and facilitators to assess the extent to which the Covid-19 pandemic has impacted on them as well as identifying any new barriers or facilitators specific to this period.

5.3.2.1 Domain 1: Intervention Characteristics (Evidence Strength and Quality; Adaptability; Complexity)

During the pandemic, findings related to perceptions about evidence strength and quality, intervention complexity and adaptability focused on using the 'dry brushing' model (as specified in version one of the Toothbrushing Standards addendum).

For example, several Childsmile coordinators identified that staff in their teams were anxious about promoting the dry brushing model amid heightened awareness about infection prevention and control during the pandemic; for example:

> *For staff they were more concerned about the whole spitting into a paper towel, why would you be encouraging someone to spit when you have Covid all over the place. So yeah, for us it would be managing the concern and anxiety around about that.*
>
> (Respondent 23 [operational], interview, November 2020)

It was recognised that some Childsmile coordinators themselves were unsure of the evidence supporting dry brushing, which affected their ability to reassure staff in their own teams as well as nursery staff:

> *Some of the coordinators didn't believe in dry brushing, so how can they then pass on the information and ask their supervisors to do that themselves? So they were needing reassurance themselves.*
>
> (Respondent 11 [strategic], programme meeting, February 2021)

Childsmile coordinator responses show this had some validity:

> *They think it is more unhygienic to have the children spitting into a paper towel than into the sink when they're going to rinse their brushes in the sink anyway. So that didn't really make sense to them, and I suppose it doesn't really make sense to me, either, so I'm struggling with what advice I can give.*
>
> (Respondent 5 [operational], programme meeting, December 2020)

It was also recognised that the requirement for children to dispose of excess toothpaste in tissues or paper towels (and proscribing toothbrushing taking place at sinks) had removed the opportunity to adapt this aspect of delivery, which led to some nursery staff resisting the intervention, as predicted in Damschroder et

al. (2009)'s model. One Childsmile coordinator commented that reimplementation may have been more straightforward if nursery staff were able to continue delivering the model they were used to, rather than making changes that, in some cases, were counter-intuitive to them:

> *A lot of our feedback...was that there was just too much change happening all at once and I think that if they'd been allowed to do the toothbrushing model that they'd always done then I think that they would have just happily continued.*
>
> (Respondent 5 [operational], programme meeting, December 2020)

Indeed, some Childsmile coordinators indicated feedback from establishments that they intended to wait until they were able to use the wet brushing model before resuming brushing.

The time required to deliver toothbrushing using the dry brushing model was a barrier (related to 'Complexity'), as there were additional demands on nursery staff's time, particularly in nurseries with larger numbers of children, due to cleaning areas potentially contaminated with children's saliva. Other aspects of the work required to clean equipment and surfaces were also identified to be complex:

> *Someone taking all the brushes away to clean them, just sounds like an utter nightmare to me. I couldn't imagine how they would keep all those toothpaste contaminated brushes separate...It sounds really 'clarty', for want of a better word.*
>
> (Respondent 8 [operational], interview, September 2020)

Nursery staff's perceptions about the toothbrushing guidance were recognised as important. For example, it was noted that staff in several nurseries thought tissues or paper towels used by children to dispose of excess toothpaste should be classed as clinical waste and disposed of accordingly. Although it was clarified that using general waste streams was appropriate, respondents in one area commented that nursery staff's perceptions about potential infection

prevention and control risks impacted whether they engaged with reimplementation:

> Respondent 27: *The waste streams for tissues...Do they go in the general waste bin? Or are they to go in, 'cos they're maybe going to have saliva on them or toothpaste et cetera, do they go in a clinical bin to be incinerated?*
>
> *Respondent 26: ...My understanding is it goes in the ordinary waste. It doesn't go into clinical waste...*[however] *it's still a barrier for them if they think it should go into a clinical waste, then they're going to say 'we're not doing that 'cos I think that should go into clinical waste'. And that's the bottom line, it doesn't matter whether it's correct or whether it's not correct, it's about whether their perception of it is correct.*
>
> (Respondents 26 & 27 [operational], interview, October 2020)

In the absence of specific trial evidence, dry brushing was identified as best practice, drawing from the clinical judgment and expertise of those involved in developing the guidance (i.e. the Childsmile Executive, the Chief Dental Officer for Scotland, Public Health Scotland, Care Inspectorate):

> *Whilst people might query dry brushing, it is a model that the Care Inspectorate supports and Health Protection Scotland supports ...if you look at SIGN guidelines there is a category for clinical judgment, it's what's seen as best practice but there's not the high quality evidence available to support it, so it's not an unusual concept in terms of delivery of services.*
>
> (Respondent 22 [strategic], programme meeting, February 2021)

Some respondents felt there was a lack of consultation about the proposals included in initial addendum, including several Childsmile coordinators highlighting that the practical, on-the-ground experience that they and their teams had of delivering the programme indicated that nurseries' concerns about

infection prevention and control were valid and that the dry brushing model did not appear to be a safer or more hygienic option. For example:

> *There's been a lot of discussion around 'children don't actually produce that much saliva', they simply use a dry brush with a tiny bit of toothpaste on it, they brush round and spit, but actually some...produce copious amounts of saliva and you see it and it goes down their top, it's on their shoes...and that has to be wiped up by somebody, it has to be dealt with by somebody.*
>
> (Respondent 9 [operational], interview, October 2020)

Despite concerns about dry brushing, existing guidance supporting the programme, used before the pandemic, was thought to be robust in relation to safety and infection prevention and control:

> *When you go back to the cross infection control, prior to Covid, I think that's enough to reassure them as well, you know, that what they were doing prior to Covid was actually really good, so if they hadn't been picked up in monitoring visits for dodgy cross infection skills then they're pretty much doing a good job.*
>
> (Respondent 17 [operational], programme meeting, May 2021)

Several respondents stressed the importance of communicating evidence supporting the nursery supervised toothbrushing programme's effectiveness and cost-effectiveness with respect to caries reduction to nursery staff; it was thought this would help engage them with reimplementation as it demonstrated why they were being asked to do it:

> *Reinforcement of the benefit of something as simple as daily toothbrushing. I think the beginning and end stats say it all and I think it's something that could be celebrated...some people see it as, "oh gosh, we've got to do this", why wouldn't we when we're really involved within our careers in improving children's opportunities, why wouldn't we want their oral health to be as best as it can?*
>
> (Respondent 4 [operational], interview, October 2020)

Taking on board the barriers associated with the dry brushing model, the Childsmile Executive reviewed the Toothbrushing Standards addendum in summer 2021. This included consulting national partners on whether it was safe for children to brush at a sink, in terms of infection prevention and control, during the pandemic. While one respondent commented that the first version of the addendum was based on the 'professional consensus' of various organisations, the initial proposal developed by the Childsmile Executive only included the dry brushing model, which was then presented to national partners to ask if this would be acceptable. When the addendum was reviewed, the Childsmile Executive took a different approach and asked national partners to consider whether each model was acceptable in terms of infection prevention and control. The national partners agreed that both dry and wet brushing models were acceptable, therefore local teams were then able to offer either model to establishments to encourage reimplementation. This demonstrates that national programme stakeholders were open to adapting elements of the programme, in light of Childsmile teams' on-the-ground experiences. Aside from the dry model of delivery, other aspects of hygiene and infection prevention and control requirements within the Toothbrushing Standards addendum created barriers related to complexity. For example, it was required that children selected, handled, rinsed and returned their own toothbrushes, and that they should be the only person to do so; however, in a large number of nurseries, nursery staff handled the toothbrushes, to ensure that children used their own toothbrush, particularly among younger children who might not be as adept at identifying and selecting their brush from the rack. Various respondents highlighted nurseries' requests to continue to do this, but this would only be permitted if

the member of nursery staff washed their hands between handling each individual brush, which would be very time-consuming.

It was also thought to be unrealistic to expect all children to be able to pick up and return their toothbrush without touching any others; and that while nursery staff should be observing children doing this, there would also be various opportunities where they might intervene and handle the toothbrushing equipment:

> *It's fine saying 'get the child to rinse the brush, get the child to put the brush back in the rack', but if you've got 30 children in the group that can be a real issue, sometimes. You need that adult supervision...but you're not going to stand with your hands behind your back, not touching anything, you know, your human nature is going to be 'uh uh, I'll just take that'.*
>
> (Respondent 9 [operational], interview, October 2020)

5.3.2.2 Domain 2: Outer Setting (Patient Needs & Resources; External Policies & Incentives)

Requiring children to select and handle toothbrushes themselves also related to the construct of 'Patient (user) Needs & Resources'; several Childsmile coordinators highlighted feedback from nurseries that children required help to identify, rinse and return their toothbrushes:

> *Children* [should] *go up one at a time to rinse their brush. Some of the nurseries have said, if a child is really young then they might need a hand with that, you can't guarantee that they wouldn't tap their brush off the sink, things like that they were a wee bit concerned about.*
>
> (Respondent 21 [operational], interview, October 2020)

Other Childsmile coordinators thought the first iteration of the Toothbrushing Standards addendum did not take children's needs and abilities into account:

> *It's also about the age… and the abilities of the child. So the younger the child, the more difficult that is to control where the splatters go...their perception is that the Covid guidance that came out is not addressing that.*
>
> (Respondent 26 [operational], interview, October 2020)

In relation to nursery staff's needs and preferences, it was thought that a slow, supportive approach was required for liaising with nursery staff about restarting brushing, which included respecting their feedback if they were not ready to restart the programme and not placing pressure on them to do so:

> *Everybody is just treading really carefully just now…I think we're just going to have to work through it, very diplomatically, very carefully, very supportively, and just see what we can achieve, and we can't force people to do it.*
>
> (Respondent 9 [operational], interview, October 2020)

It was also recognised that there were various pressures affecting educational establishments due to the Covid-19 pandemic, with the nursery supervised toothbrushing programme being one among many competing priorities:

> *Nursery staff are under a huge amount of pressure as well, one thing they are feeding back is that between the additional hand washing in the day and the changes they've had to accommodate for lunches and things like that, everything just takes that little bit longer.*
>
> (Respondent 10 [operational], interview, September 2020)

Wider restrictions designed to prevent the spread of the Covid-19 virus had a knock-on effect on reimplementation, such as nurseries limiting numbers of external visitors at certain time points. In several areas Childsmile staff were unable to access nursery premises at all, therefore could not provide in-person training or support to nursery staff. For example, in one health board where Childsmile staff had provided lots of in-person support in nurseries (including

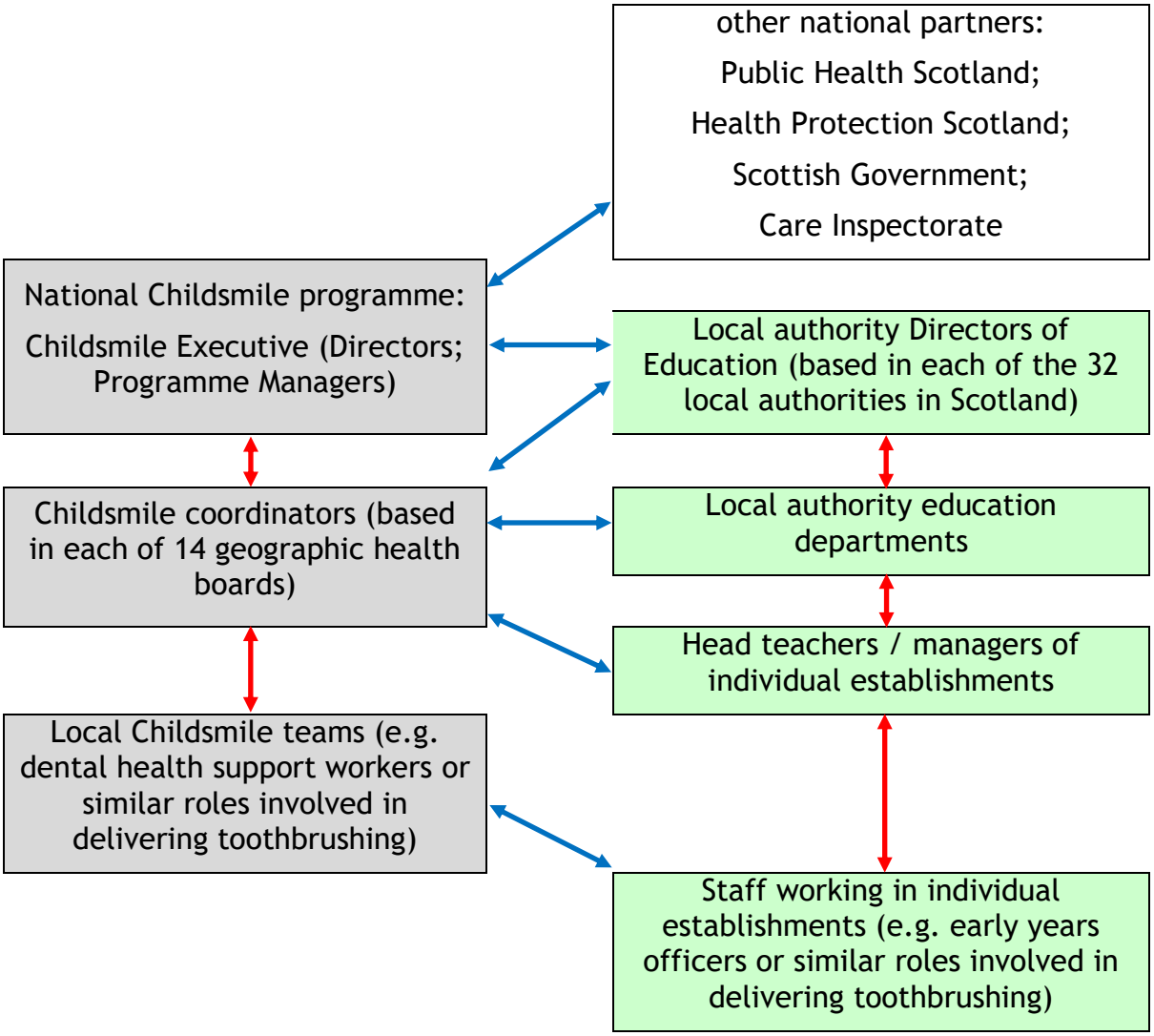
practical demonstrations of toothbrushing) prior to the pandemic, it was reported that this would require adjustments in how they worked going forward:

> *A lot of them still don't want external visitors...because of the way we've always operated before, we could be in, depending on how many children you're working with, in a day, and what you're actually doing out there, we could be in as many six different places in the day. So we're having to limit that too.*
>
> (Respondent 31 [operational], interview, September 2020)

5.3.2.3 Domain 3: Inner Setting (Networks and Communications; Implementation Climate; Readiness for Implementation)

There was multi-faceted communication taking place in relation to programme reimplementation, taking place at multiple levels and between various individuals and organisations.

Within analysis of these data, the Childsmile programme (comprising the national Childsmile Executive and local Childsmile teams within the 14 geographic health boards) is taken to be a single organisation; likewise, individual nurseries are grouped together with the body that oversees them, i.e. the local authority education department, as a single organisation (in each geographic area). Inter-organisational and intra-organisational communication took place in relation to programme reimplementation, at multiple levels, depicted in Figure 12, below.



Key

↔	Red arrows show ***intra***-organisational communication (i.e. taking place within individuals or staff groups, situated in the same organisation);
↔	Blue arrows show ***inter***-organisational (i.e. between individuals or staff groups, situated in different organisations)
	Grey boxes depict groupings of individuals situated within the 'Childsmile programme' organisation
	Green boxes depict groupings of individuals situated within 'nurseries/local authority education departments' organisations
	Unshaded box relates to national partner organisations outside of these two categories.

Figure 12 Intra- and inter-organisational communication taking place in relation to the nursery supervised toothbrushing programme during Covid-19 pandemic

In terms of intra-organisational communication within the Childsmile programme, some Childsmile coordinators highlighted limited communication between the Childsmile Executive and local teams in the earlier stages of the pandemic, which had created uncertainty among local teams in some cases, for example:

> *I kept thinking maybe* [programme manager] *will just put out an email to say 'look, don't worry, things are just getting organised' or 'we will be in touch'...I'm not meaning that in a negative way, I want it to be just a comment that it seemed to be a long time where we had no contact. And I felt that, I didn't want to contact because* [they would] *all be so busy.*
>
> (Respondent 2 [operational], interview, October 2020)

Several Childsmile coordinators commented on the fact that they, as a professional group, were not consulted during the development of the Toothbrushing Standards addendum:

> *The first we heard of it was when it landed on our doorstep...my main gripe was the lack of partnership and consultation, that's where it kind of falls down with me, I think they could have done that better.*
>
> (Respondent 10 [operational], interview, September 2020)

Childsmile coordinators also discussed intra-organisational communication within local authorities. In one area an Education Manager informed establishments not to resume programme delivery, without consulting the Childsmile coordinator:

> [Education Manager] *meets with head teachers as a group every Friday morning and I think that really it's just one person then relaying this information to a group of people, they've kind of all jumped on the bandwagon, probably thinking 'Thank God we don't have to do brushing!' along with all the hand washing and everything else*
> (Respondent 8 [operational], interview, September 2020)

Information about restarting the programme, provided to local authority colleagues by Childsmile teams, did not always reach staff in individual establishments; this required Childsmile teams to disseminate information to individual establishments directly.

At the national level communication took place between the Childsmile Executive and national partners (including the Scottish Government) to address barriers to remobilisation. This included providing feedback to the Chief Dental Officer for Scotland's office on potential risks affecting remobilisation such as challenges in engaging with some local authorities. This led to the Childsmile Executive being asked to prepare a paper for the national Directors of Education group with a view to securing their endorsement for Childsmile programme remobilisation, in May 2021. The Childsmile Executive received feedback that this paper was circulated to the group and no concerns were raised regarding plans for restarting Childsmile programmes, including toothbrushing, in educational establishments. Communication between Childsmile and national partners is highlighted as a facilitator as it demonstrates that the Childsmile Executive took on board feedback from local Childsmile coordinators regarding difficulties in engaging some local authority education departments and took steps to address this barrier. However, the programme managers were cautious when appraising the impact of this communication, noting that they had not communicated with the Directors of Education directly and had received limited feedback from the group, therefore were unsure the extent to which they had engaged with the information provided.

Another facilitator identified was that of national partners' input to developing and reviewing the Toothbrushing Standards addendum. In particular, access to a 'guidance cell' hosted by Public Health Scotland, whose remit was to provide expert opinion on Covid-19-related guidance for various settings, was thought to be a positive development; the guidance cell assisted the programme to review the Toothbrushing Standards addendum in summer 2021, which led to agreement that wet brushing could resume in establishments. This is another example of the national Childsmile programme acting on Childsmile coordinators' feedback that the requirement for using the dry brushing model alone was a barrier to remobilisation.

Several respondents discussed communication between Childsmile teams and local authority education department contacts, with several Childsmile coordinators highlighting the importance of having backing from local authority education departments before approaching individual establishments:

> *Initially we didn't get that backing from the Head of Education ...there was no point in us contacting all the establishments 'cos it would get back to the Head of Education...they did quite rightly say it's not a priority so they won't be doing anything any time soon, so I said, right, I'll back off.*
>
> (Respondent 6 [operational], interview, October 2020)

In another area, it was noted that obtaining agreement from the local authority had not increased engagement among some establishments:

> *We tried to do this from the top, to give it some weight...in some places it's worked, in some places it hasn't, that was the main communication, rather than sending off lots of separate emails to lots of separate people.*
>
> (Respondent 9 [operational], interview, October 2020)

In some areas it appeared that there were no straightforward routes to communicating with nurseries about restarting the programme, for example, due to how local authorities' networks and mechanisms for communication were set up, or changes to structures in place previously. In one area, the Childsmile coordinator approached the local authority's Early Years Manager initially regarding restart, who then tasked colleagues (known as Quality Improvement Officers) to liaise with staff in nurseries they oversaw. This resulted in the Childsmile coordinator receiving feedback that establishments were not ready to restart brushing. However, as the Childsmile coordinator was removed from the process of communicating with establishments, it was noted that some of the information may have been distorted whereas information provided directly by Childsmile coordinators and teams is more likely to remain accurate. Indeed, the

same Childsmile coordinator noted that their staff received different messages from nursery staff themselves:

> *They've got Quality Improvement Officers, that manage certain clusters of nurseries, so they'd gone round and got feedback from nurseries, and they all said, bar one, 'no, we're not doing it, it's too much just now'...while we were doing door stop drops at the nurseries...one of them said 'oh we're wanting to get started with our brushing' so we got a different view from what we were told.*
>
> (Respondent 6 [operational], interview, October 2020)

Childsmile coordinators also identified challenges in making links with specific contacts in local authority education departments, such as being unable to communicate with the Director of Education directly, but diverted to someone else who was not aware of the programme, which required additional time and effort to explain. It was also noted that communication with local authorities was challenging due to staff changes in local authority education departments:

> *I've worked with the same person probably for about the past 15 years. She's left now. And since she's left there's been two different changes. I've only just got the name of the one person that came into post. Before I even got to speak to her, they've left ...what that means is you're losing a bit of your momentum.*
>
> (Respondent 26 [operational], interview, October 2020)

Other Childsmile coordinators encountered barriers in making initial contact with colleagues in local authority education departments; in some cases, this was ascribed to various pressures they faced in relation to establishments reopening:

> *It's been very, very difficult to try and get engagement because we're way down the priority list...*[the] *Senior Dental Officer, she has actually contacted both Heads of Education for* [local authorities] *because we felt that's the way the communication should go initially, get them on board then start working from the ground up, but she's not even had a reply.*
>
> (Respondent 31 [operational], interview, September 2020)

Another Childsmile coordinator commented that they were unable to reach a named individual within the local authority education department but rather had to submit a generic contact request form via the local authority's website, which created delays in communicating with the relevant parties in the education department.

There were also barriers in relation to views among staff working in local authority education departments. Several Childsmile coordinators received feedback from local authority contacts that the programme should not restart at that time, due to concerns about the wider changes required post-lockdown, as well as being mindful of wider restrictions in place to mitigate against the virus:

> *I had a conversation with the Lead for Early Years and the Lead for Education within* [local authority] *and they both felt very strongly that they didn't want to reintroduce toothbrushing when term started...they felt that the staff were going to be overwhelmed with all of the new restrictions and there was concern about staff having to go in from the Childsmile team to support, for monitoring, for training.*
>
> (Respondent 4 [operational], interview, October 2020)

In relation to these initial discussions with local authority contacts, it was clear that some Childsmile coordinators were unwilling to place pressure on them to restart the programme in case this damaged relationships they had developed over long periods, for example:

> *We're making moves to get the programme back up and running but we're doing it in a very slow and cautious way and I don't think we can push anybody just now to do something that they don't feel they're able to do.*
>
> (Respondent 9 [operational], interview, October 2020)

Respondents also discussed communication taking place between Childsmile teams and contacts within individual nurseries (e.g. head teachers, nursery managers or other staff). It was apparent from feedback provided by several Childsmile coordinators that they were approaching communications with individual establishments cautiously, as they were mindful of the various pressures facing them following the lockdowns. For example:

> *I didn't feel it was appropriate at the beginning of the first school term to start emailing all my head teachers to say 'what do you think about this?' …I think most of them would have been 'What? We've just been off for months and you're asking me about this?'…being kind and supportive to each other right now, saying 'I appreciate that we really want to get kids brushing right now cos it's so good for them, but equally we understand that you've got a lot going on just now'.*
>
> (Respondent 9 [operational], interview, October 2020)

In areas where Childsmile coordinators reported good progress in restarting the programme following the first lockdown, it was identified that establishments were less keen to proceed following the subsequent lockdown; for example:

> *After the first lockdown we have about 30-odd establishments that started brushing in school and nursery and there were more coming on board…with this second lockdown [they] are much more anxious. ...We've got two that have restarted. We're having many more questions about if it's appropriate to do.*
>
> (Respondent 7 [operational], programme meeting, March 2021)

Several Childsmile coordinators reported that they continued to receive negative feedback from nursery staff about the dry brushing model, which was cited as a reason for toothbrushing not restarting. For example, in one area, Childsmile staff contacted each establishment during summer 2021 to find out if they were ready to restart the programme and found that the requirement for dry brushing was the main barrier to them agreeing to participate:

> *My team's been surveying all our schools and nurseries that would typically toothbrush just to see what their intentions are with regards to restarting after the summer holidays and we've asked them if it was model B, how prepared are you to restart brushing, and then if it's model A, because we've had quite a lot of resistance to model B within my area...we're still seeing that level of resistance.*
>
> (Respondent 10 [operational], programme meeting, June 2021)

One Childsmile coordinator highlighted feedback from contacts in the local authority education department and nursery staff which indicated they had either not read or not understood the guidance fully:

> [Local authority contact] *told me it was going to be very costly because his staff would require more PPE to deliver the toothbrushing programme...I was like 'have you actually read the Toothbrushing Standards?'...I think things just escalate, don't they, and people are often listening to rumours rather than factual information.*
>
> (Respondent 8 [operational], interview, September 2020)

While various respondents identified challenges in communicating with local authority education departments during this period, several Childsmile coordinators indicated that their links with colleagues in local authority education departments were maintained and strengthened, with some local authorities including Childsmile teams in plans for establishments reopening. For example, one Childsmile coordinator noted that they were contacted by their local authority education department prior to the publication of the Toothbrushing Standards addendum, to enquire about plans for restarting

toothbrushing, in conjunction with their wider plans for reopening educational establishments:

> *I went back to the early years team and said we were waiting for further announcements from Childsmile...they've been quite a driving force in contacting me to say 'Can we start? Anything happening, any news?'.*
>
> (Respondent 7 [operational], interview, September 2020)

Another Childsmile coordinator was invited to deliver training on the Toothbrushing Standards addendum to a large group of local authority early years staff:

> *She asked us to do an in-service training day with all the early years workers so there were 94 participants so we managed to promote the toothbrushing programme, it was quite a big step in the door...Since that training day we have had establishments call us up wanting to start their programme now so it has helped to bump up the numbers.*
>
> (Respondent 21 [operational], programme meeting, May 2021)

In another area the local authority education department included information about restarting the nursery supervised toothbrushing programme in guidance provided to establishments to support reopening in August 2020. The Childsmile coordinator commented that this gave them the 'backing' to start contacting individual establishments:

> *We just started to slowly but surely pick up the phone and make contact ourselves...there had been a document come out from* [local authority] *that had said that toothbrushing could continue, so we had that, we had the Standards, so therefore we felt we had enough information, enough of a back-up, to make that initial contact.*
>
> (Respondent 16 [operational], interview, September 2020)

Communication between local Childsmile teams and individual establishments (e.g. head teachers, nursery managers and other nursery staff) was also discussed:

> *We just phoned the individual establishments and asked them 'would you like to take part?'... we informed them it was dry brushing, the changes to the Standards ... we had more than 100 coming on board and a lot of them pulled out ...But we just continually phone them and say 'have you changed your mind? Would you like to take part?'.*
>
> (Respondent 21 [operational], programme meeting, May 2021)

Some Childsmile teams started contacting nurseries following the start of the new school term in August 2020, to find out which were interested in restarting the programme, with several identifying nurseries expressing interest in taking part at that time. It was thought that having Childsmile staff with long-standing relationships with nurseries facilitated discussions about restarting the programme. Similarly, among Childsmile coordinators who identified that nursery staff had declined to restart the nursery supervised toothbrushing programme, it was thought that Childsmile staff's relationships with nursery staff placed them in good stead to continue making contact and encouraging participation in the nursery supervised toothbrushing programme:

> *The oral health educators that I have at present are the main link for schools and nurseries ...so I do feel that them going back, it is reasonable to ask them to go back at least once with regards to restarting toothbrushing.*
>
> (Respondent 10 [operational], programme meeting, September 2021)

In another area with limited programme uptake after nurseries reopened in 2020, the Childsmile coordinator reported subsequently that nurseries had begun to ask to resume brushing, suggesting it was a matter of waiting until the 'right' time for nursery staff to feel ready to recommence programme delivery:

> *I am sitting, just like, goosebumps-excited, cos I've got all these emails pinging in saying 'yes we would like to start toothbrushing!' ... Our biggest nursery has been on the phone this morning saying yes, cos I sent stuff out earlier and a few of them are starting to come back...We have a nursery that started last week, and they're going 'hey, this is dead easy!' So that's really good, so that's hopefully going to have a positive effect on others who may start to get involved...moving to dry brushing, they've actually gone 'we can do this'.*
>
> (Respondent 1 [operational], programme meeting, March 2021)

Another Childsmile coordinator highlighted that having Childsmile staff able to visit establishments in person, once restrictions were eased, had facilitated discussions with nursery staff regarding the Toothbrushing Standards addendum and to check how they were getting on with delivering the programme.

Alongside the Toothbrushing Standards addendum, a 'Frequently Asked Questions' document was produced for Childsmile staff, to support their conversations with nursery staff about restarting the programme; and a visual step-by-step guide for display in establishments, which was found to be beneficial for communicating how to deliver the programme with nursery staff.

While the intended model of programme delivery, developed with key stakeholders (depicted in the logic model, Figure 8), did not include communication with parents/carers, various respondents reported planning or carrying out activities to engage with parents/carers of children participating in the programme. It was recognised that parents/carers may have concerns about infection prevention and control and safety in the context of the Covid-19 pandemic, although it was also acknowledged that communication with parents/carers needed to be approached carefully in order that concerns about safety were not raised inadvertently. Several Childsmile coordinators requested that the Childsmile programme produced information for parents/carers on programme remobilisation, to provide consistent messaging:

> *There could have been information for...parents, you know, six weeks ago. Yes, I appreciate how difficult it was, everything was changing, but I think we've certainly felt that we're having to make up the information, we're having to answer the questions...that was a little bit of a miss at the beginning that there wasn't that consistent statement out there that we could have used with everybody.*
>
> (Respondent 16 [operational], programme meeting, September 2020)

Some Childsmile coordinators reported producing information for parents/carers locally, to provide reassurance; for example:

> *We felt it would be good to refresh the negative consent letter and actually have a statement...to just reassure parents, I suppose, that we have considered that things have to be done differently during this heightened alert...just to assure you that we have updated our guidance.*
>
> (Respondent 9 [operational], interview, October 2020)

Some health boards also sent out consent information to all parents/carers again (as the programme uses a negative consent process, meaning that children who participated previously remained consented), to provide the opportunity to opt out of the programme, if desired:

> *It's really just to give the parents an informed choice rather than just going ahead with brushing, it was really to stop any complaints that children were brushing when parents weren't aware it had restarted again and then maybe some parents, under these unique circumstances, don't want to brush, so it's to give the parents an opportunity to withdraw from the programme.*
>
> (Respondent 14 [operational], interview, October 2020)

While some nurseries were reported to have requested permission be sought from parents/carers before toothbrushing resumed, in others there was

uncertainty about whether and how establishments were communicating with parents/carers about restarting the programme:

> *One nursery said that they'd never told parents they'd stopped, so they don't plan to tell them they've restarted. And it's, what's the line there? ...Do you tell all parents, how is that communicated? Is it with consents, should they all be getting them, or is it just information given out to nurseries? Is it up to nurseries to make that decision themselves? Do they update parents that it's restarted or is it just the nursery routine and it's happening and it's for parents to just kind of find out?*
>
> (Respondent 17 [operational], interview, September 2020)

The 'Implementation Climate' construct relates to receptivity among those involved in implementation towards the intervention; this emerged as a barrier to reimplementation, particularly in relation to uncertainties and anxieties among both Childsmile staff and nursery staff. For example, one Childsmile coordinator highlighted that the second round of school and nursery closures in early 2021 created apprehension about taking forward plans for restarting the programme:

> *As a result of the latest lockdown staff find it difficult to look beyond the present...it is difficult to realistically have firm plans in place as due to the pandemic the picture is ever-changing.*
>
> (Respondent 17 [operational], programme meeting, May 2021)

Another Childsmile coordinator highlighted concerns in relation to a 'climate of fear':

> *The biggest fear would be scaremongering because I guess the more attention you draw to something, the more people start to think there is something they should be worried about, so it's getting that balance...your children are as safe as they ever were but still trying to understand that people have anxieties around Covid, cross-infection.*
> (Respondent 23 [operational], interview, November 2020)

It was also highlighted that there were anxieties among both nursery staff and Childsmile staff involved in delivering the programme, due to heightened awareness of infection prevention and control during the pandemic and the fact that they were entering unknown territory, as there was no evidence available at that point to support the changes within the Toothbrushing Standards addendum:

> *I think there's bound to be concerns. But I don't really know until we actually ask them to start it...how it's going to work with them approaching the sink and rinsing their toothbrush without turning off the tap and putting it away without touching any other brushes. ...it's all just a bit of an unknown at the moment, what the reaction is going to be. And also, I'm thinking in the back of my mind, is it safe? Is there going to be any droplets going somewhere that somebody else could touch?*
>
> (Respondent 3 [operational], interview, October 2020)

One Childsmile coordinator commented that while there were some nurseries where staff worked hard to overcome challenges to programme delivery, there were others in which the challenges seemed to be insurmountable; in some cases, this appeared to be due to a lack of willingness, although the Childsmile coordinator acknowledged that there were mitigating factors which made toothbrushing difficult to deliver in some settings:

> *You know the ones that will go all out, pull out all the stops, do everything possible to get children brushing and support the programme, and then you get the other ones that you know will really just not, no matter how much evidence you provide to support the reason for toothbrushing in that particular establishment, they find every excuse that they can to not take it on. And in some cases you can agree, you can look at the geography of the school, the way it's laid out, the resources that they had, the behaviour of children, and you can understand that it's not a simple ask, often, that we're asking them to do.*
>
> (Respondent 9 [operational], interview, October 2020)

Similarly another Childsmile coordinator provided feedback from nurseries that they felt unable to participate in the programme now, *"due to hand washing facilities, time, space and supervision"* (Respondent 13 [operational], survey, May 2021).

It was also identified that aspects of the previously discussed dry brushing model were incompatible with routines in some establishments, such as the process for cleaning toothbrushes, particularly among those who only used the wet brushing model previously:

> *It's got to be something that's easily done and happens quickly ... dry brushing doesn't lend itself to that...I can see how dry brushing eliminates the need for a child to be at a sink for spit process, but as far as the cleaning of the brush, then that's the sticking point…taking all the brushes away to clean them, just sounds like an utter nightmare to me. I couldn't imagine how they would keep all those toothpaste contaminated brushes separate.*
>
> (Respondent 8 [operational], interview, September 2020)

In terms of the extent to which those involved in implementing the nursery supervised toothbrushing programme viewed it as a priority, various respondents highlighted that the Covid-19 pandemic introduced a range of pressures and priorities which affected the extent to which individuals within educational establishments were able to engage with the Childsmile programme. For example, several Childsmile coordinators provided feedback from nurseries that they required time to reacclimatize children to the nursery environment, after not attending for periods of time due to closures, as well as introducing other measures such as additional hand hygiene requirements. While it was acknowledged that some nurseries were genuinely unable to prioritise the programme at that time, it was also suggested that the pandemic provided a convenient reason to not participate among those who had not prioritised it before the pandemic:

> [They] *think it's too much for them to do, they've got so many more things to worry about in general in nursery establishments, between handwashing et cetera, they feel it's just too much. However I do think that you were able to tell which ones, the non-toothbrushing supporters pre-Covid, because it is kind of an excuse...it's easy to say 'because of Covid, we're not toothbrushing'.*
>
> (Respondent 17 [operational], programme meeting, December 2020)

It was recognised that local Childsmile teams needed to work in partnership with individual nurseries, at their pace, to avoid placing excessive pressure on them which might damage relationships going forward:

> *We are wanting them to come with us rather than to force anyone or to make people feel uncomfortable. And they have so many other things at the moment that we don't want to put extra pressure on them.*
>
> (Respondent 11 [strategic], programme meeting, September 2020)

Some nurseries had made progress in restarting the programme, which was attributed to nursery staff recognising toothbrushing as part of their 'normal' routines:

> *The Education Manager...said 'it's really important that children get back to thinking things are normal, and toothbrushing is normal' so they were really supportive and I've heard that from other teachers that have attended the training who have said, 'we just want some form of normality for the children'.*
>
> (Respondent 7 [operational], interview, September 2020)

Another Childsmile coordinator highlighted that nurseries that had resumed toothbrushing were often those that were well-engaged prior to the pandemic and recognised the importance of children participating in toothbrushing:

> *It depends on the individual establishment. I think where you've got the 'can-do' attitude they will do everything possible to make it work, and they see the value of it, they wholly support it...it's those nurseries or schools that have been contacting us to say 'when can we start again?' and you know that obstacles they encounter they will overcome them.*
>
> (Respondent 9 [operational], interview, October 2020)

It was also suggested that the pandemic presented an opportunity to highlight to local authority education departments and nursery staff why the programme should be prioritised. For example, it was acknowledged that, as lockdowns and nursery closures had potentially impacted children's oral health negatively, it was important to highlight evidence that participating in the nursery supervised toothbrushing programme prevented poor oral health outcomes among children. However, it was thought that a national approach to prioritising the programme within educational settings was required, to maximize opportunities and remove potential local variations in stakeholders' engagement:

> *To drive it forward as policy, in education, to say 'this is a really valuable, cost-saving intervention that is very simple to deliver'...rather than saying 'oh no, the toothbrushing's too difficult to achieve, we've all got to be so careful now' ... I do think that needs to come from government-level, I think that needs to be driven through as health policy, through education... it's much more of a, 'this is the expectation, because this is one of the factors that mitigates the widening health inequalities'.*
>
> (Respondent 9 [operational], interview, October 2020)

In relation to the 'Readiness for Implementation' construct, engaging leaders within local authority education departments was required prior to approaching individual establishments, as it was identified to be difficult to proceed without securing local authority education departments' agreement:

> *We got a very direct steer from the local authority education department saying 'we don't want this happening yet' so that really just stopped it right there.*
>
> (Respondent 1 [operational], interview, October 2020)

Another Childsmile coordinator identified that an Education Manager had prevented nurseries from participating in the programme, despite it being approved by another manager within the education department, and without prior discussion with the Childsmile coordinator:

> *In one week I had virtually everybody good to go, shift forward to the end of the next week and no one was interested. And we were like 'what's going on?' and at that stage that's when I realized that there was an individual, who is an Area Manager who...had advised the schools and nurseries that they shouldn't resume toothbrushing.*
>
> (Respondent 8 [operational], interview, September 2020)

The need for safe methods for children to dispose of toothpaste (i.e. using paper towels, tissues or another receptacle, rather than into sinks) associated with the dry brushing model led some Childsmile coordinators to anticipate potential barriers relating to who was responsible for supplying or funding these additional resources:

> *A lot are almost saying 'you are asking us to do this programme so you need to provide us with all the things that we need. Why should we be running out of paper towels?'.*
>
> (Respondent 9 [operational], interview, October 2020)

Other changes within nurseries, such as children being assigned to smaller groups to minimise the number of other children they come into contact with, impacted on how toothbrushing was delivered:

> *Toothbrushing in establishments is carried out in 'bubbles'...hence they're needing extra racks, so we've had to purchase extra racks.*
>
> (Respondent 21 [operational], programme meeting, December 2020)

Childsmile teams in some areas supplied additional resources, such as disposable gloves, to nurseries to support their delivery. One Childsmile coordinator noted that they had provided gloves to establishments since before the pandemic, as otherwise nursery staff were unwilling to participate due to concerns about hygiene. While it was acknowledged that personal protective equipment such as gloves were not required within the programme guidance, the Childsmile coordinator thought that they would have to continue to supply these to make delivery more palatable to nursery staff, particularly in the context of heightened awareness about infection prevention and control.

Time constraints were said to impact negatively. One Childsmile coordinator thought that resources demonstrating streamlined processes for delivering toothbrushing within nursery routines would support more establishments to participate:

> *At a time where they're trying to do a million and one things, I think time, that's a huge issue for them. I think if you could provide them with a way of saying 'this is how you can do it in this many minutes' then possibly they might be a bit keener.*
>
> (Respondent 10 [operational], interview, September 2020)

Disseminating knowledge and information to contacts in education departments was not always straightforward. Childsmile coordinators highlighted that they often relied on contacts within local authority education departments to circulate information to nursery staff. However, several Childsmile coordinators reported examples of nurseries recommencing toothbrushing upon reopening, without being aware of the Toothbrushing Standards addendum and it was recognised that there was a need to ensure relevant information was disseminated before this took place:

> *There was another establishment we had found that was ready to start ...we're like 'no, don't brush, whatever you do, there's changes!' So it was trying to get that out...*[or] *they'll carry on thinking it's OK to do what they did previously and if they had started and we hadn't known anything about it then we came in and said 'you're not allowed to do it like that, you've got to do it like this' and they're like 'why? We've been doing it this way'.*
> (Respondent 6 [operational], interview, October 2020)

Similarly, another Childsmile coordinator provided feedback from their staff about the content of the Toothbrushing Standards addendum and challenges in interpreting it for communicating with nursery staff:

> *I think staff would have liked more clarity on some of the points regarding what the establishments have to do...for us to say we need* [nursery staff] *to refer to the non-health care guidance, especially around environmental decontamination, to our staff they're like 'what does that mean?'...so I think a more black-and-white answer to that sort of question, to give the staff confidence to be able to say that to people.*
> (Respondent 13 [operational], interview, October 2020)

Aside from the requirement to only use the dry brushing model (included in the initial version), several Childsmile coordinators thought it was appropriate that there were minimal changes within the guidance, as it was thought this demonstrated that the infection prevention and control procedures were robust:

> *What we didn't want was a whole raft of documents that then will just keep changing over time as new evidence emerges. I think it was the least complicated, 'business-as-usual' kind of approach and I think that's been welcomed by the majority of staff...why would you change the system that was specifically produced to control a potential infection from an activity such as toothbrushing?...if there's little change it shows confidence in the programme.*
> (Respondent 9 [operational], interview, October 2020)

Various respondents suggested that a visual resource, such as a video, was required to demonstrate setting up and delivering the programme, per the Toothbrushing Standards addendum, to nursery staff. Indeed, in one area the Childsmile coordinator and their dental colleagues developed a video of a child carrying out dry brushing, although further work was required before this could be shared more widely:

> *I think if they see it they'll not be as worried about it. They're going to conjure up all manner of things when we say 'spit into a tissue'...I think if they saw [a] video that would just alleviate a lot of the issues they might have in their minds.*
>
> (Respondent 6 [operational], programme meeting, March 2021)

However, proposed work to develop visual resources to support programme remobilisation on behalf of the Childsmile Executive were not progressed due to other demands on partner organisations' time.

Childsmile teams attempted to progress communication and training with nursery staff, with varying degrees of success, with one Childsmile coordinator noting that training sessions arranged with some nurseries were pushed back repeatedly due to concerns about rising numbers of Covid-19 cases locally. There were also challenges in bringing groups of nursery staff together to deliver toothbrushing training:

> *A lot of the feedback we're having now within our nurseries is... staffing is very minimal on the floor, and they're doing a lot of split-shifts within bigger nursery establishments, so to allow anybody time to come off the floor for face-to-face training is proving really difficult...[if they] pull one member of staff at a time, in one of our nurseries, it worked out, the support worker would have been six weeks training staff in a nursery if we'd done it that way. So it's looking at ways to deliver the training.*
>
> (Respondent 13 [operational], programme meeting, September 2021)

In some areas there were ‘toothbrushing leads’ identified within nurseries to disseminate information to colleagues, rather than Childsmile staff providing repeated sessions in each nursery. However, one Childsmile coordinator commented that it was unclear whether dissemination among nursery staff took place or whether the information passed on was wholly accurate. This Childsmile coordinator suggested that there was now an opportunity to retrain all nursery staff, as well as introducing the requirement for regular update training to be carried out.

There were examples of local authority colleagues facilitating access to knowledge and information, such as arranging virtual training sessions on the Toothbrushing Standards addendum for nursery staff, delivered by Childsmile staff. Several Childsmile coordinators also indicated that the Frequently Asked Questions document, produced alongside the Toothbrushing Standards addendum, had supported Childsmile staff to communicate with nursery staff about restarting the programme.

Work was taken forward through the national Childsmile programme to develop a training presentation on the Toothbrushing Standards addendum, for local teams to use for communicating with nursery staff about restarting brushing, which was well-received among several establishments.

5.3.2.4 Domain 4: Characteristics of Individuals (Knowledge & Beliefs about the Intervention)

As noted, the initial version of the Toothbrushing Standards addendum required establishments used the ‘dry’ model of toothbrushing, taking place away from sinks with children disposing excess toothpaste into tissues or paper towels which were then placed in a lidded bin. However, prior to the pandemic it was reported that wet-brushing was used exclusively in nurseries in five health boards and a mixture of wet- and dry-brushing was used in eight health boards (with the majority of nurseries carrying out wet-brushing in three of those). Only one health board identified that the majority of establishments used the dry brushing model and there were no areas in which dry-brushing was used exclusively.

In most of the areas using the wet brushing model predominantly, Childsmile coordinators reported that changing to dry brushing was a barrier for staff. While respondents acknowledged that there were minimal changes to processes within the Toothbrushing Standards addendum, it was thought that requiring establishments used to brushing at sinks to adopt the dry brushing model was challenging, particularly with heightened awareness of the need for infection prevention and control:

> *In the times that we're in just now they're even more averse to dealing with saliva and it seems to be counter-intuitive to be wiping it up off the desks, the strands of saliva, and the paper towels that the schools tend to have* [are] *just not absorbent at all...one of the teachers very poetically described it as 'festooning the classroom with slobbers', that's their general view on it.*
>
> (Respondent 9 [operational], programme meeting, December 2020)

Several Childsmile coordinators highlighted that using terminology such as 'spitting' was problematic as it might invoke feelings of disgust among nursery staff:

> *I think people have a kind of 'ugh' feeling about it, you know this whole spitting out bit...it's the language in the addendum that we're maybe using, about spitting out. You know, there might be something about, for younger children, saying 'when they wipe any excess'...straight into the tissue and straight into the bin, that is the tidiest way to do it.*
>
> (Respondent 1 [operational], interview, October 2020)

It was also suggested that the word 'spit' might give nursery staff a false, negative impression about the amount of excess toothpaste and saliva produced:

> *If non-health people didn't focus on the word 'spit', then that might make it so much easier for us...if there was a way to word that differently it might help, but we're beyond that...when they hear the word 'spit' they're not thinking doing it gently into a tissue, they're probably thinking of something very different.*
>
> (Respondent 8 [operational], interview, September 2020)

However, it was also acknowledged that nursery staff's perceptions about the dry brushing model might be influenced by wider changes in relation to restrictions arising from the pandemic:

> *I feel that they're perceiving that there's a challenge, rather than there actually being one, you know, just because there's been a lot of change. And I think it's maybe just the fact that it's another change, another thing for them to get their heads round.*
>
> (Respondent 5 [operational], interview, October 2020)

Childsmile coordinators' and other Childsmile staff's knowledge and beliefs about the intervention, specifically dry brushing, was also important. As noted, several Childsmile coordinators commented that they were unsure what the rationale was for only allowing dry brushing:

> *I don't understand, it doesn't compute, because they're still spitting...*[it] *is still producing particles. To me, in my head, it probably could be slightly worse 'cos it could be everywhere rather than contained in a sink.*
>
> (Respondent 6 [operational], interview, October 2020)

It was recognised that the attitudes of Childsmile staff towards the dry brushing model would affect how they communicated with nursery staff about it, and nursery staff would pick up on it if they appeared unenthusiastic or concerned:

> *The attitudes of the staff that are going to be going out there and almost selling this all over again*...[some staff] *are very blinkered as to how they would do something, so if changes have to be made...I need to make sure that my staff are buying into it first, before I try and get anyone else to, that will be hard.*
>
> (Respondent 23 [operational], interview, November 2020)

For example, one Childsmile coordinator noted that some of their staff viewed the dry brushing model negatively:

> *I know the dry brushing, even for some of our staff, they see it as this really wet, horrible, yucky tissue, they think it's worse.*
>
> (Respondent 17 [operational], interview, September 2020)

However, in two areas where nurseries had used the wet brushing model predominantly, Childsmile coordinators reported that they had supported a number of nurseries to restart brushing using the dry brushing model, with both commenting that there was better engagement among nursery staff than they had expected at the outset:

> *The response has been really good, really positive…*[a number of establishments said] *'yep, desperate to get going!' They're happy with the dry toothbrushing, 'cos all of our establishments did wet brushing and I thought, when they found out it was going to be dry that would be it, they'd be like 'no thanks' but that hasn't been the case, so it's been really positive.*
>
> (Respondent 6 [operational], programme meeting, March 2021)

It was thought that this model provided a faster process to undertake brushing, which had facilitated establishments' buy-in. The Childsmile coordinator also noted that establishments were likely to continue using the dry brushing model, despite the guidance being amended to allow wet-brushing again:

> [Establishments were previously] *unwilling to take on model B and some of them have surprised me and are now saying that that would be preferable for them… if we do get back to a stage where toothbrushing at a sink becomes an option I could foresee that we'd have people who'd choose to stay with model B.*
>
> (Respondent 1 [operational], programme meeting, June 2021)

In another health board, the Childsmile coordinator highlighted that some Childsmile staff who expressed negative views about the dry-brushing model previously, now perceived it positively and were keen that establishments continued to use it:

> *When I mentioned that the wet brushing was now incorporated into the addendum, the support workers that were actually horrified at dry brushing this time last year were the ones that voiced 'oh, I'm not even going to mention it to staff, I've got dry brushing, it's far easier, it's far better'...that initial, gut reaction was 'I don't want to go to that', last year I wouldn't believe they were even contemplating telling staff to dry brush.*
>
> (Respondent 17 [operational], programme meeting, September 2021)

Aside from perceptions about the dry brushing aspect of the programme, it was noted that some nursery staff continued to view the toothbrushing programme as low priority or as an activity that should be carried out at home, instead of in nurseries; this was identified as a challenge both before and during the pandemic:

> *The attitude...unfortunately, is 'this is something that should be done at home', you still get that, you still hear that. So I think that lack of buy-in is huge...they just see it as something quite expendable.*
>
> (Respondent 9 [operational], interview, October 2020)

Another Childsmile coordinator perceived that establishments that were not well-engaged in the programme previously would view the pandemic as a reason to stop participating.

5.3.2.5 Domain 5: Process of Implementation (Planning; Engaging; Executing)

The 'Planning' construct relates to the extent to which tasks and behaviours required to implement an intervention are explicated; and how well those plans are communicated to those involved in implementation. Damschroder et al. (2009) expounded the construct further by setting out a number of components that implementation plans should include, such as ensuring stakeholders' needs and perspectives are taken into account and communicating via relevant channels, using appropriate content, language and imagery. However it appeared that there were limitations to the implementation plan devised in relation to restarting the nursery supervised toothbrushing programme.

As noted, implementation plans should consider stakeholders' needs and views; however, as discussed in relation several constructs, the initial version of the Toothbrushing Standards addendum was developed by the Childsmile Executive in conjunction with national partners, without consulting Childsmile coordinators or staff involved in delivering the programme on-the-ground:

> *It would have been quite nice to have had a coordinator's input...it was a bit of a surprise for everybody, I was almost frightened to read it in case it was something that we could not achieve.*
>
> (Respondent 14 [operational], interview, October 2020)

Initial implementation plans did not consider how many establishments used wet brushing predominantly (or exclusively) prior to the pandemic, which meant the needs of nurseries for whom moving to the dry brushing model represented a major change to delivery-as-usual were not taken into account. Another recommended aspect of implementation plans related to the content and modes of communication of information to those involved in implementation. In terms

of the national Childsmile programme communicating about implementation plans with local Childsmile teams, some Childsmile coordinators thought that more detailed information on what they were expected to achieve was required:

> *We actually need it getting fed down to us...I think there needs to be more clarity around the programme and the information that we're getting, that needs to be set nationally and not just left to, see what you feel locally, just go with it and then you find that that's maybe not right. I do feel that it needs a lot more leadership.*
>
> (Respondent 16 [operational], interview, September 2020)

In contrast to these limitations, positive points included Childsmile coordinators' plans to 'test out' the dry brushing model with a small number of nurseries thought to be more receptive to these changes, with a view to sharing those experiences and learning with other establishments.

It should be acknowledged that, while respondents identified barriers relating to the Toothbrushing Standards addendum being developed initially without taking all stakeholders' needs and perspectives into account, the Childsmile Executive went on to review the addendum and include the wet brushing model, albeit twelve months after its initial publication.

The construct of 'Engaging' is related to the process through which appropriate individuals are involved in implementing and using an intervention. Within these data, there was considerable overlap between this construct and the construct of 'Networks and Communication' (within the 'Inner Setting' domain). Most Childsmile coordinators shared the Toothbrushing Standards addendum with local authority education departments and requested this was disseminated to nurseries; or sent it to nurseries directly. However, as discussed, some Childsmile coordinators were unsure whether information was disseminated to all nursery staff, or whether their partners in education had engaged with the information provided. It was also suggested that the Toothbrushing Standards addendum required simplification to enable it to be understood and implemented by nursery staff:

> *I'd also want to simplify the guidance, 'cos it's quite long… I don't think I would present it to them as it is. 'Cos there's a big spiel at the beginning, you know, I think I'd try and find a more simple way of presenting it.*
>
> (Respondent 3 [operational], interview, October 2020)

Another challenge to communicating implementation plans was the limited opportunities to visit nurseries in-person, to explain or demonstrate programme delivery face-to-face. While several Childsmile coordinators planned to undertake virtual training with nursery staff, it was recognized that there was the potential for information to be misinterpreted when not delivered in person:

> *How we then made sure that people actually watched it, read it and understood, exactly, cos the problem with not doing training face-to-face, I think, is the misinterpretation that can come from it, that's my only concern with doing it that way. Especially just now, they need to be understanding exactly what it is that we're asking.*
>
> (Respondent 6 [operational], interview, October 2020)

As noted in relation to the 'Networks and Communications' construct, it was thought that developing simple, visual resources (such as videos) to demonstrate how to deliver toothbrushing according to the Toothbrushing Standards addendum would support Childsmile staff to share implementation plans with nursery staff (although developing these resources was not progressed):

> *A video of it would be good, to show, 'look, this is what it looks like to do it, so you might imagine that it's going to be bad, but actually this is a class doing it', that would be quite useful. So they can actually see what it looks like.*
>
> (Respondent 3 [operational], interview, October 2020)

Several Childsmile coordinators identified that communicating with nurseries about the Toothbrushing Standards addendum and plans for restarting the

programme directly had been successful in engaging with nursery staff, who were also engaged with training:

> *I'm reassured by the number of staff that we've had attending the training ... last week there was 44 members of education who'd come along to hear about the brushing, there might be five from one nursery attending, but still I'm reassured by people who are coming along.*
> (Respondent 7 [operational], interview, September 2020)

The 'Executing' construct is concerned with the extent to which implementation is undertaken as intended. As reported in Chapter 4 there was limited progress towards resuming the nursery supervised toothbrushing programme between nurseries reopening in August 2020 and September 2021, due to decisions made by local authority education departments; lack of buy-in among nurseries (particularly in relation to using the dry brushing model); or lack of Childsmile staff available due to redeployment. Since September 2021, Childsmile coordinators in 10 health boards indicated that toothbrushing had resumed in some form, albeit in small numbers of nurseries (with no toothbrushing taking place in nurseries in three health boards). Where there had been progress in resuming the programme, Childsmile coordinators highlighted the efforts of Childsmile staff in encouraging nurseries to participate:

> *We've just been plugging away to try and get establishments on board with the toothbrushing programme, we've got 39 percent, I think it is, of the early years…Which is quite low and sometimes the support workers are quite despondent with that, but I'm quite chuffed, it's better than probably what I thought we would get at this stage… any nurseries that have started toothbrushing have not stopped and they're actually getting on fine, so fingers crossed that continues.*
>
> (Respondent 17 [operational], programme meeting, December 2020)

The importance of getting the timing right when engaging with nursery staff was highlighted, to ensure they felt ready to deliver the programme:

> *We've had to bide our time and very much take it from where they are. But it feels, for some of them, it's feeling like the timing's a bit better now.*
>
> (Respondent 1 [operational], programme meeting, March 2021)

5.3.3 Mapping constructs to appropriate implementation strategies to address factors affecting programme delivery

As shown in Table 23 and reported in the preceding sections, a total of 14 constructs, across all five CFIR domains, were found to be relevant to implementing the nursery supervised toothbrushing programme. Of those, ten constructs represented ongoing factors that required actions to be taken to optimise programme delivery: 'Cost' and 'Design quality & packaging' constructs were generally identified as facilitators with no further actions required; and the barriers related to the 'Evidence strength & quality' and 'Adaptability' constructs were already addressed via the programme's revision to guidance which allowed nurseries to deliver toothbrushing either at or away from sinks.

The ten remaining constructs were mapped to Expert Recommendations for Implementing Change (ERIC) implementation strategies (Powell et al., 2015), with the highest rated strategies selected for each construct. This yielded 17 potential implementation strategies, with some strategies mapped to more than one construct. The categories of ERIC implementation strategies, identified in Waltz et al. (2015), were reviewed and amended to better fit the specific context of this research. This included aggregating some categories, to combine strategies with similar aims, as well as amending some category and strategy names (e.g. 'Engage consumers' was changed to 'Increase buy-in & engagement: among service users (parents, carers, children)' as this more closely reflected the target audience for this group of implementation strategies. This resulted in three categories for the 17 strategies: 1) 'Knowledge-gathering, describing intervention & expectations'; 2) 'Train & educate stakeholders'; and 3) 'Increase buy-in & engagement', which was further divided into three sub-categories of stakeholders: a) operational; b) strategic; and c) service users (parents, carers,

children). Figure 13 sets out these categories alongside the CFIR constructs that the implementation strategies were mapped to.

(Tables 33 and 34, in Appendix 16, set out the names, categories and definitions of each ERIC implementation strategy alongside which CFIR construct these were mapped to; and further details on the amendments made to Waltz et al. (2015)'s categorisation of the ERIC implementation strategies.)

Categories of implementation strategies	CFIR constructs that implementation strategies are mapped to
Knowledge-gathering; describing intervention & expectations	
Conduct local needs assessments	PN&R, IC, RfI, Planning
Develop a formal implementation blueprint	Complexity, Planning
Promote adaptability	Complexity
Purposely re-examine the implementation	Executing
Train & educate stakeholders	
Conduct ongoing training	Complexity, Engaging
Conduct educational meetings / Develop educational materials	K&B
Increase buy-in & engagement among:	
Operational stakeholders	
Identify & prepare champions [via *identifying nurseries where programme appears to be working well]*	IC, K&B, Engaging
Organise nursery implementation team meetings	N&C
Promote network weaving	N&C
Build a coalition	EP&I, N&C, RfI
Obtain formal commitments	EP&I
Strategic stakeholders	
Build a coalition	EP&I, N&C, RfI
Obtain formal commitments / Involve executive boards / Mandate change	EP&I
Service users (parents, carers, children)	
Involve parents, carers, children / Obtain and use feedback from parents, carers, children	PN&R

informs content of

which supports

Key				
	CFIR Domain		**Abbreviated CFIR construct names used**	
	Intervention Characteristics		PN&R	Patient needs & resources
	Characteristics of Individuals		EP&I	External policies & incentives
	Inner Setting		N&C	Networks & communications
	Outer Setting		IC	Implementation climate
	Process of Implementation		RfI	Readiness for implementation
			K&B	Knowledge & beliefs about intervention

Figure 13 Revised categories and implementation strategies with mapped CFIR constructs

These categories and implementation strategies are described further in sections 5.3.3.1 to 5.3.3.3, below; recommendations for future programme developments, based on these strategies, are provided in the Discussion (Chapter 6, section 6.7.1).

5.3.3.1 Knowledge gathering; describing intervention and expectations

The first category of implementation strategies refers to those describing what is required to deliver the nursery supervised toothbrushing programme as well as gathering knowledge about its delivery on-the-ground. The component implementation strategies are: i) conduct local needs assessments; ii) develop formal implementation blueprint; iii) promote adaptability; and iv) purposively re-examine the implementation.

Local needs assessments should be undertaken at each nursery not delivering toothbrushing as intended. Per the description of this strategy provided by Powell et al. (2015) this should identify all relevant considerations for delivering the intervention in a specific context, such as the challenges related to children's particular needs and abilities and what the specific barriers to fitting toothbrushing into each nursery's schedule are, to identify solutions to barriers that would enhance the 'Implementation Climate' and 'Readiness for Implementation'.

Powell et al. (2015) describe formal implementation blueprints as setting out the aims of an implementation effort, specifying what is required, who is involved (at various organisational levels); these plans should include appropriate progress measures, to track changes over time and monitor implementation fidelity. (The strategy 'purposively re-examine the implementation' is a sub-set of this, as it entails monitoring progress in implementing the intervention.) This research has provided the basis for an implementation blueprint, by setting out the toothbrushing programme's Theory of Change within the logic model and assessed delivery-in-reality against this. The programme should consider developing and incorporating appropriate progress measures and mechanisms to monitor fidelity of programme delivery in future.

The final implementation strategy within this category is to 'promote adaptability', which entails identifying how the intervention can be tailored to meet local needs and fit into different contexts; this requires the core elements of the intervention that need to remain unchanged to be clarified, to preserve fidelity. Going forward, any adaptation of toothbrushing programme delivery would be intended to address the perceived challenges arising from its complexity, in terms of fitting it into nursery routines; however, this requires further specification of what can be adapted, and what must be retained, within delivery of the toothbrushing programme.

5.3.3.2 Train and educate stakeholders

Knowledge gathered about the implementation of the toothbrushing programme-in-reality, plus the blueprint setting out expectations about its delivery, should be used to inform the second category of implementation strategies, which relate to training and sharing knowledge with stakeholders. The component implementation strategies are: i) conduct ongoing training; ii) conduct educational meetings; and iii) develop educational materials.

Powell et al. (2015) emphasised that training provided to stakeholders about interventions should be ongoing, with efforts made to ensure it reaches everyone necessary. Within Childsmile, training is provided to nursery staff on toothbrushing programme delivery; however, as discussed, some respondents were unsure if methods to cascade training between nursery staff were effective. The programme should consider enhancing the training provided to nursery staff, using learning from the previous set of implementation strategies discussed, to address specific challenges within individual nurseries, such as identifying practical solutions to overcome time constraints and other barriers to fitting toothbrushing into nursery routines. Ongoing training delivery would be supported by the two other implementation strategies within this category; for 'conduct educational meetings', these should be targeted at specific groups of stakeholders (e.g. local authority education department colleagues; head teachers and nursery managers; nursery staff; parents and carers; or children) to provide information tailored to their role about what the programme involves and what is expected of them in relation to programme delivery. Both ongoing

training and educational meetings would be enhanced by manuals, toolkits or other reference materials which make it easy for stakeholders to learn about the intervention and how to deliver it.

5.3.3.3 Increase buy-in and engagement among stakeholders

Training and education undertaken with stakeholders will contribute to the final category of implementation strategies identified, which relate to enhancing stakeholders' engagement with the programme. This is comprised of three sub-categories of stakeholder: operational (i.e. individuals involved in 'on-the-ground' delivery of the toothbrushing programme in nurseries); strategic (i.e. those involved in making decisions that affect programme delivery, such as nursery managers and head teachers and local authority education departments); and service users (i.e. children and their parents/carers).

Increasing buy-in among services users (parents/carers and children) requires their needs to be understood and addressed. As discussed, it was found that children's needs and abilities, including their reluctance to participate in toothbrushing, was a barrier to delivery in some nurseries. The programme should consider more involvement of children, parents and carers in developing the toothbrushing programme; seeking feedback from children, parents and carers and using this to enhance programme delivery will help it to meet their specific needs and preferences.

For increasing buy-in and engagement among operational stakeholders, the component implementation strategies are: i) identify and prepare champions (by identifying nursery staff with an interest in oral health, in nurseries where the programme appears to be working well); ii) organise nursery implementation team meetings; iii) promote network weaving; iv) build a coalition; and v) obtain formal commitments. The strategies 'build a coalition' and 'obtain formal commitments' are also relevant for enhancing strategic stakeholders' engagements, alongside 'involve executive boards' and 'mandate change'.

'Champions' are identified as individuals who are dedicated to supporting, marketing and driving forward the implementation of an intervention (Powell et

al., 2015). Their role includes supporting others to overcome challenges to implementation, as well as addressing others' resistance or indifference to the intervention. While Powell et al. (2015) suggested that 'early adopter' sites may provide a good pool of potential champions, this has been redesignated as nurseries where the programme appears to be working well within this research (as the length of time since the nursery supervised toothbrushing programme was first implemented means that early adoption is no longer relevant). The programme should consider identifying nursery staff with an interest in oral health, in nurseries where the programme appears to be working well, to invite them to act as 'champions' to communicate with peers to share their experiences and learning about programme delivery. There is also merit in identifying well-engaged stakeholders at other organisational levels (such as head teachers/nursery managers and local authority education department colleagues) to act as champions and advocate for the toothbrushing programme with their peers.

Several of these strategies overlap. For example, 'nursery implementation team meetings', which Powell et al. (2015) describes as providing protected time for stakeholders involved in delivery to reflect and share learning with one another, may be led by programme champions, who use those opportunities to meet with peers to describe their own experiences in delivering the programme and addressing barriers (e.g. how they fit toothbrushing into nursery routines and overcome time constraints). Similarly, 'promote network weaving', described as identifying and building on existing relationships, within and between organisations, to share information, develop a shared vision and undertake collaborative problem solving, is similar to 'build a coalition', which involves recruiting and cultivating relationships with partners involved in implementation efforts.

It is suggested that obtaining formal commitments from partners involved in programme delivery, at both strategic and operational levels, will set out what is expected of each role in delivering the intervention. This may be enhanced further at the strategic level by involving 'executive boards', or existing governing structures, to provide mandates on implementing the intervention; that is, securing the decision-makers' commitment to prioritise toothbrushing

programme delivery and make clear their determination that it will be implemented as intended.

5.4 Chapter summary

This chapter identified a range of barriers and facilitators influencing the implementation of the nursery supervised toothbrushing programme, before and during the Covid-19 pandemic, which were mapped to relevant domains and constructs of the CFIR. The CFIR was shown to be representative of the factors involved in programme implementation (including all five domains and 14 of its 26 constructs).

Within the 'Intervention Characteristics' domain, the 'Complexity' construct encompassed challenges with fitting into nurseries' routines and perceptions that it was too time-consuming, although this also related to the extent to which nursery staff prioritised the programme among the range of activities they delivered. In relation to 'Evidence strength & quality' construct it was highlighted that evidence supporting the programme's infection prevention and control procedures was robust and that there was strong evidence for its effectiveness, although respondents questioned the evidence behind changing the guidance to using dry brushing only during the pandemic. The resources provided to nurseries (i.e. toothbrushes, toothpaste and racks) were described positively by the majority of respondents; furthermore it was identified that providing those toothbrushing resources free-of-charge facilitated delivery.

The 'Patient needs & resources' and 'External policies & incentives' constructs emerged as relevant to implementation in relation to the 'Outer Setting' domain. Children's ability to follow instructions and perform the required actions to brush their teeth independently influenced delivery, as well as children's reluctance to participate, as they were often not directed to participate in toothbrushing if they preferred to do other activities. Again, this was linked to whether toothbrushing was prioritised compared with other activities in nurseries.

Respondents thought that being unable to direct nurseries to participate and ensure all children brushed their teeth every day they attended was a barrier to implementation. To address this, several respondents suggested there was a need for intervention (i.e. from the Scottish Government) to make participation in the programme mandatory for all nurseries.

Challenges in communication between Childsmile staff and nursery staff were highlighted, including uncertainties among Childsmile staff whether toothbrushing took place every day, or nursery staff feeling able to 'admit' if toothbrushing was not taking place every day. During the pandemic, limited opportunities for communication between Childsmile staff and nursery staff was a barrier to remobilisation. Differences were found in the extent to which local networks with local authority education departments were well-developed, in terms of local authority support for the programme.

Positive examples of communication, between the national Childsmile programme and other national partners during the pandemic, included developing the Toothbrushing Standards addendum and the Chief Dental Officer for Scotland's office facilitating communication with the Directors of Education group to support remobilisation. However, communication between the national programme and local Childsmile teams was a barrier during the pandemic, specifically in relation to the development of the Toothbrushing Standards addendum, as Childsmile coordinators were not consulted in advance of its publication.

One of the main barriers (mapped to the 'Knowledge & beliefs about the intervention' construct) was negative attitudes among nursery staff towards toothbrushing, including feelings of discomfort or disgust; perceptions that delivering toothbrushing was not part of their job (i.e. it should be carried out at home, by parents/carers); and that other activities within nurseries took precedence above toothbrushing. Conversely, there were positive attitudes identified among nursery staff who recognised the value and importance of the programme and were aware of its benefits for the participating children.

The 'Process of implementation' domain ('Planning', 'Engaging' and 'Executing' constructs) emerged as relevant during the pandemic period, as the programme

was being re-implemented following its suspension (whereas prior to the pandemic, it had been delivered for a long period of time and processes involved in its implementation were less pertinent to respondents).

Overall, several of these findings related to the extent to which the nursery supervised toothbrushing programme fitted within nurseries' routines, which was linked with nursery staff's willingness to rearrange activities or accommodate toothbrushing flexible within schedules. Recognising how toothbrushing fitted with other activities had a positive effect on its delivery and it was identified that initial effort among nursery staff was required to carry out toothbrushing, to allow it to become routinised.

Mapping these constructs to the Expert Recommendations for Implementing Change (ERIC) implementation strategies identified 17 potential strategies, grouped within three categories, to address the barriers to delivering the nursery supervised toothbrushing programme. These related to: gathering knowledge and describing the intervention; training and educating stakeholders; and increasing buy-in and engagement among operational and strategic stakeholders and service users (children, parents and carers).

6 Discussion

This is a novel study which has identified that optimising the Childsmile nursery supervised toothbrushing programme requires a shared vision to be developed and strengthened among partners involved in its implementation. This would be supported by developing a formal implementation blueprint and further work to increase nursery staff's buy-in, including using local champions and providing enhanced training. Continuing to monitor and evaluate the fidelity of programme delivery, using the methodology and logic model developed in this thesis, will also support programme improvements. This research has shown the strengths of using a pragmatic, mixed methods approach, as it was found there were inconsistencies between the quantitative data on nurseries' participation in toothbrushing (collected via the national survey) and the qualitative data describing stakeholders' perceptions about nurseries' participation.

This research has explored and agreed the Theory of Change for the nursery supervised toothbrushing programme with programme stakeholders. The research provided a new logic model depicting the Theory of Change to specify the agreed inputs (providing toothbrushing resources and the time provided by Childsmile staff and nursery staff); activities (i.e. children have the opportunity to brush their teeth every day they attend nursery, which is supervised by nursery staff, who are trained and supported by Childsmile staff; and partnerships are developed between local Childsmile teams and education colleagues, and between the programme and national partners); and outcomes (i.e. increased frequency of children participating in toothbrushing, children acquire toothbrushing skills and are exposed to appropriate levels of fluoride); and the linkages between these.

Assessing the fidelity of delivery-in-reality using the agreed logic model found that the primary activity – that 100% of children brush their teeth every day they attend in 100% of nurseries – was found not delivered as intended, with considerable variation between health boards. There was partial fidelity in the delivery of several of the intended activities: for example, training was provided by Childsmile staff to nursery staff, although there was variation in frequency and content between areas; and twice-yearly monitoring visits to nurseries took

place in the majority of areas before the pandemic, although the frequency of these reduced during the pandemic.

This research has identified barriers and facilitators influencing programme delivery, which aligned with a range of CFIR domains and constructs. For example, the constructs of 'Complexity' (Intervention Characteristics domain) and 'Readiness for Implementation' (Inner Setting domain) were linked to the extent to which nursery staff prioritised programme delivery, due to perceptions about time constraints and challenges fitting toothbrushing into nursery routines. This was also linked with the constructs of 'External Policies & Incentives'(Outer Setting domain) and 'Knowledge & Beliefs about the Intervention' (Characteristics of Individuals domain) as prioritisation of toothbrushing was affected by the interpretation of policies on early learning and childcare (such as providing 'free play') among some nursery staff. Furthermore, the 'Patient Needs & Resources' construct (Outer Setting domain) was linked to perceptions about children's ability to perform the required actions and brush their teeth independently, which included differences in whether children who were reluctant to participate were directed to do so (which was related to the interpretation of the aforementioned early learning and childcare policies). In relation to 'Adaptability': removing nurseries' choice about carrying out toothbrushing at or away from sinks during the pandemic had a negative impact on their engagement.

The research uncovered challenges relating to communication between Childsmile staff and nursery staff (related to 'Networks & Communications' construct, Inner Setting domain), such as uncertainties whether toothbrushing was taking place every day; and differences between levels of engagement of local authority education departments with the programme. Barriers to communication were exacerbated during the Covid-19 pandemic, particularly as opportunities for informal, face-to-face contact were curtailed.

This chapter will discuss the key findings of this research, considering how these fit within the wider literature on implementation science, with recommendations provided on how to further optimise programme delivery.

6.1 Explicating the theory of change for the nursery supervised toothbrushing programme

This research successfully revised and adapted a logic model to depict programme stakeholders' views on the programme's Theory of Change, which included obtaining stakeholders' agreement that the primary activity of the programme was that all children have the opportunity to brush their teeth in nursery, every day they attended; and that all nurseries in Scotland should participate in the programme. Consensus among stakeholders was also reached that this activity, alongside the supporting activities identified, would lead to the intended outcomes, namely to prevent dental decay among children and reduce oral health inequalities, by increasing their exposure to appropriate amounts of fluoride, by establishing oral hygiene routines in nurseries which also support their toothbrushing skills acquisition. However there were some differences uncovered in programme stakeholders' perceptions about some of the supporting activities, such as the extent to which 'supervision' of toothbrushing required nursery staff to closely observe children while toothbrushing. Stakeholders' views regarding prioritisation of toothbrushing in nurseries also differed; while it was recognised that delivering the programme was one of many demands on nursery staff's time, stakeholders indicated differing levels of acceptance regarding 'less than ideal' delivery (i.e. toothbrushing not taking place every day, or with all children present).

The approach used by the principal researcher to develop the programme's Theory of Change is commensurate with approaches described in the literature, i.e. identifying what the intended impact of an intervention is, specified via outcomes (to be reached in the short-, interim- and long-terms), known as the programme's impact theory; then working back from those outcomes to identify the inputs, activities and outputs comprising the programme's process theory, which are expected to achieve the identified outcomes (Coryn et al., 2011). This enables potential risks to achieving outcomes to be identified, where delivery of any programme activities is sub-optimal (de Silva et al., 2014).

A combination of reviewing programme documentation and literature and interviewing strategic programme stakeholders involved in strategic decision-making within the Childsmile programme (programme directors and managers plus a representative of the Scottish Government) was used to explicate the programme's Theory of Change. The literature recommends involving stakeholders in the process of developing the Theory of Change for interventions (Connell and Kubisch, 1998, Sullivan and Stewart, 2006, Mason and Barnes, 2007). Within the literature, 'stakeholders' are defined as those with a primary interest in the topic of concern within a given context. These are comprised of groups with differing priorities and levels of power and influence, including: funders; decision makers; programme managers; staff involving in delivering an intervention; and individuals participating in or receiving an intervention (Sullivan and Stewart, 2006, Chen, 2015). Sullivan and Stewart (2006) acknowledged that it was not usually possible to involve wider communities in developing programmes' Theory of Change, but that the interests of those communities would be represented by active participants from the various stakeholder groups, with the assumption that those representatives would be able to engender buy-in among wider communities affected by programmes. For example, de Silva et al. (2014) suggested that stakeholder participation encourages their buy-in and ensures that real-world contexts and constraints (e.g. access to resources) are taken into account within the Theory of Change, although their experience of developing a counselling intervention for maternal depression found that buy-in was often difficult to maintain beyond initial Theory of Change development workshops, suggesting the need for ongoing engagement of stakeholders in the process. Breuer et al. (2016)'s systematic review of the use of theory of change in developing and evaluating public health interventions found that many studies lack detailed description of the development of theories of change, often with superficial involvement from stakeholders.

Hernandez and Hodges (2006) suggested that stakeholder involvement in developing the Theory of Change for mental health services for young people within the youth justice system ensured a shared vision and cohesive actions, as this involved multiple organisations with disparate goals and competing priorities in allocating staff and resources; and Breuer et al. (2014) found that undertaking

workshops with stakeholders across multiple organisations (and at multiple levels within hierarchies of those organisations) allowed for a wider sense of ownership of the Theory of Change among all those involved in developing mental health care services in low- and middle-income countries.

These examples have parallels with the nursery supervised toothbrushing programme, which also involves multiple organisational levels: within the Childsmile programme, there is national programme management as well as operational stakeholders from each NHS health board; and outside of the Childsmile/NHS structure, the programme relies on the involvement of local authority education departments (across 32 individual local authorities in Scotland) and individual nurseries. However, developing the Theory of Change for the nursery supervised toothbrushing programme only involved strategic stakeholders from within the Childsmile programme, and did not include a wider range of stakeholders on whom programme delivery depends (i.e. those within local authority education departments or individual nurseries). It could therefore be argued that the Theory of Change is biased towards the Childsmile/NHS perspective and does not take into account the needs and priorities of stakeholders based outside of Childsmile/NHS (but on whom programme delivery depends nonetheless). However, including this group of strategic programme stakeholders in developing the Theory of Change ensured it reflected their expertise and knowledge of oral health improvement and Childsmile, and represented their vision for the programme as the programme's key decision-makers.

Within their evaluation of the development of multi-agency preventive services for children in England, Mason and Barnes (2007) found that it was necessary to include both key decision-makers and those working in operational roles (i.e. involved directly in delivering the interventions activities) to ensure adequate coverage and feasibility of the proposed Theory of Change. Based on their experience of developing Theory of Change for national programmes in England (e.g. Health Action Zones) Sullivan and Stewart (2006) found that achieving total ownership among all stakeholders was elusive, with 'elite' ownership (i.e. involving a small group of leaders) or 'principal' ownership (i.e. lying with one or more dominant stakeholders) more common.

The literature also highlights the need to identify and explore assumptions within theories of change with stakeholders, to strengthen interventions' feasibility, allow stakeholders to understand one another's perspectives and ensure the Theory of Change is meaningful for all involved (Sullivan and Stewart, 2006, de Silva et al., 2014, Breuer et al., 2014). Sullivan and Stewart (2006) identified that achieving consensus among stakeholders in relation to Theory of Change was often difficult and required time to obtain an understanding of their different perspectives and identify ways of working collaboratively. For example, stakeholders may have competing agendas or discordant views about an intervention; nonetheless, stakeholders' assumptions about interventions need to be uncovered, to ensure these are reconciled and do not act against a programme's intentions. This research uncovered differences in strategic stakeholders' assumptions about the programme, such as how 'supervision' of toothbrushing was understood and the role of nursery staff as supervisors, or the extent to which 'less than ideal' programme delivery (such as toothbrushing not taking place every day) was acceptable. These were presented and discussed with strategic programme stakeholders from the Childsmile Executive via a focus group in the final stage of work to develop the logic model. Specific attention was given to the areas of difference identified during interviews, such as what 'supervision' of toothbrushing entailed to reach consensus among participants on what should be included in the final version of the logic model. This resulted in agreement that the primary aim of the programme was for all children to brush their teeth, every day they attended, in 100% of nurseries in Scotland, with further detail given on what the activity of supervising toothbrushing entailed.

6.2 Assessing the fidelity of the implementation of the nursery supervised toothbrushing programme

The implementation science literature recognises that inadequately implemented interventions are not as effective as they could be, requiring the extent to which implementation has taken place as intended to be investigated (Dusenbury et al., 2003, Carroll et al., 2007, Proctor et al., 2011). It was therefore important to assess the fidelity of the implementation of the nursery supervised toothbrushing programme, per its agreed Theory of Change, within

this doctoral research. Implementation fidelity is defined as the extent to which an intervention is implemented as intended by its developers (Carroll et al., 2007, Proctor et al., 2011, Breitenstein et al., 2012). Within their conceptual framework for implementation fidelity, Carroll et al. (2007) defined adherence as the *"bottom-line measurement of implementation fidelity"*, with other components of implementation theory conceptualised as: exposure/dose (the amount and duration of the intervention received by participants and whether all intended participations receive the intervention); quality of delivery; participants' responsiveness; and programme differentiation (identifying components of the intervention that are 'essential for success').

However, it is recognised that assessing implementation fidelity is challenging, as it requires significant time, effort and resources (Proctor et al., 2011, Feely et al., 2018). As a starting point, Pérez et al. (2016) recommended setting out an intervention's expected outcomes, activities and overall Theory of Change, to provide a clear idea of what is intended to be implemented; thereafter questions can be developed to identify whether delivery-in-reality has achieved what was intended. This approach was utilised in this research, using the Theory of Change developed with programme stakeholders to demonstrate what was intended to be delivered and achieved through delivering the nursery supervised toothbrushing programme.

Respondents' feedback highlighted the difficulties in knowing whether nurseries truly participated every day, or supervised children while brushing as intended (which was related to the 'Networks and Communication' construct in the CFIR's Inner Setting domain) and some Childsmile staff perceived that nursery staff may have felt unable to tell them if they were not brushing every day. While Childsmile teams provided advice and support to encourage daily participation and effective supervision, they are unable to 'force' nursery staff to do it. This was also found during the Covid-19 pandemic, where the programme was suspended due to educational establishment closures; progress towards remobilisation was reported to be challenging and slow, with respondents reporting that, where toothbrushing had resumed in nurseries, they did not believe this was taking place every day as intended.

This research used a combination of quantitative and qualitative data, gathered from surveys and interviews, to assess implementation fidelity. This is consistent with approaches used in other studies (Keith et al., 2010, Cross and West, 2011, Wiltsey Stirman et al., 2019, Holtrop et al., 2022). For example, Keith et al. (2010) carried out qualitative interviews with nurse practitioners responsible for delivering a case management programme for patients with chronic heart failure to assess their commitment to delivering the intervention components as specified; this was compared against patient hospital admissions and mortality data to assess intervention effectiveness, which found a positive association between higher levels of implementation fidelity and better patient outcomes.

However there are also examples of studies using observations (e.g. of programme meetings or delivery) (Cross and West, 2011, Mars et al., 2013, James et al., 2017, Wiltsey Stirman et al., 2019, Holtrop et al., 2022); recording and reviewing routine monitoring data (Keith et al., 2010, Dusenbury et al., 2003); or staff involved in delivery keeping reflective diaries (Hawe et al., 2004).

While commonly used, there are limitations associated with implementers' self-reports of adherence to intervention delivery (Lillehoj et al., 2004, Pankratz et al., 2006, Breitenstein et al., 2010, Lendrum and Humphrey, 2012), such as over-estimating. It has been found that observed adherence to intervention guidelines often do not correspond to individuals' self-reported adherence (Dane and Schneider, 1998, Jenner et al., 2006, Melde et al., 2006), such as over-estimating the dose delivered to participants (Dusenbury et al., 2003) or their overall level of implementation fidelity (Cross and West, 2011, Sanetti and Collier-Meek, 2014). Dusenbury et al. (2003, p.241) attributed this to *"perceived pressure to perform"* which is a form of self-reporting bias caused by social desirability, whereby individuals seek to present themselves favourably to others, regardless of their actual feelings on a particular matter (Podsakoff et al., 2003). Within this research, the national survey of nurseries found a high rate of participation in toothbrushing among nurseries (with 92.2% of children present reported to have brushed their teeth on the day of the survey). However, the survey results are likely to be an overestimation of the numbers of nurseries providing toothbrushing every day; due to self-reporting bias, some

nursery staff may have presented themselves favourably to Childsmile staff by indicating they participated as intended when this is not the case in reality. Furthermore, being asked by Childsmile staff to record data on toothbrushing activity for the survey may have prompted nursery staff to carry out toothbrushing when they would not have done so otherwise.

Some authors advocate using observational methods to assess implementation fidelity, to control for social desirability bias and uncover modifications that were 'unrecognised' by implementers (Dane and Schneider, 1998, Wiltsey Stirman et al., 2019). While observational ratings were found to be more reliable than self-report measures to assess implementation fidelity, it was recognised that this was more difficult and time-intensive to administer (Dusenbury et al., 2003, Cross and West, 2011) and did not indicate the reasons for modifications being made (Wiltsey Stirman et al., 2019). Furthermore it was suggested that being observed may influence implementers' behaviours negatively, such as only adhering to protocols while the observer was present, or reducing adherence due to anxiety about being observed (Breitenstein et al., 2010).

6.2.1 Implementation fidelity of the nursery supervised toothbrushing programme

This research found that the primary activity within the logic model (i.e. *"children attending nursery have the opportunity to brush their teeth every day they attend in 100% of nurseries"*) was not delivered as intended. The survey undertaken in 2019 found that 92.2% of children (of all ages) brushed their teeth while attending nursery. There was also a marked difference in the percentages of children brushing on the day of the survey between health boards (e.g. 81.9% in NHS Fife compared with 98.5% in NHS Borders). Furthermore, the survey results indicated that less than 100% of nurseries had all children who attended brushing their teeth on the day of the survey (e.g. 80.2% of nurseries reported that all children aged three and over brushed their teeth on the day of the survey).

This research found that the size of nursery (in terms of the number of children attending) was associated with rates of children brushing, as nurseries with

fewer children attending were more likely to have 100% of children brushing. This finding was backed up by respondents' perceptions that brushing was easier to establish within nurseries' routines when fewer children were attending. The range of age groups attending a nursery was also associated with rates of children brushing, as those with only one age group attending were more likely to report 100% of children brushing. However, the type of nursery (i.e. whether nurseries were private or operated by local authorities) and the area-based deprivation of the nursery were not found to be associated with having 100% of children brushing.

The findings also reported programmes stakeholders' perceptions that not all children were given the opportunity to brush, every day, in all nurseries. While respondents thought that the toothbrushing programme was 'mature' and 'well-established' in most areas, there were data indicating respondents' views that toothbrushing was not taking place in all nurseries as intended. While nursery staff might identify themselves as 'participating', it was thought unlikely that all children were given opportunity to brush every day they attended.

In terms of other activities within the logic model, the findings showed that these were largely delivered as described, although there was some suggestions that these were modified, in some cases; for example, the training delivered to nursery staff to support toothbrushing delivery was not standardised which allowed for tailoring depending on nursery staff's needs and prior experience. Similarly it was reported that the extent and type of support that Childsmile staff provided to nurseries varied, with some receiving 'enhanced' in-person support where Childsmile staff carried out toothbrushing with children; however, support was mainly limited to monitoring visits which took place twice per year in the majority of health boards, although respondents in some health boards reported lacking capacity to support nurseries outside of these twice-yearly visits. Monitoring visits varied between areas in terms of what these entailed (i.e. whether children were observed by Childsmile staff directly while brushing). Supporting nurseries during the Covid-19 pandemic was challenging, due to restrictions preventing in-person support and practical demonstration, with a limited number of monitoring visits taking place since nurseries had reopened.

6.2.2 Adaptation and modification of interventions

Assessing programme implementation found that some aspects (e.g. providing all children the opportunity to brush every day) had mixed levels of fidelity, and others (e.g. training for nursery staff and support provided by Childsmile teams) had been modified to suit local circumstances.

It is recognised that adhering to intervention protocols and implementing all aspects of programme exactly as intended is challenging in 'real-world' settings (Cohen et al., 2008), with tensions between ensuring implementation fidelity and adapting or modifying interventions to meet local needs (Cross and West, 2011, Breitenstein et al., 2012, Pérez et al., 2016). The complexity of interventions is thought to increase the scope for variations in delivery (Carroll et al., 2007). Within the Childsmile programme, there is flexibility afforded to local health boards in deciding how to implement and delivery the programme, to take each health boards' unique context into account, which programme stakeholders have previously identified as a strength of the programme's approach, although the potential for local adaptations to deviate too far from the core features of the Theory of Change were acknowledged (Eaves and Gnich, 2013).

Dusenbury et al. (2003) suggested that those involved in programme delivery tend to want to adapt or alter interventions, while programme developers' tended to lean towards maintaining strict adherence to protocols; indeed in an evaluation of a health promotion intervention for new mothers, community development workers involved in delivery reported that they experienced *"local pressure to adapt"* the intervention, despite programme developers intentions to standardise delivery of all components (Hawe et al., 2004, p.791). Within this research, there were differences found between Childsmile programme stakeholders in whether potential deviations from the agreed programme activities (such as toothbrushing not taking place every day or being offered to all children present) were seen as acceptable. However, the consensus reached among programme stakeholders, as reflected in the final version of the logic model developed, was that the primary aim was for all children brushing their teeth, every day they attended nursery, in 100% of nurseries in Scotland.

The ability to adapt an intervention for local use is thought to increase its acceptability among recipients and those involved in its delivery (Rogers, 2003, Proctor et al., 2011) allowing for implementation that is responsive to local cultural and contextual circumstances (Dusenbury et al., 2003, Carroll et al., 2007, Cross and West, 2011). It appears that the modifications to programme delivery may have taken place for these reasons; for example, in nurseries where toothbrushing was taking place but not every day or with all children present, nursery staff may have chosen to modify delivery in this way to fit it in to the wider schedule within nurseries or to accommodate children's preferences per the child-centred, 'free play' approach used in nurseries. Similarly, it was found that the ability to modify the training delivered to nursery staff was a facilitator as it allowed training to be responsive to individual staff's needs. These changes may have made the intervention more acceptable to nursery staff, as a lack of acceptability is recognised as a major challenge to implementation (Proctor et al., 2011) as users or those involved in delivery may resist it without the flexibility to make changes (Pérez et al., 2016). Indeed, during the pandemic, removing nurseries' choice whether children brushed their teeth at a sink (wet model) or away from a sink (dry model) impacted negatively on remobilising toothbrushing delivery in nurseries, with respondents reporting feedback from nursery staff that indicated the dry brushing model was not acceptable to them.

However, the rationale behind intervention adaptation and modification is often not apparent and there is little evidence to guide the circumstances in which adapting an intervention is appropriate or how to assess if those adaptations will increase or decrease an intervention's effectiveness (Mars et al., 2013, Toomey et al., 2020, Movsisyan et al., 2021). While some authors describe adaptations as intentional, planned changes to interventions, made by programme developers in advance of introducing an intervention into a new context or to address an emerging issue (Movsisyan et al., 2021), others recognise that implementation variation arises from interventions delivered 'in reality' by various partners which includes unintentional changes (also known as 'drift') which may not be immediately obvious to programme developers (Olson et al., 2022, Sundell et al., 2016, Holtrop et al., 2022, Wiltsey Stirman et al., 2019).

This raises the question of who decides that adaptation of an intervention is required; within the nursery supervised toothbrushing programme it appears that staff in some nurseries modified delivery so that toothbrushing was not offered to all children, every day they attended, without consulting with the Childsmile programme, which may have increased their acceptance of the intervention, but at the cost of it no longer delivering the same dose as intended by the programme planners. Indeed, it is highlighted within the literature that removing or making major changes to components may lead to an intervention no longer resembling what was intended originally (i.e. fidelity is threatened) which may compromise its validity (Cohen et al., 2008, Pérez et al., 2016), with Breitenstein et al. (2012) describing changing the dose or removing content of interventions as 'unacceptable' types of adaptations. It is not clear whether the modifications made to programme delivery threaten the theoretical basis of the intervention. This research began from the viewpoint that the strategic stakeholders involved in developing the programme's Theory of Change represented all relevant individuals who were in a position to identify the key outcomes and activities for the programme; and that only full implementation fidelity of the vision for the programme set out by those stakeholders was acceptable. As noted, it is recognised that programme developers (such as the strategic stakeholders involved in the nursery supervised toothbrushing programme) often aim for strict adherence to intervention protocols (Dusenbury et al., 2003, Chiodo and Kolpin, 2018). Strategic stakeholders were clear that the primary activity of the nursery supervised toothbrushing programme was that all nurseries offered *daily* toothbrushing to all children; however, is it acceptable within the Theory of Change if the dose or frequency is less than daily, as long as *some* toothbrushing takes place? To identify the minimum acceptable 'dose' in terms of numbers of days per week that children brushed their teeth in nurseries would require further clinical trial research to investigate the impact of differing toothbrushing frequency on children's caries experience, which would be time- and resource-intensive. The alternative, pragmatic approach would be to aim for 100% implementation fidelity, while accepting that this might not always achieved, and factoring in differences in fidelity as a moderator in assessments of programme impact on outcomes (Abry et al., 2015, An et al, 2020). This approach would require ongoing data collection to assess nurseries' participation in the programme over time.

The question of determining what level of adherence to programme guidelines is 'good enough' (i.e. how much of the programme content, to which level of quality, will achieve positive results) has been considered within the implementation science literature (Cross and West, 2011), centring on identifying and maintaining 'core' or 'essential' intervention components (thought to contribute directly to outcomes) while allowing peripheral modifications (Cohen et al., 2008). However several authors have highlighted that there is insufficient guidance within the literature on how to identify which components are essential and which can be changed (Carroll et al., 2007, Pérez et al., 2016, Haynes et al., 2016). It has been suggested that core components of interventions should be articulated by programme developers (Abry et al., 2015, Haynes et al., 2016) which is the approach used within this research, whereby developing the Theory of Change with strategic stakeholders included them identifying what they perceived to be the key activities required to reach the intended outcomes, i.e. the 'core' components. However it is also suggested that it is difficult to ascertain what are the 'active ingredients' that lead to outcomes within complex interventions, due to the multiple components operating at different levels (Greenhalgh et al., 2022). It must also be recognised that the context in which interventions are delivered does not remain static, but is subject to various influences which affect how the intervention is delivered, suggesting that implementation should be viewed as an iterative process that responds to these changes over time (Greenhalgh and Papoutsi, 2018, Braithwaite et al., 2018).

Another finding relating to intervention adaptation concerns the addendum to the Toothbrushing Standards, developed by the national Childsmile programme to guide toothbrushing delivery in nurseries and schools during the Covid-19 pandemic. This required all children to brush away from sinks (the 'dry' model) including disposing of excess toothpaste and saliva into paper towels instead of into sinks. However, local Childsmile coordinators and teams were not consulted in relation to the amended guidance, which had a negative impact on their buy-in. For example, it came to light that dry brushing was not predominant model used in the majority of the health boards before the pandemic, but this was not taken into account by the national Childsmile programme management when developing the guidance. This meant that Childsmile teams' needs, in terms of

planning and support to communicate with nursery staff about this change to delivery, were not taken into account. Respondents perceived that progress in restarting the programme was stalled due to the initial version of the guidance, although this was later rectified with the national Childsmile programme management reviewing and amending the guidance (which allowed both 'wet' and 'dry' brushing models). The wider lesson from this example is that those involved in delivery on-the-ground should be consulted when guidance affecting delivery of an intervention is developed, to ensure it reflects their on-the-ground experience and meets their needs. Indeed, in their framework for reporting intervention adaptations, Wiltsey Stirman et al. (2019) highlighted that who was involved in making decisions about modifying interventions, and how participatory the decision-making process was, influences the likelihood of the modifications having intended impacts.

6.2.3 Impact of context on implementation fidelity

The context, i.e. the social, political and organisation setting (Hawe et al., 2004) within which an intervention is implemented, is recognised to influence its implementation, which may include staffing availability, resources, support from other agencies. Haynes et al. (2016) identified the need to assess the *"complex, interactive, organisational and system level properties"* acting on the implementation of interventions, as assessing individual behaviours was not sufficient to uncover how and why interventions were implemented as intended or not.

Through the course of this research it became apparent that the context into which the programme was implemented was complex and changing; for example, wider changes within early learning and childcare delivery had impacted on programme delivery, such as more flexible attendance patterns (instead of the rigid, five morning or afternoon sessions per week, which was commonplace when the programme was first introduced in nurseries) or the child-centred 'free play' approach which has changed nursery routines, with fewer structured, group-based activities (which toothbrushing appeared to be more naturally aligned to). This suggests there may be a need to explore what is 'good enough' implementation of the nursery supervised toothbrushing

programme with stakeholders, in light of changes within the implementation context. As noted by Smith (2017), a ‘less than ideal’ intervention may be the best that can be achieved within particular contexts, such as those with competing agendas among stakeholders. Within the literature on implementation of other health-related interventions in educational settings, teachers questioned how to identify what to ‘lose’ when many activities were considered to be ‘priority’ (Griffin et al., 2015); as it is not within the gift of the Childsmile programme to mandate which activities should be prioritised within Education settings, there is an argument that ‘good enough’ implementation within the limitations of the context should be accepted by programme stakeholders.

The impact of changes within the implementation context was also highlighted in relation to remobilisation following its suspension while establishments were closed during the Covid-19 pandemic. The pandemic represented a major disruption to the context into which the programme was delivered. Various studies have reported negative impacts for children associated with the closure of educational establishments during the pandemic, including increased emotional and behavioural problems (Viner et al., 2022), including sleep disruption and difficulty with regulating emotions (Vasileva et al., 2021); higher prevalence of symptoms of depression and anxiety compared with pre-pandemic (Samji et al., 2022); poorer academic attainment (particularly among those from socioeconomically disadvantaged backgrounds) (Svaleryd and Vlachos, 2020, Irwin et al., 2022). Other potential impacts suggested within the literature include the removal of opportunities for socialisation, which are important for developing self-confidence, empathy and emotional regulation (Colao et al., 2020, Irwin et al., 2022). All of these factors are likely to have ongoing repercussions for children and require input from early years professionals, including staff in nurseries, adding to time constraints within those settings; indeed, the survey of nurseries carried out in 2019 found that supporting children’s additional support needs, including factors related to children’s behaviour or developmental stage, was one of the most commonly identified barriers to delivering the programme. These additional pressures affecting nurseries suggest that the programme needs to adapt to this new, post-pandemic context.

Findings from the post-pandemic survey of nursery staff highlighted that concerns about infection prevention and control were commonly cited as barriers to restarting toothbrushing in the setting (whereas very few respondents identified infection prevention and control as a barrier to delivery in the pre-pandemic nursery survey). It is likely that the experience of living through the pandemic will have changed many individual's perceptions and understanding of infection prevention and control as well as affecting their views on levels of 'acceptable risk' regarding exposure to infection. Supervising toothbrushing involves being exposed to saliva, as children need to dispose of excess toothpaste as well as brushes that have been in children's mouths requiring cleaning; meanwhile there has been lots of attention given to the role of saliva as a route for Covid-19 infection, meaning that concerns about potential risk of Covid-19 infection from toothbrushing are likely to have arisen among nursery staff. Other studies have investigated the psychosocial effects of the Covid-19 pandemic on school staff, which have found that school staff experienced feelings of fear and anxiety relating to becoming infected, transmitting the infection to their families, and their ability to implement infection prevention and control procedures within school settings effectively (Nabe-Nielsen et al., 2021, Wakui et al., 2021, Fukuda and Fukuda, 2022).

6.3 Factors influencing implementation of the nursery supervised toothbrushing programme

6.3.1 Using the CFIR to assess factors influencing implementation

There are other examples of studies using the CFIR to investigate implementation of interventions in nursery and school settings, focused on healthy eating, physical activity or obesity prevention interventions, in countries including Sweden, the Netherlands, Germany and the UK. In common with findings from this research, all of these studies found that balancing intervention delivery alongside other required activities (e.g. within curriculums) within the limited time available were barriers to implementing interventions in nurseries

(Norman et al., 2019, Burton et al., 2019, van de Kolk et al., 2021, Müller and Hassel, 2021, Meshkovska et al., 2022, Asada et al., 2023). In their study assessing the implementation of an obesity prevention intervention in Swedish preschools, Norman et al. (2019) recommended that the intervention should be integrated into the curriculum to overcome these barriers; conversely, van de Kolk et al. (2021) advocated for bottom-up approaches to planning interventions, involving nursery staff, to ensure better fit between interventions and other preschool activities.

A number of studies highlighted the impact of leadership engagement on implementing interventions, such as Norman et al. (2019) who found that a lack of engagement among managers made it difficult for nursery staff to direct their time towards delivering the intervention. This has parallels with this research's findings around the interpretation of early learning and childcare policies in nurseries, which led to other activities being prioritised over toothbrushing and the 'free play' approach meaning children were not directed to brush their teeth if they chose to participate in a different activity.

The adaptability of the intervention was a facilitator in a number of these studies (Burton et al., 2019, Meshkovska et al., 2022, Asada et al., 2023); for example, Meshkovska et al. (2022) identified that staff having flexibility in deciding when to have 'fruit and vegetable' breaks during sessions facilitated their engagement in delivering the intervention.

6.3.2 Using the CFIR-ERIC Implementation Strategy Matching Tool

Since its publication, the CFIR-ERIC Implementation Strategy Matching Tool has been used in various studies to identify appropriate implementation strategies to address determinants affecting implementation of a diverse range of interventions, taking place in countries including USA, Canada, Netherlands, Denmark and Malaysia. These included hospital infection control programmes (Dekker et al., 2022); digital cancer care platforms (Verweij et al., 2022); access to emergency contraception (Simmons et al., 2022); harm reduction services for substance use (Harvey et al., 2023); telehealth interventions for older adults

(Kernan et al., 2023); and the implementation of various types of guidelines and risk assessment tools for use in healthcare settings, focused on falls prevention (Juckett et al, 2020); geriatric screening (Southerland et al., 2021); loss of consciousness (Li et al., 2021); cardiovascular disease (Baldwin et al., 2022); treatment-related toxicity self-management for cancer patients (Howell et al., 2022); and medication review (Mustafa et al., 2023).

Several of these authors identified strengths associated with using the tool, including that it identified multi-faceted strategies that would address the barriers identified (Simmons et al., 2022, Kernan et al., 2023, Mustafa et al., 2023). Baldwin et al. (2022) included both clinicians and implementation researchers in the process of mapping barriers to implementing a cardiovascular disease risk assessment tool, to appropriate implementation strategies. The authors found that there was some divergence in the strategies prioritised by these two groups; they suggested that, while the implementation researchers were more familiar with the ERIC strategies, they were less able to select which strategies were most applicable to the clinical setting. This highlights the importance of including partners from the intended implementation settings in developing implementation strategies, to maximise the potential for the selected strategies to fit within the context. Similarly, Kernan et al. (2023) noted that refining the implementation strategies identified through their research (on implementing telehealth interventions for older adults) required input from the stakeholders expected to implement the intervention, to draw on their knowledge and skills.

While Southerland et al. (2021) and Dekker et al. (2022) both commented on the utility of applying a single strategy identified using the tool to address multiple barriers, Juckett et al. (2020) highlighted that some strategies, such as ‘conduct educational meetings’, were not effective in changing behaviours when used alone and should be combined with other strategies.

However, some drawbacks were identified, including that the ERIC strategies were often generic and required further tailoring to fit within specific contexts and identify methods and techniques to operationalise them (Li et al., 2021; Howell et al., 2022, Kernan et al., 2023). Some of the wording and definitions

used within the ERIC strategies required simplification to ensure all terminology was accessible to clinicians and other stakeholders (Baldwin et al., 2022). It was also noted that the effectiveness of the strategies identified via the tool has not been widely evaluated to date (Dekker et al., 2022, Howell et al., 2022). Some of the strategies identified were not feasible within specific contexts, such as accessing additional staff and other resources (Southerland et al., 2021).

6.3.3 Individual's perceptions and prioritisation of intervention delivery

Findings mapped to a number of CFIR constructs related to how nursery staff perceived the toothbrushing programme, which affected the extent to which they prioritised it compared with other activities taking place in the setting. One of the main challenges identified before and during the pandemic related to fitting toothbrushing into nursery routines, due to time constraints resulting from other activities taking place and perceptions that carrying out toothbrushing was time-consuming. This was linked to the CFIR constructs of 'Intervention Complexity' (Intervention Characteristics domain) and 'Readiness for Implementation' (Inner Setting domain).

There were differences in the extent to which nursery staff were willing to rearrange other activities to accommodate toothbrushing. Childsmile staff also indicated that they could identify which nurseries would support restarting toothbrushing once establishments reopened during the pandemic, and which would raise barriers, based on prior experience. In general Childsmile staff reported that, following initial effort, toothbrushing delivery became more routinised, the more it was carried out; however, this depended on willingness among nursery staff to deliver the programme consistently. It is likely that most nurseries experience similar time pressures, which raises the question of why some nursery staff found toothbrushing to be too challenging to fit in to their schedules, while others were able to deliver it within similarly structured routines? One explanation for this may relate to the level of priority nursery staff gave to delivering toothbrushing compared to other activities being delivered, which was related to the 'Knowledge and Beliefs about the

Intervention' construct (Characteristics of Individuals domain). Negative views towards the programme among nursery staff was another factor related to this construct. This included feelings of discomfort or disgust towards toothbrushing (in relation to dealing with children's saliva), which came to the fore during the pandemic when the programme attempted to change delivery to 'dry' brushing at a time where nursery staff had heightened awareness of infection prevention and control. Other negative views included some nursery staff's perceptions that delivering toothbrushing was not part of their job (as this should be carried out at home, by parents/carers). Conversely, there were positive attitudes reported among nursery staff who recognised the value and importance of the programme, as they were aware of the benefits for children who participate.

Carroll et al. (2007) identified 'participant responsiveness' as an important factor in achieving implementation fidelity, which refers to the extent to which participants view the intervention as relevant to them, and their engagement with it; the authors noted that 'participants' referred to both recipients of the intervention and those responsible for its delivery, highlighting that higher levels of implementation fidelity tend to be achieved where those involved in delivering an intervention are enthusiastic about it. This is supported by findings from other studies which found that implementation fidelity depended on implementers' attitudes and beliefs about the intervention and the extent to which it matched their values (Dusenbury et al., 2003, Pérez et al., 2016, James et al., 2017).

The construct 'Patient Needs and Resources' (Outer Setting domain) was relevant in relation to perceptions about children's ability to follow instructions and perform the required actions independently. This also related to children's reluctance to participate if they prefer to do other activities, and are not 'forced' to do toothbrushing; however, this is again linked to the level of priority given to toothbrushing versus other activities taking place in the nursery setting.

In relation to the 'External Policies and Incentives' construct (Outer Setting domain), it was highlighted that nursery staff's interpretation of policies relating to early learning and childcare provision impacted negatively on delivering the toothbrushing programme. As noted, nursery provision in Scotland has changed

since the nursery supervised toothbrushing programme was first introduced, with more flexible attendance patterns in place compared with the structure of children attending either five morning or afternoon sessions at fixed times each week, with set timetables within session for activities, including toothbrushing. Furthermore, the Scottish Government's National Play Strategy states that all learning environments, including nurseries, should provide opportunities for free play, which is chosen and directed by children themselves (Scottish Government, 2013b). It is recognised that locally powerful voices or perspectives can influence service development and cause particular perspectives to take precedence over others (Mason and Barnes, 2007); within this research, the 'free play' approach has taken precedence over group-based, directed activities in nurseries (including toothbrushing).

Within the literature, several authors have highlighted tensions between free play, and teacher-led approaches to early learning, or achieving outcomes in early years curriculums. For example, some may view free play as leading to 'incidental' learning, whereas teacher-directed approaches may use play to support learners to reach pre-determined outcomes (McKendrick, 2019b). Studies have identified free play approaches in nurseries as key barriers to engaging children in learning about technology, as it was found that children who did not choose to participate in technology-related activities missed out on developing this knowledge (Plowman and Stephen, 2005, Hallström et al., 2015). Other authors have described nursery staff's interpretations of free play as problematic, as adopting a passive role in observing and facilitating children's activities may result in some children not being engaged in knowledge and skills acquisition (Walsh et al., 2019a), with other research highlighting that supportive interactions with nursery staff and participation in adult-initiated activities benefits children's learning (Hill and Reed, 1990, Karlsen and Lekhal, 2019). McKendrick (2019a) highlighted the need to accommodate both child-led free play and adult-directed purposeful activities in early years settings, with nursery staff responsible for applying each approach as appropriate. Wider adoption of this approach in nurseries in Scotland would benefit delivery of the toothbrushing programme, as it would be unrealistic to expect children to always choose to brush their teeth when given autonomy over their participation in activities in nurseries.

Advocates of the free play approach believe it supports children's holistic development and lays foundations for future learning, and supporting children's development and wellbeing is at the core of early learning and childcare (Bubikova-Moan et al., 2019). To this end, it may increase acceptability of the programme if nursery staff were included in its planning and development, to highlight how it contributes to children's wellbeing and development, as well as support them to identify strategies for delivery that fit within existing free play approaches.

6.4 Inter-organisational collaboration

It is recognised that the determinants of health encompass social, economic and physical factors and are not limited to the health sector (Marmot et al., 2012, World Health Organization, 2017a) therefore addressing health inequalities and improving population health requires collective action between sectors (de Leeuw, 2017, van Vooren et al., 2023). Inter-organisational collaboration involves organisations working together (e.g. sharing information and resources and carrying out joint activities) towards a common goal, that would not otherwise be achieved working alone (Aunger et al., 2022, van Vooren et al., 2023). However, in terms of the nursery supervised toothbrushing programme, this entails the type of complex collective action taking place whereby one group of participants (i.e. the Childsmile programme) intervenes in a context that they do not control, requiring another group of participants (i.e. nursery staff) to change their work or do new work (May et al., 2016); that is, day-to-day programme delivery depends on nursery staff, who are based in different organisations from oral health teams and for whom toothbrushing is just one of many activities they are expected to carry out.

Partnerships between health and education sectors, as takes place within the nursery supervised toothbrushing programme, are commonly cited as examples of inter-organisational collaboration within the literature. Educational settings provide access to large populations of children and there is evidence that education staff recognise that promoting health is part of their role in supporting holistic child development (e.g. learning 'life skills') as well as perceiving that good health is linked with children's readiness to learn (Griffin et al., 2015,

Clarke et al., 2017, Bergström et al., 2020). However the literature on inter-organisational collaboration shows that individuals from different professional backgrounds, working with different organisational cultures, creates barriers to partnership working (Aunger et al., 2022).

The programme's logic model included activities relating to inter-organisational collaboration, between local Childsmile teams and local authorities and individual establishments, and at the national level between the Childsmile programme and other relevant organisations. It was found that Childsmile coordinators had established strong links with local authority partners in the majority of areas, including strong backing from local authority education departments to encourage participation among reluctant establishments. During the pandemic, Childsmile coordinators continuing to communicate with local authority partners, although progress was often found to be challenging due to other demands on them, such as pandemic-related restrictions and planning for re-opening educational establishments. Several respondents highlighted their perceptions that they needed to manage relationships with their local authority colleagues sensitively. It was also found that there was a mismatch between the local authority education department agreeing to participate, and what individual establishments actually do.

During the pandemic there was a greater focus on partnership working between Childsmile and other national partners (e.g. Scottish Government, Care Inspectorate and Health Protection Scotland) in relation to developing guidance for delivering the toothbrushing programme during this period, as well as supporting remobilisation of the programme, with the Scottish Government facilitating access to the Directors of Education group. However, while working with these external partners was thought to be important, findings from this period also highlighted the need to consult with and involve those within the programme, to ensure that guidance being developed would fit with on-the-ground delivery.

6.4.1 Factors influencing inter-organisational collaboration

6.4.1.1 Developing a shared vision and commitment to programmes

Literature on inter-organisational collaboration in healthcare has found that having a shared vision between organisations, understood by all partners, is essential to avoid conflict, enhance motivation and increased implementation fidelity (Ling et al., 2012, Alderwick et al., 2021, Aunger et al., 2022, van Vooren et al., 2023). It is recognised that it requires effort to achieve this shared vision among all those involved, including making it clear why the intervention is being implemented and what is expected of those involved in implementation (Beets et al., 2008, Aunger et al., 2022). For example, Sheppard et al. (2022) found that delivery of a health and social care support programme provided in supported housing for older people was hindered by a lack of understanding among housing staff of health issues affecting residents, and how health and social care professionals could support these. Conversely, studies investigating implementation of school-based health-promotion and social- and behavioural development interventions found that school staff's receptivity, beliefs that the interventions would deliver positive outcomes, and perceptions that the interventions were congruent with their values, were associated with higher implementation fidelity (Deschesnes et al., 2010, Beets et al., 2008).

Collaboration between organisations requires regular interpersonal communication, with informal face-to-face communication identified to develop trust between partners (Aunger et al., 2022). Within the nursery supervised toothbrushing programme, the twice-yearly monitoring visits (plus any additional contacts) were thought to help with maintaining communication with nursery staff. However, it was highlighted that pandemic-related restrictions curtailed opportunities for communication between Childsmile staff and nursery staff, especially in-person.

It was noted that investing in building relationships and trust between partners at the outset of the partnership helps to overcome challenges during delivery (van Vooren et al., 2023). Reviews of inter-organisational collaborations have demonstrated the need for ongoing efforts to develop and maintain trust and

goodwill between partners (Bryson et al. 2015), which Aunger et al. (2021) referred to as ‘trust-building loops’, whereby each partner demonstrates that they are carrying out actions that contribute to achieving shared goals, which leads to trust that partners will do what is required for the ‘collective good’ of the programme. van Vooren et al. (2023) also reported that actively engaging partners throughout programme delivery was required otherwise participation waned, despite initial enthusiasm. This includes ongoing communication about roles and expectations of all partners, to ensure required activities were carried out as planned. Indeed an evaluation of the implementation of Integrated Care Pilots in England found that some partners perceived the intervention was imposed on them without sufficient consultation or instruction on what was required of them (Ling et al., 2012).

Conversely it has been identified that allowing those involved in delivery to have control over developing and implementing the intervention increases their engagement; this was the case with the implementation of the health-promoting schools approach in sample of Scottish schools, which was thought to foster ownership of the intervention among school staff and enhance its fit with local needs (Inchley et al., 2007).

6.4.1.2 Organisational support for programme delivery

A systematic review of implementation of school-based health promotion programmes in the UK found that teachers were more engaged with delivering interventions when given sufficient support to do so (Pearson et al., 2015); types of support that enhanced engagement included ongoing training, recognition and incentives linked to implementation outcomes (Blaine et al., 2017).

Within school settings, it is recognised that head teachers have significant control over how activities are delivered within individual settings (Clarke et al., 2017), highlighting their influence over whether interventions are implemented successfully. Previous studies have found that implementation fidelity was enhanced when those in senior roles within settings (e.g. head teachers) supported programme delivery, including allowing sufficient staffing and time for delivery, providing clear information on how interventions would be

operationalised within the settings and integrating interventions within school policies (Inchley et al., 2007, Beets et al., 2008, Pearson et al., 2015, Herlitz et al., 2020). Conversely, Day et al. (2019) found that a lack of leadership support led to delivery of a physical activity and healthy eating intervention in schools not being prioritised, as teachers were not encouraged to deliver it.

Aside from educational settings, Aunger et al. (2022) found that leaders involved in establishing integrated care systems in England played an important role in developing effective collaboration; visible leaders who demonstrated a consistent approach were more likely to foster trust between partners involved. Furthermore, it was reported that a trusted leader can be useful to draw out different perspectives and lead partners towards identifying shared goals (van Vooren et al., 2023).

In addition to the role of those in leadership roles contributing to inter-organisational collaboration, several studies have found that successful implementation was often associated with influential individuals identified among those involved in delivery, often referred to as ‘champions’, whose role included encouraging others’ participation and communicating shared visions among partners delivering health-related interventions in educational settings (Jago et al., 2015, Pearson et al., 2015, Blaine et al., 2017) and in wider examples of cross-sector collaborative programmes (Ling et al., 2012, Bryson et al., 2015, Aunger et al., 2022).

There were also examples of influential individuals working within organisations that hindered inter-organisational collaboration; in their study of a programme delivered by health and social care professionals in supported housing for older people in Canada, Sheppard et al. (2022) found that some housing staff were ‘gatekeepers’ within the supported housing settings, which hindered access to residents where those individuals did not participate fully in the programme.

6.4.1.3 Prioritisation of programme delivery

It is recognised that competing organisational norms and priorities impact on collaboration, which require focused efforts to address, to optimise delivery of collaborative interventions (Bryson et al., 2015, Alderwick et al., 2021).

In relation to the literature on implementing health-related interventions in school settings, it was commonly identified that time constraints resulted in less-than-optimal implementation, with 'core' activities often prioritised over intervention delivery, including ceasing delivery in some cases where staff perceived too many demands on their time (Jago et al., 2015, Griffin et al., 2015, Day et al., 2019, Bergström et al., 2020). A systematic review of public health interventions delivered in school settings found that educational outcomes took precedence over health promotion activities, which were considered 'dispensable' when school staff encountered time constraints (Herlitz et al., 2020).

Clarke et al. (2017)'s qualitative research investigating head teachers' perceptions of schools' roles in promoting health found that participation in delivering health-related interventions was curtailed by priorities such as a 'prescriptive' curriculum and government targets focused on academic attainment. Blaine et al. (2017) also found that shifting priorities in schools reduced staff commitment to delivering health promotion interventions over time. In another study, teachers questioned how to identify time within schedules to deliver an obesity prevention intervention without removing another activity considered 'priority' (Griffin et al., 2015).

However there were examples of individuals involved in delivering interventions finding solutions to address time constraints to delivery, such as integrating components of obesity prevention interventions (e.g. physical activity) into other classroom activities (Griffin et al., 2015, Blaine et al., 2017, Day et al., 2019).

Prioritisation of programme delivery was also influenced by the level of confidence among those involved in delivery (Herlitz et al., 2020); for example,

Jago et al. (2015) found that teachers gave lower priority to delivering components of an obesity prevention intervention they felt less confident or less interested in delivering (e.g. physical activities). Conversely, Bergström et al. (2020) found that implementation was successful where school staff felt supported to deliver interventions through guidance and training which set out clearly what was required of them and how delivery should happen.

6.5 Mandating organisations' participation in intervention delivery

This research found that programme delivery was influenced by the extent to which local authorities (e.g. managers within Education Departments) supported the programme, such as whether they intervened when nurseries did not participate in the programme as intended. This was related to the 'Networks and Communication' construct (Inner Setting domain) in the CFIR. Some Childsmile coordinators reported that local authority education departments communicated to nurseries that participation in the programme was an expected part of early learning and childcare delivery, while others reported difficulties in obtaining this type of support from local authority colleagues. During the pandemic it was challenging to obtain local authorities' support with remobilisation following establishment closures, which required time and effort on the part of Childsmile coordinators and staff. In several cases, pre-existing relationships between Childsmile staff and colleagues in local authorities helped them to secure support for remobilisation. This included examples of some local authority education departments proactively including the nursery supervised toothbrushing programme in wider plans for reopening educational establishments, which reflected strong pre-existing relationships. However, it was also reported by other Childsmile coordinators that local authorities' input did not translate to increased participation among nurseries.

There was also feedback on whether the Scottish Government could support the programme by providing firmer direction to educational establishments regarding their participation, as several respondents suggested that challenges

around obtaining nurseries' participation stemmed from the fact the programme was not mandatory.

Within the literature there were various examples of inter-organisational collaborations where organisations' delivery of interventions was mandated, by senior members within organisations or others in regulatory or other leadership roles. However, it was highlighted that mandating participation influenced the process of cross-sectoral collaboration (Aunger et al., 2022).

Reviews of inter-organisational collaborations have found that mandating organisations' participation in interventions facilitated collaborative working as this established accountability and increased the likelihood that partners would fulfil their roles (Bryson et al., 2015, Aunger et al., 2021, Sheppard et al., 2022). In some cases it was reported that top-down decisions to implement health-related programmes in organisations had a positive effect, as staff perceived this 'legitimised' using their time to deliver interventions, coordinated resources to support delivery and reduced the influence of individuals within organisations (e.g. head teachers) who may not support the intervention (Darlington et al., 2018, Bergström et al., 2020, Sheppard et al., 2022).

However, it was also found that mandating school staff to deliver health-related programmes led to less acceptance and lower engagement among staff, as they perceived it was being 'imposed' on them (Darlington et al., 2018, Bergström et al., 2020). Alderwick et al. (2021) cautioned that mandating partnerships' delivery of programmes may reflect an underlying lack of motivation for joint-working among the organisations involved. Where organisations mandated to participate in programmes, it is highlighted that efforts are needed to develop well-functioning interpersonal relationships between partners to optimise collaborative working (Aunger et al., 2022).

6.6 Study Strengths and Limitations

6.6.1 Strengths

This research was supported by the embedded nature of the overarching Childsmile evaluation, undertaken in partnership between University of Glasgow and NHS Scotland. Academic advice and support was provided by the steering group of the dedicated Childsmile Evaluation and Research Team (within University of Glasgow's Community Oral Health Section), which also facilitated links between this research and the overarching theory-based evaluation of Childsmile. Being an embedded researcher who is employed by and based within NHS Scotland has facilitated access to programme stakeholders, for example, through being included in programme meetings and working groups which are also attended by national programme managers and local Childsmile coordinators. This has enabled rapid knowledge exchange, both through collecting data about programme delivery from stakeholders but also providing regular opportunities to share observations and feedback from the research with those stakeholders. It has also allowed for positive relationships with a range of programme stakeholders to be developed. Within the literature it is recognised that embedded research models, such as within healthcare organisations, allows researchers to access 'insider' knowledge and contextual information that would be less available to outsiders (Coates and Mickan, 2020), as the researcher's proximity to research participants allows strong relationships to be developed (Rowley, 2014). Within this research, for example, observing programme meetings (conducted online) during the pandemic provided rich data on developments and stakeholders' perspectives as the programme navigated through the disruption caused by the pandemic.

The findings of this research are directly relevant to the ongoing development of the Childsmile programme and it is intended they will be used to address the determinants identified, to improve programme implementation (and thus its effectiveness). The research provided insight into the factors affecting implementation, in the periods before, during and after the Covid-19 pandemic,

which can support programme improvements in relation to its post-pandemic remobilisation.

One of the research outputs was a logic model depicting the programme's Theory of Change as understood by programme stakeholders, which provides a useful basis to explore and understand programme delivery and assess progress towards its outcomes. It is recognised that logic models are useful tools for communicating a programme's aims and how it intends to achieve them, promoting a shared understanding among stakeholders. Logic models also support ongoing programme improvement, by helping programme managers and staff to identify appropriate performance measures to track delivery over time as well as allowing periodic review and reflection on whether the approaches used within a programme continue to be appropriate and effective (McLaughlin and Jordan, 2015).

Data collected for this research came from key respondents involved in Childsmile delivery from every health board in Scotland, at various time points, which provides excellent coverage of a range of views and changing contexts. The research also included data gathered from nursery staff, via surveys undertaken in 2019 and 2022. The response rate for the survey undertaken in 2019 was very high, with data received from 96.1% of all nurseries operating in Scotland at that time, indicating a high level of representativeness and lower likelihood of response bias (Glaser, 2008). Furthermore, gathering feedback from nursery staff at different time points allowed for more thorough assessment of the impact of changing contexts of delivery.

Another advantage of this research was using a mixed methods approach, as the triangulation of data obtained through quantitative and qualitative methods allowed for a more complete picture when assessing the fidelity of programme implementation. The quantitative data found that 100% of children did not participate in toothbrushing every day they attended nursery and that having 100% of children brushing was more likely in nurseries with fewer children attending, only one age group attending, and situated in some geographical health boards and not others. Qualitative data expanded these findings, through exploring the reasons why participation might not take place as intended,

providing a rich description of programme delivery across different areas. The qualitative data also identified inconsistencies between nurseries' reported participation (via the survey) and stakeholders' perceptions about whether nurseries delivered toothbrushing every day as intended.

Reporting the qualitative strands of this research was guided by the Consolidated Criteria for Reporting Qualitative Research (COREQ) which aims to enhance the quality and transparency of reporting qualitative research (Tong et al., 2007, de Yong et al, 2021). This has clarified the characteristics of the principal researcher who conducted the interviews and explained the researcher's prior role and exisiting relationships with participants. The participants' characteristics were described and it was noted that they were selected purposively for their roles within the programme and their specific, local, contextual knowledge of programme delivery. Data collection and analysis was guided by the concept of theoretical sufficiency, to ensure that sufficient data were gathered to answer the study's research questions. The COREQ guidelines also supported description of the coding and analysis process undertaken by the principal researcher in discussion with the supervisory team.

Using a recognised and well-regarded theoretical framework to explore the programme implementation was another strength of this research, as it is recognised that this contributes to understanding how and why implementation efforts succeed or fail (Nilsen, 2015). Damschroder et al. (2009)'s Consolidated Framework for Implementation Research provided a structured framework to investigating implementation, with shared terminology and definitions of the range of factors affecting implementation, which has been used to investigate implementation in a wide range of settings (Kirk et al., 2016, Damschroder et al., 2022b). As highlighted in the literature by others using the CFIR (e.g. Birken et al., 2017a, Smith, 2017) it was beneficial to have the Outer Setting domain, to capture the influence of the wider environmental and organisational factors affecting implementation of the nursery supervised toothbrushing programme, alongside the Inner Setting and other domains, to acknowledge that there were multiple partners working at different organisational levels; and the interaction between the various constructs that influenced the extent to which the programme was prioritised in nurseries.

Mapping the constructs identified to potential implementation strategies that would address the barriers and enhance the facilitators, using the CFIR-ERIC Implementation Strategy Matching Tool, provided a range of potential future actions that can be taken to optimise programme delivery. (These are discussed further in section 6.7.)

6.6.2 Limitations

The process for developing the Theory of Change only involved stakeholders directly involved in strategic decision making within the Childsmile programme and not a wider range of stakeholders, representing partner organisations and parents/carers, on whom programme delivery depends. The Theory of Change may therefore not represent the full range of needs and priorities of stakeholders based outside of the Childsmile programme. However, the decision to include this group of strategic stakeholders in developing the Theory of Change for the purposes of this research was to capture their expertise and detailed knowledge about the Childsmile programme and represent their vision for the nursery supervised toothbrushing programme.

Another limitation was that there was no direct observation of programme delivery in nursery settings. The survey of nurseries carried out in 2019 aimed to quantify numbers of children participating in toothbrushing; while observation would have provided a more objective measure of participation, time constraints and the number of nurseries involved meant this was not feasible, although it should be acknowledged that the presence of an observer may have prompted nursery staff to carry out toothbrushing where they would not have done so otherwise (i.e. introducing demand characteristics) (Burr, 2002). Data on whether nurseries provided toothbrushing every day, and barriers and facilitators to delivery, were self-reported by nursery staff to Childsmile staff, which raises the potential for response bias as nursery staff may have been compelled to provide ‘socially desirable’ responses (that toothbrushing took place as intended) as they were not able to respond anonymously (Podsakoff et al., 2003). To mitigate potential response bias, information about the purpose of the survey (i.e. to support programme improvements) was communicated to nursery staff, who were encouraged to provide accurate, candid information

about their experiences of delivering the programme. The data also showed that nurseries were willing to provide responses that were not 'socially desirable', as it was reported that almost 8% of eligible children did not brush their teeth on the day of the survey, and 12-20% of nurseries (depending on age group) reported less than 100% of children brushing.

It should be acknowledged that this study was undertaken by an embedded researcher within the Childsmile programme. It is recognised that a challenge for embedded researchers relates to maintaining objectivity, impartiality and independence when conducting research that has implications for the organisation they are based in (Hudson, 2021, Reen et al., 2022). There may be a risk that the embedded researcher's proximity to programme stakeholders results in the research being skewed towards the views and priorities of those stakeholders. It may be argued that this was the case within this research, in relation to developing the programme's Theory of Change, which did not go beyond consulting with stakeholders within the Childsmile programme to ensure that it reflected the needs of a wider group of partner organisations. However there were efforts to represent views of staff in nurseries within this research, including the surveys of nurseries undertaken in 2019 and 2022.

As highlighted in the COREQ guidelines (Tong et al, 2007) it was important to approach all stages of this research reflexively, acknowledging that my previous experience within the Childsmile programme and existing relationships with participants would affect my approach to undertaking fieldwork and analysing and interpreting data. Throughout the research I made conscious efforts to reflect on how my assumptions affecting how I was approaching the various tasks involved, with ongoing discussions with my supervisory team focused on checking and questioning my assumptions and interpretations of the data.

As noted, this research was disrupted by the Covid-19 pandemic as planned fieldwork in nurseries to assess programme delivery in reality, including interviews and focus groups with nursery staff and parents/carers of children attending, could not take place due to educational establishment closures across Scotland between March 2020 and February 2021. Fieldwork with Childsmile staff was also limited due to their redeployment to other roles within health

boards to support the NHS pandemic response. However, the pandemic provided the opportunity to study how a national public health programme was impacted by a major disruption and how it remobilised subsequently.

6.7 Conclusions and Recommendations

This research investigated the implementation of the nursery supervised toothbrushing programme, one of the components of Childsmile, Scotland's national oral health improvement programme for children. Previous research has demonstrated strong evidence that the nursery supervised toothbrushing programme prevents dental decay in children and saves money in prevented dental treatments (Macpherson et al., 2013, Anopa et al., 2015, Kidd et al., 2020). The purpose of this research was to assess the implementation of the programme, to identify barriers and facilitators to its delivery in order that these can be addressed in future, to optimise delivery and further enhance its effectiveness.

The first stage of the research entailed developing the Theory of Change for the nursery supervised toothbrushing programme with programme stakeholders. This identified stakeholders' perceptions of the programme's outcomes and the activities that were thought would achieve those outcomes. The Theory of Change was refined and discussed with programme stakeholders to reach consensus on its content, which was depicted in a logic model. However, a limitation of the approach used was that it did not include stakeholders outside of the Childsmile programme, which may explain why some activities delivered by individuals based in other, non-health organisations (i.e. nursery staff) were not fully delivered as intended, as the envisaged activities included in the logic model did not reflect the needs or priorities of those individuals.

The logic model was used as a basis to assess fidelity of programme delivery in reality, compared to the 'ideal' version of delivery shown in the logic model. This included quantifying percentages of children participating in brushing in nurseries. This phase of the research found that, while various aspects of the programme were being delivered with fidelity, most of the activities included in the logic model had components that were not being fully delivered as intended.

This included the finding that toothbrushing was not taking place with all children, in 100% of nurseries.

Factors influencing whether implementation was taking place as intended or not were investigated using the CFIR (Damschroder et al., 2009), with a view to explaining the less-than-optimal implementation fidelity uncovered. It became apparent that the nursery context into which the nursery supervised toothbrushing programme was implemented was complex and changing, with many competing demands on nursery staff's time and attention. Programme delivery depended on nursery staff, who are employed in organisations in a separate sector from that where the Childsmile programme is situated, which highlighted that factors associated with inter-organisational collaboration were influential. There is a need to recognise and accept that there are competing demands in nurseries, which the nursery supervised toothbrushing programme needs to accommodate. For example, the 'free play' approach is part of nursery provision in Scotland, therefore Childsmile programme stakeholders need to accept that the previous, structured routine in nurseries no longer exists and move forward with identifying ways to fit the programme in to this approach.

While a range of CFIR constructs were found to be relevant within analyses undertaken for this research, one of the main themes linking these was that individual nursery staff's perceptions influenced the extent to which they prioritised delivering the toothbrushing programme in their setting. Factors such as time constraints, (in)compatibility of toothbrushing with nursery routines, or children's needs and preferences to participate in other activities were identified as barriers to delivery. However, it is likely that these challenges affected the majority of nurseries, but some nursery staff were well-engaged with the programme and were willing to accommodate it, while others were not. Unfortunately these factors were not explored with nursery staff directly within this research, as planned fieldwork to do this could not go ahead due to Covid-19 pandemic restrictions.

Following on from these findings, a number of recommendations for programme improvements (directed to the Childsmile programme), and recommendations for further research, are provided below.

6.7.1 Recommendations for the Childsmile programme

1. The research has identified the need to develop and strengthen the shared vision and commitment to the nursery supervised toothbrushing programme among stakeholders involved in delivering the programme in partner organisations (i.e. local authority education departments, head teachers and nursery managers, and individual nursery staff). Several implementation strategies were identified that would support the Childsmile programme to achieve this, including 'build a coalition', 'promote network weaving' and 'conduct educational meetings'. In addition to ongoing work taking place via the programme's Childsmile Executive committee and individual Childsmile teams in health boards to develop relationships with partners, there should be a focused campaign of communications targeted at those stakeholders which focuses on how the programme fits within the wider nursery curriculum and its contribution to children's health and wellbeing, to encourage partners to incorporate programme delivery within their roles. Drawing on the implementation strategy 'conduct educational meetings' communication should be targeted at specific groups of stakeholders (e.g. local authority education department colleagues; head teachers and nursery managers; nursery staff) to provide information tailored to their role which clarifies what is involved in programme delivery.

2. This work would be supported by developing a formal implementation blueprint, which specifies the aims of the nursery supervised toothbrushing programme, who is involved and what is required of them in its delivery; this may help to address perceptions about the programme's complexity, in terms of delivering it alongside other demands within nurseries. This research has provided the basis for such an implementation blueprint, by setting out the toothbrushing programme's Theory of Change within the logic model and assessed delivery-in-reality against this.

3. To increase participation and buy-in among nursery staff, the Childsmile programme should establish a knowledge exchange and support network among nurseries. This would involve 'identifying and preparing champions' to support and mentor peers to overcome challenges to delivering the

toothbrushing programme, by sharing their own experiences and learning, and addressing others' resistance or indifference to the programme. Nursery staff with an interest in oral health, in nurseries where the supervised toothbrushing programme appears to be working well (e.g. from the results of the national survey of nurseries or via local knowledge among Childsmile teams) should be invited to undertake the role of champions for the toothbrushing programme. Champions will require support from the programme, such as additional training, to carry out this role effectively.

4. The programme should also consider identifying 'champions' among stakeholders at other organisational levels (such as head teachers/nursery managers and local authority education department colleagues) to advocate for the toothbrushing programme with their peers.

5. The programme should consider enhancing the training provided to nursery staff, using learning from assessing individual nurseries' needs, challenges and experiences, to address specific challenges within individual nurseries (such as identifying practical solutions to overcome time constraints and other barriers to fitting toothbrushing into nursery routines). Training should include opportunities for 'champions' to meet with staff in nurseries requiring further support to deliver the programme as intended, to describe their own experiences in delivering the programme and overcoming challenges.

6. As part of any formal implementation blueprint developed, it is recommended that these include appropriate progress measures, to track changes over time and monitor implementation fidelity. The programme should consider developing and incorporating appropriate progress measures and mechanisms to monitor fidelity of programme delivery going forward; however, any methods introduced should not place additional, unmanageable burdens on nursery staff, given the findings that time constraints and competing demands on their time impact negatively on toothbrushing delivery.

7. To address the finding that there were variable levels of buy-in and support from local authorities' education departments and individual establishments'

head teachers and managers for the nursery supervised toothbrushing programme, the Childsmile programme (via its Childsmile Executive committee) should advocate for further dialogue between the Scottish Government and local authority education departments to encourage their participation in the programme. This fits within the group of implementation strategies related to increasing buy-in and engagement among stakeholders, specifically 'involving executive boards' (or existing governing structures), 'obtaining formal commitments'(from partners involved in programme delivery), and 'mandate change'. Mandates are intended to secure and demonstrate decision-makers' commitment to implementing an intervention; in relation to the toothbrushing programme, this could follow the example of existing mandates in Scottish schools related to health and wellbeing, such as delivering two hours of physical education per week in primary schools (Scottish Government, 2023). Dialogue between the Childsmile programme, the Scottish Government and partners in local authorities should be supportive, to encourage participation in the programme, and combined with the preceding recommendations to enhance nursery staff's engagement with the programme, to mitigate against potential perceptions about the programme being 'imposed' on nurseries.

6.7.2 Recommendations for further research

1. As the programme's Theory of Change developed for this research involved stakeholders from within the Childsmile programme only, there should be further research undertaken with a wider group of stakeholders, including representatives of local authority education departments, individual nursery staff, parents/carers and children, to further review and refine the Theory of Change. This should identify changes required to enhance its fit with their needs and priorities and consider whether any changes to the Theory of Change are required to reflect the impact of the Covid-19 pandemic on programme delivery.

2. The implementation strategy 'promote adaptability' was identified as appropriate to address barriers related to the construct of 'complexity', in relation to fitting the toothbrushing programme into existing nursery

routines. However, to achieve this, there needs to be agreement on which elements of programme delivery can be altered to suit local contexts and which must be retained unchanged. This will require further investigation with Childsmile programme stakeholders, to specify the programme's 'core' components and 'adaptable periphery', with a view to agreeing what is acceptable in terms of 'good enough' delivery in circumstances where nurseries truly cannot accommodate toothbrushing every day or with all children, that will still allow progress towards achieving outcomes.

3. Further research should be undertaken with a sample of nursery staff, with different levels of engagement with the programme, to explore in detail factors affecting their perception of the programme. This should aim to identify strategies to address those factors and enhance nursery staff's engagement with the programme. Indeed, Damschroder et al. (2022b)'s updated version of the CFIR may be an asset for this proposed research, as the modified Individual Characteristics sub-domain utilises Michie et al.(2011)'s COM-B model, which is recognised as a robust framework for investigating individual-level determinants of implementation and has an associated guide to developing behaviour change interventions based on COM-B assessment (Michie et al., 2014).

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Appendices

Appendix 1A: Supervised toothbrushing interventions: literature search strategy

All databases searched

1.	Embase
2.	Ovid MEDLINE
3.	CINAHL
4.	Psychology and Behavioral Sciences Collection
5.	PsycINFO
6.	Health Source (Nursing/Academic Edition)
7.	PsycARTICLES
8.	Applied Social Sciences Index & Abstracts
9.	Public Health Database
10.	Sociological Abstracts

Searches

A. Databases

1.	Embase
2.	Ovid MEDLINE

Search terms used

Population	
1.	child*.mp
2.	student*.mp
3.	two year* old.mp
4.	(age* adj5 two).mp
5.	three year* old.mp
6.	(age* adj5 three).mp
7.	four year* old.mp
8.	(age* adj5 four).mp

9.	five year* old.mp
10.	(age* adj5 five).mp
11.	six year* old.mp
12.	(age* adj5 six).mp
13.	seven year* old.mp
14.	(age* adj5 seven).mp
15.	eight year* old.mp
16.	(age* adj5 eight).mp
17.	nine year* old.mp
18.	(age* adj5 nine).mp
19.	ten year* old.mp
20.	(age* adj5 ten).mp
21.	eleven year* old.mp
22.	(age* adj5 eleven).mp
23.	twelve year* old.mp
24.	(age* adj5 twelve).mp
Intervention	
25.	(supervis* adj8 toothbrush*).mp
26.	(assist* adj8 toothbrush*).mp
27.	(support* adj8 toothbrush*).mp
28.	(tooth adj3 brush* adj8 supervis*).mp
29.	(tooth adj3 brush* adj8 assist*).mp
30.	(tooth adj3 brush* adj8 support*).mp
31.	(teeth adj3 brush* adj8 supervis*).mp
32.	(teeth adj3 brush* adj8 assist*).mp
33.	(teeth adj3 brush* adj8 support*).mp
34.	(clean* adj3 teeth adj8 supervis*).mp
35.	(clean* adj3 teeth adj8 assist*).mp
36.	(clean* adj3 teeth adj8 support*).mp
37.	(clean* adj3 tooth adj8 supervis*).mp
38.	(clean* adj3 tooth adj8 assist*).mp
39.	(clean* adj3 tooth adj8 support*).mp
Outcome	
40.	(reduc* adj5 decay).mp
41.	(reduc* adj5 plaque).mp
42.	(reduc* adj5 caries).mp

43.	(reduc* adj5 extract*).mp
44.	(decreas* adj5 decay).mp
45.	(decreas* adj5 plaque).mp
46.	(decreas* adj5 caries).mp
47.	(decreas* adj5 extract*).mp
48.	(lower* adj5 decay).mp
49.	(lower* adj5 plaque).mp
50.	(lower* adj5 caries).mp
51.	(lower* adj5 decay).mp
52.	(lower* adj5 extract*).mp
53.	(stabili#* adj5 decay).mp
54.	(stabili#* adj5 plaque).mp
55.	(stabili#* adj5 caries).mp
56.	(stabili#* adj5 extract*).mp
57.	(DMF# adj5 lower*).mp
58.	(DMF# adj5 reduc*).mp
59.	(DMF# adj5 decreas*).mp
60.	(DMF# adj5 stabili#*).mp
61.	(better adj3 technique).mp
62.	(better adj3 method).mp
63.	(better adj3 delivery).mp
64.	(better adj3 execution).mp
65.	(improv* adj3 technique).mp
66.	(improv* adj3 method).mp
67.	(improv* adj3 delivery).mp
68.	(improv* adj3 execution).mp
69.	(improv* adj3 toothbrushing).mp
70.	(better adj3 toothbrushing).mp
71.	(increas* adj5 fluoride).mp
72.	(more adj5 fluoride).mp
73.	(higher adj5 fluoride).mp
74.	(increas* adj5 frequency).mp
75.	(increas* adj5 time*).mp
76.	(increas* adj5 duration).mp
77.	(improv* adj5 duration).mp

78.	(improv* adj5 time*).mp
79.	(improv* adj5 frequency).mp
80.	(improv* adj5 oral health).mp
81.	(improv* adj5 dental health).mp
82.	(improv* adj5 mouth health).mp
Setting	
83.	nurser*.mp
84.	preschool*.mp
85.	pre-school*.mp
86.	(primary adj1 school*).mp
87.	(elementary adj1 school*).mp
88.	kindergarten*.mp
89.	(education* adj3 setting).mp
90.	(education* adj3 establishment*).mp
91.	(education* adj3 institution*).mp
92.	(childcare adj3 setting).mp
93.	(child care adj3 setting).mp
94.	(childcare adj3 centre).mp
95.	(child care adj3 center).mp
96.	(daycare adj3 setting).mp
97.	(daycare adj3 centre).mp
98.	(daycare adj3 center).mp
99.	(day care adj3 setting).mp
100.	(day care adj3 center).mp
101.	(day care adj3 centre).mp
102.	83 or 84 or 85 or 86 or 87 or 88 or 89 or 90 or 91 or 92 or 93 or 94 or 95 or 96 or 97 or 98 or 99 or 100 or 101
103.	40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or 80 or 81 or 82
104.	25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39
105.	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24
106.	102 and 103 and 104 and 105
107.	remove duplicates from 106

B. Databases

3.	CINAHL
4.	Psychology and Behavioral Sciences Collection
5.	PsycINFO
6.	Health Source (Nursing/Academic Edition)
7.	PsycARTICLES

Search terms used

1.	S107 AND S108 AND S109 AND S110
2.	S87 OR S88 OR S89 OR S90 OR S91 OR S92 OR S93 OR S94 OR S95 OR S96 OR S97 OR S98 OR S99 OR S100 OR S101 OR S102 OR S103 OR S104 OR S105 OR S106
3.	S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51 OR S52 OR S53 OR S54 OR S55 OR S56 OR S57 OR S58 OR S59 OR S60 OR S61 OR S62 OR S63 OR S64 OR S65 OR S66 OR S67 OR S68 OR S69 OR S70 OR S71 OR S72 OR S73 OR S74 OR S75 OR S76 OR S77 OR S78 OR S79 OR S80 OR S81 OR S82 OR S83 OR S84 OR S85 OR S86
4.	S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 OR S39
5.	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24
Setting	
6.	day W1 care N3 centre
7.	day W1 care N3 center
8.	day W1 care N3 setting
9.	daycare N3 center
10.	daycare N3 centre
11.	daycare N3 setting
12.	child W1 care N3 center

13.	childcare N3 centre
14.	child W1 care N3 setting
15.	childcare N3 setting
16.	education* N3 institution*
17.	education* N3 establishment*
18.	education* N3 setting
19.	kindergarten*
20.	elementary N1 school*
21.	primary N1 school*
22.	pre school
23.	pre-school*
24.	preschool*
25.	nurser*
Outcome	
26.	improv* N5 mouth health
27.	improv* N5 dental health
28.	improv* N5 oral health
29.	improv* N5 frequency
30.	improv* N5 time*
31.	improv* N5 duration
32.	increas* N5 duration
33.	increas* N5 time*
34.	increas* N5 frequency
35.	higher N5 fluoride

36.	more N5 fluoride
37.	increas* N5 fluoride
38.	better N3 toothbrushing
39.	improv* N3 toothbrushing
40.	improv* N3 execution
41.	improv* N3 delivery
42.	improv* N3 method
43.	improv* N3 technique
44.	better N3 execution
45.	better N3 delivery
46.	better N3 method
47.	better N3 technique
48.	DMF? N5 stabili?*
49.	DMF? N5 decreas*
50.	DMF? N5 reduc*
51.	DMF? N5 lower*
52.	stabili?* N5 extract*
53.	stabili?* N5 caries
54.	stabili?* N5 biofilm
55.	stabili?* N5 plaque
56.	stabili?* N5 decay
57.	lower* N5 extract*
58.	lower* N5 decay
59.	lower* N5 caries

60.	lower* N5 biofilm
61.	lower* N5 plaque
62.	lower* N5 decay
63.	decreas* N5 extract*
64.	decreas* N5 caries
65.	decreas* N5 biofilm
66.	decreas* N5 plaque
67.	decreas* N5 decay
68.	reduc* N5 extract*
69.	reduc* N5 caries
70.	reduc* N5 biofilm
71.	reduc* N5 plaque
72.	reduc* N5 decay
Intervention	
73.	clean* N3 tooth N8 support*
74.	clean* N3 tooth N8 assist*
75.	clean* N3 tooth N8 supervis*
76.	clean* N3 teeth N8 support*
77.	clean* N3 teeth N8 assist*
78.	clean* N3 teeth N8 supervis*
79.	teeth N3 brush* N8 support*
80.	teeth N3 brush* N8 assist*
81.	teeth N3 brush* N8 supervis*
82.	tooth N3 brush* N8 support*

83.	tooth N3 brush* N8 assist*
84.	tooth N3 brush* N8 supervis*
85.	support* N8 toothbrush*
86.	assist* N8 toothbrush*
87.	supervis* N8 toothbrush*
Population	
88.	age* N5 twelve
89.	twelve year* old
90.	age* N5 eleven
91.	eleven year* old
92.	age* N5 ten
93.	ten year* old
94.	age* N5 nine
95.	nine year* old
96.	age* N5 eight
97.	eight year* old
98.	age* N5 seven
99.	seven year* old
100.	age* N5 six
101.	six year* old
102.	age* N5 five
103.	five year* old
104.	age* N5 four
105.	four year* old

106.	age* N5 three
107.	three year* old
108.	age* N5 two
109.	two year* old
110.	student*
111.	child*

C. Databases

8.	Applied Social Sciences Index & Abstracts
9.	Public Health Database
10.	Sociological Abstracts

Search terms used

S111	S107 AND S108 AND S109 AND S110
S110	S87 OR S88 OR S89 OR S90 OR S91 OR S92 OR S93 OR S94 OR S95 OR S96 OR S97 OR S98 OR S99 OR S100 OR S101 OR S102 OR S103 OR S104 OR S105 OR S106
S109	S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51 OR S52 OR S53 OR S54 OR S55 OR S56 OR S57 OR S58 OR S59 OR S60 OR S61 OR S62 OR S63 OR S64 OR S65 OR S66 OR S67 OR S68 OR S69 OR S70 OR S71 OR S72 OR S73 OR S74 OR S75 OR S76 OR S77 OR S78 OR S79 OR S80 OR S81 OR S82 OR S83 OR S84 OR S85 OR S86
S108	S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 OR S39
S107	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24
Setting	
S106	day NEAR/2 W1 care NEAR/3 centre
S105	day NEAR/2 W1 care NEAR/3 center

S104	day NEAR/2 W1 care NEAR/3 setting
S103	daycare NEAR/3 center
S102	daycare NEAR/3 centre
S101	daycare NEAR/3 setting
S100	child W1 NEAR/2 care NEAR/3 center
S99	childcare NEAR/3 centre
S98	child W1 NEAR/2 care NEAR/3 setting
S97	childcare NEAR/3 setting
S96	education* NEAR/3 institution*
S95	education* NEAR/3 establishment*
S94	education* NEAR/3 setting
S93	kindergarten*
S92	elementary NEAR/1 school*
S91	primary NEAR/1 school*
S90	Pre NEAR/1 school
S89	pre-school*
S88	preschool*
S87	nurser*
Outcome	
S86	improv* NEAR/5 mouth health
S85	improv* NEAR/5 dental health
S84	improv* NEAR/5 oral health
S83	improv* NEAR/5 frequency
S82	improv* NEAR/5 time*

S81	improv* NEAR/5 duration
S80	increas* NEAR/5 duration
S79	increas* NEAR/5 time*
S78	increas* NEAR/5 frequency
S77	higher NEAR/5 fluoride
S76	more NEAR/5 fluoride
S75	increas* NEAR/5 fluoride
S74	better NEAR/3 toothbrushing
S73	improv* NEAR/3 toothbrushing
S72	improv* NEAR/3 execution
S71	improv* NEAR/3 delivery
S70	improv* NEAR/3 method
S69	improv* NEAR/3 technique
S68	better NEAR/3 execution
S67	better NEAR/3 delivery
S66	better NEAR/3 method
S65	better NEAR/3 technique
S64	DMF? NEAR/5 stabili?*
S63	DMF? NEAR/5 decreas*
S62	DMF? NEAR/5 reduc*
S61	DMF? NEAR/5 lower*
S60	stabili?* NEAR/5 extract*
S59	stabili?* NEAR/5 caries
S58	stabili?* NEAR/5 biofilm

S57	stabili?* NEAR/5 plaque
S56	stabili?* NEAR/5 decay
S55	lower* NEAR/5 extract*
S54	lower* NEAR/5 decay
S53	lower* NEAR/5 caries
S52	lower* NEAR/5 biofilm
S51	lower* NEAR/5 plaque
S50	lower* NEAR/5 decay
S49	decreas* NEAR/5 extract*
S48	decreas* NEAR/5 caries
S47	decreas* NEAR/5 biofilm
S46	decreas* NEAR/5 plaque
S45	decreas* NEAR/5 decay
S44	reduc* NEAR/5 extract*
S43	reduc* NEAR/5 caries
S42	reduc* NEAR/5 biofilm
S41	reduc* NEAR/5 plaque
S40	reduc* NEAR/5 decay
Intervention	
S39	clean* NEAR/3 tooth NEAR/8 support*
S38	clean* NEAR/3 tooth NEAR/8 assist*
S37	clean* NEAR/3 tooth NEAR/8 supervis*
S36	clean* NEAR/3 teeth NEAR/8 support*
S35	clean* NEAR/3 teeth NEAR/8 assist*

S34	clean* NEAR/3 teeth NEAR/8 supervis*
S33	teeth NEAR/3 brush* NEAR/8 support*
S32	teeth NEAR/3 brush* NEAR/8 assist*
S31	teeth NEAR/3 brush* NEAR/8 supervis*
S30	tooth NEAR/3 brush* NEAR/8 support*
S29	tooth NEAR/3 brush* NEAR/8 assist*
S28	tooth NEAR/3 brush* NEAR/8 supervis*
S27	support* NEAR/8 toothbrush*
S26	assist* NEAR/8 toothbrush*
S25	supervis* NEAR/8 toothbrush*

Appendix 1B: Additional supervised toothbrushing interventions literature search terms

1. Databases: Embase; Ovid MEDLINE

Outcome	
1.	complex*.mp
2.	(mixed adj2 method*).mp
3.	(program* adj2 theory).mp
4.	(Theory adj2 Change).mp
5.	(Logic adj2 Model).mp

2. Databases: CINAHL; Psychology and Behavioral Sciences Collection; PsycINFO; Health Source (Nursing/Academic Edition); PsycARTICLES

Outcome	
1.	complex*
2.	mixed N2 method*
3.	program* N2 theory
4.	Theory N2 Change
5.	Logic N2 Model

Appendix 2: Nursery- and school-based supervised toothbrushing interventions

Table 24 Summary of standalone studies involving supervised toothbrushing interventions in nurseries and schools

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Pakhomov et al. (1997); Bulgaria *(Pazardjik)*	1989-1992	Nursery; Primary school. 3-12 years	Teachers	Once per day; 2 minutes	*not provided*	Cohort study which assessed effect of participating in daily, supervised toothbrushing with fluoride toothpaste in school settings on participants' caries experience (dmft; DMFT). Participants were examined after 3 years participation in the intervention; statistically significant difference in dmft between intervention and control groups was found, although no difference in DMFT between groups was found. Study procedure was not described e.g. toothpaste fluoride content, how intervention was carried out. Analysis undertaken is unclear (not clear if within-group 'repeated measures' design used or if different cohorts were compared). 386 fewer children included in post-intervention experimental group (26% loss of sample) which is not discussed within the paper.
Lo et al. (1998), Schwarz et al. (1998) China *(Conghua, Guangdong province)*	1992-1995	Nursery. Mean age: 3 years	Teachers	Once per day; 2 minutes	1000 ppmF	Quasi-experimental trial which assessed effect of participating in daily, supervised toothbrushing using 1000 ppmF toothpaste in nurseries on participants' caries experience (dmfs). Participants were examined after 3 years participation in the intervention; statistically significant difference in dmfs between intervention and control groups was found.Risk of selection bias is inherent within this study, as the participating nurseries were selected on the basis of being the largest in the area.

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
You et al. (2002) China *(Huariou and Miyun counties)*	*not provided*	Nursery. 3 years	*not provided*	Twice per day; 60 seconds	1100 ppmF	Cluster randomised controlled trial which assessed effect of participating in daily, supervised toothbrushing using 1100 ppmF toothpaste in nurseries on participants' caries experience (dmfs). Participants were examined after 2 years participation in the intervention; statistically significant difference in dmfs between intervention and control groups was found. However, large regional differences in caries experience in the intervention group were observed: 40% versus 7% reduction in caries increment compared to controls, with the latter not a statistically significant difference to controls. 31% loss to follow up after two years; total of 38% of original sample was excluded from final analysis due to subset of participants not adhering to 'study protocol continuance criteria', although these criteria were not further explained.
Curnow et al. (2002), Pine et al. (2007) Scotland *(Dundee)*	*not provided*	Primary school. Age at outset: 5 years	Parent volunteers	Once per day; *Duration not provided*	1000 ppmF	Cluster randomised controlled trial which assessed effect of participating in daily, supervised toothbrushing in primary schools, using 1000 ppmF toothpaste, on participants' caries experience (dmfs; DMFS). Participants were examined after 2 years participation in the intervention; statistically significant difference in DMFS between intervention and control groups was found, although no difference in dmfs between groups was found.While the authors claimed that children attending large primary schools in Scotland, with more than one class per year group, had an equal chance of being assigned to any available class, this may not be accurate as some Scottish primary schools assigned children to classes based on date of birth (e.g. older children in one Primary 1 class and younger children in another Primary 1 class). If this was the case for schools in this study, it

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
						would introduce a potential source of bias, as children's toothbrushing ability may have differed by age therefore the groups are not directly comparable.Given that experimental and control groups were based alongside each other in schools, control group participants would not be blinded to their group allocation.
Rong et al. (2003) China *(Miyun county)*	started 1998	Nursery. Mean age: 3 years	Teachers	Twice per day; 60 seconds	*not provided*	Cluster randomised controlled trial which assessed effect of participating in twice-daily, supervised toothbrushing with fluoride toothpaste in nurseries on participants' caries experience (dmfs). Participants were examined after 2 years participation in the intervention; statistically significant difference in dmfs between intervention and control groups was found, although caries experience increased in intervention group.Risk of selection bias is present as participating nurseries were selected based on being largest in the area, although nurseries were assigned to experimental or control groups randomly.30% loss to follow-up after two years with no information provided on these participants' caries experience at baseline compared with those who remained in the study.
Jackson et al. (2005) England *(London)*	2000-2002	Primary school. 5-6 years	Teachers	Once per day; *Duration not provided*	1450 ppmF	Cluster randomised controlled trial which assessed effect of participating in daily, supervised toothbrushing with 1450 ppmF toothpaste in primary schools, on participants' caries experience (dmfs; DMFS). Participants were examined after 2 years participation in the intervention; statistically significant difference in dmfs between intervention and control groups was found, although no difference in DMFS between groups was found. 28% loss to follow-up; reasons given for this were children absent or had left the school but no information given about whether

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
						these children had significantly different caries experience compared with those who remained in the study. Analyses were carried out on a subset of participants (113 experimental group, 96 control group) as participants who remained caries-free at final examination (68 experimental group, 93 control group) were excluded from analyses. While the authors claimed this was to evaluate the intervention's effectiveness on a "less caries-resistant group", cherry-picking data erodes the validity of the analyses.
Al-Jundi et al. (2006) Jordan *(Irbid City)*	*not provided*	Primary school. Ages at outset: 6 & 11 years	Research assistants	Once per day; *Duration not provided*	500 ppmF (6 year olds); 1000 ppmF (11 year olds)	Cohort study which assessed effect of participating in daily, supervised toothbrushing using 500-1000 ppmF toothpaste, in schools, on participants' caries experience (dmft; DMFT). Participants were examined after 4 years participation in the intervention; statistically significant difference in dmft & DMFT between intervention and control groups was found. No indication whether adherence to the study protocol was assessed. dos Santos et al. (2018) identified selective reporting in this study, noting it was unclear how statistical analyses were carried out.
Andruskeviciene et al. (2008) Lithuania *(Kaunas City)*	2002-2005	Nursery. 3-5 years	*not provided*	Once per day; *Duration not provided*	500 ppmF	Quasi-experimental trial which assessed effect of participating in daily, supervised toothbrushing using 500 ppmF toothpaste (in addition to fluoride gel applications three times per year) in school settings, on participant's caries experience (dmft). Participants were examined after 3 years participation in the intervention. Statistically significant difference in dmft between intervention and control groups was found; however, caries experience increased in intervention group.Participants' allocation

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
						to experimental or control groups was not described; and the interventions are not well described e.g. who supervised toothbrushing, how this was carried out, whether it was delivered as intended.
Fit for School Health Outcomes Study Monse et al. (2013) Philippines *(Camiguin and Gingoog, Mindanao)*	started 2009	Primary school. 6-7 years	Teachers	Once per day; 2 minutes	1450 ppmF	Cohort study which assessed effect of participating in daily, supervised toothbrushing with 1450ppmF toothpaste, in schools on participants' caries experience (dmfs; DMFS). Participants were examined after 1 year participation in the intervention; no significant difference in dmfs or DMFS was found between intervention and control groups. Three schools were selected as controls by a government department, not at random, although the authors acknowledged this as a potential source of bias.
Petersen et al. (2015) Thailand *(Songkhla province)*	*not provided*	Nursery. 3-5 years	Teachers	Once per day; 2 minutes	1450 ppmF	Cluster randomised controlled trial which assessed effect of participating in daily, supervised toothbrushing using 1450ppmF toothpaste in nurseries on participants' caries experience (DMFT) and plaque scores. Participants were examined after 2 years participation in the intervention; statistically significant difference in DMFT between intervention and control groups was found.Control group also participated in toothbrushing in nurseries, which was described as 'unstructured' and 'unsupervised', but it is difficult to ascertain the extent to which activities undertaken in experimental and control groups differed. It is not clear why caries experience in the permanent dentition only was assessed, as the age of the participants means it was likely many still had primary dentition, or no permanent dentition present. There is no mention of assessing caries experience in the

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
						primary dentition of participants within the paper. There was 25% loss to follow up (380 control group, 535 experimental group); reasons given for this were children absent or had left the school, but no information given on whether these children had significantly different caries experience or plaque levels compared with those who remained in the study.
Smile Grenada 7 Wolff et al. (2016) 8 Grenada	2010-2013	Primary school. 6-15 years	Teachers	Once per day; 2 minutes	1000 ppmF	Cohort study which assessed effect of participating in daily, supervised toothbrushing using 1000 ppmF toothpaste in schools (via the 'Smile Grenada' programme) on participants' caries experience (dmfs; DMFS). Participants were examined after 3 years participation in the toothbrushing intervention; statistically significant difference in participants' dmfs between baseline and post-intervention was found. It is not clear if within-group 'repeated measures' design used, or if children in different age categories at outset were compared with different cohort of children in those age categories at the end of the intervention. No control group of children not participating in oral health preventive interventions was included in this study.
Pieper et al. (2016), Winter et al. (2017) Germany *(Marburg-Biedenkopf & Waldeck-*	2006-2009	Nursery. Age at outset: 2-4 years	Dental & medical personnel	Once per day; *Duration not provided*	500 ppmF	Randomised controlled trial which assessed effect of participating in daily, supervised toothbrushing using 500ppmF toothpaste in nurseries on participants' caries experience (dmft; DMFT). Participants were examined after 3 years participation in the intervention, then again 6 years after first participating in the intervention. Statistically significant difference in dmft between intervention and control groups was found; however, no

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Frankenberg counties)						difference in DMFT between groups was found.Intervention was delivered by staff recruited for the study (rather than being part of nursery staff's role) therefore applicability of the intervention to day-to-day delivery in nurseries cannot be assessed.
Cakar et al. (2018) Australia *(Queensland)*	started 2006	Primary school. 5-12 years	Teachers	Once per day; *Duration not provided*	500 ppmF (5 year olds); 1000 ppmF (6 year olds and over)	Quasi-experimental trial which assessed effect of participating in daily, supervised toothbrushing with 500-1000 ppmF toothpaste in schools on participants' caries experience (dmft; DMFT). Participants were examined after 5-9 years of participating in the programme; statistically significant difference in dmft & DMFT between intervention and control groups was found, although caries experience increased in intervention group. Participating schools were described as being matched for socioeconomic measures and geographical proximity, but it was not explained how schools were assigned to experimental or control groups. Participants' caries experience was assessed via dental records, rather than undertaking dental examinations specifically for the study. It is not clear if all participants' dental records would be up to date (e.g. due to differences in how often participants attended dental settings).
Brushadromes programme Gasoyan et al. (2019); Armenia *(Armavir, Aragatsotn and Lori provinces)*	started 2013	Primary school. 6-7 & 10-11 years	Teachers; School nurses	Once per day; 2 minutes	1000 ppmF	Repeated cross-sectional study which assessed effect of participating in daily, supervised toothbrushing with 1000 ppmF toothpaste in the school setting on participants' caries experience (dmft; DMFT). Participants were examined after 4 years of participating in the toothbrushing intervention. Among 6-7 year olds: there was a non-significant difference in dmft between intervention and control groups; among 10-11 year olds: there was a statistically significant difference in DMFT between intervention

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
						and control groups. The repeated cross-sectional design was a limitation as it only allows patterns of change to be considered at the aggregate level, rather than evaluating individuals' outcomes at different time points; the authors themselves acknowledge that there was limitations in comparing the groups because of this. While it was reported that the toothbrushing programme had been implemented in nine villages at time of data collection, data from schools in two villages only were included.
School Interventions-based Prevention of Early-Childhood Caries (SIPEC) Samuel et al. (2020) India *(Chennai district)*	2015-2017	Nursery. 3-5 years	Teachers	Once per day; *Duration not provided*	1000 ppmF	Cluster randomised controlled trial which assessed effect of participating in daily, supervised toothbrushing using 1000 ppmF toothpaste (in addition to oral health education and measures to prohibit sugary foods) in nurseries on participants' caries experience (dmft). Participants were examined after 2 years participation in the intervention; statistically significant difference in dmft between intervention and control groups was found. However, one of the control groups also participated in supervised toothbrushing, therefore the specific impact of participating in supervised toothbrushing in nurseries on participants' caries experience cannot be determined. It was noted that teachers involved required 'constant motivation' to continue delivering the intervention; it is unclear the extent to which the intervention was delivered as intended.
Babaei et al. (2020) Iran *(Tehran)*	*not provided*	Primary school. 6-7 years	*not provided*	Once per day; *Duration not provided*	*not provided*	Cluster randomised controlled trial which assessed effect of participating in daily, supervised toothbrushing (in addition to an oral health education session and receiving oral health products for home use) on participants' oral hygiene status (in addition to

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
						their teachers' and parents/carers' oral health knowledge). Participants were examined at baseline then one month later. Statistically significant difference in oral hygiene status between intervention and control groups was reported; however, it was not clear what was measured in this respect. It is not explained why caries experience was not considered as a suitable outcome measure. Outcome measures were collected after one month of intervention delivery, which may not have given enough time for the intervention's effectiveness to be evaluated.
Natapov et al. (2021) Israel	started 2015	Nursery. 3-5 years	*not provided*	Once per day; *Duration not provided*	600 ppmF	Cluster randomised controlled trial which assessed effect of participating in daily, supervised toothbrushing using 600 ppmF toothpaste in nurseries on participants' caries experience (dmft). Participants were examined after 2 years participation in the intervention; while a difference in dmft between intervention and control groups was observed, this was not statistically significant. It is not clear how nurseries were selected for experimental or control groups. Participants' caries experience was not measured at baseline, only after the intervention was delivered for two years.

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Leal et al. (2002) Brazil *(Brasilia)*	*not provided*	Nursery. 3-6 years	*not provided*	*not provided*	*not provided*	Quasi-experimental crossover study which assessed effect of three methods of toothbrushing instruction (group-based audiovisual; group-based using a child as a model; and individual instruction) on participants' toothbrushing efficacy (measured by dentist-assessed plaque scores). The largest reduction in plaque scores was found following the individual instruction method.There was insufficient description of the types of instruction or how it was delivered. There is considerable risk of carryover effect given that all participants received all three types of instruction, culminating in individual instruction (which was found to have the greatest effect on plaque scores) which could have been controlled by randomised counterbalancing of the order of interventions.
Makuch et al. (2011) Germany *(Leipzig)*	*not provided*	Nursery. 2-4 years	*not provided*	*not provided*	*not provided*	Randomised controlled trial which assessed effect of four methods of toothbrushing instruction (using a giant teeth model; an animal puppet with teeth; with child using mirror; with another person using mirror) on participants' toothbrushing efficacy (measured via observation of toothbrushing position and movement). It was found that more participants displayed correct positioning and movement when instructed using the human models. Randomisation methods were not explained. No information regarding duration of teaching, whether it was only provided once, or who provided the demonstrations. It is also not clear if/how children were encouraged to brush their teeth.
Wind et al (2005) Netherlands *(Midden-Limburg)*	1998-2002	Primary school. 7-10 years	*not provided*	Once per day; *Duration not provided*	*not provided*	Quasi-experimental trial which assessed effect of participating in daily, supervised toothbrushing in schools on participants' self-reported toothbrushing frequency, attitudes towards toothbrushing and habit strength. Study duration was 3 years.

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
						Frequency of brushing increased among intervention group participants during intervention period, but was not maintained after one year. No differences were found in attitudes towards toothbrushing or habit strength between experimental and control groups. No description of delivery of the toothbrushing intervention was provided.

Table 25 Summary of ongoing dental public health programmes including supervised toothbrushing in nurseries and schools

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Barnet Young Brushers Barnet Council (2022) England *(Barnet)*	started 2022	Nursery. 3-4 years	*not provided*	Twice per day; *Duration not provided*	*not provided*	Pilot supervised toothbrushing programme offered to 40 early years establishments; 18 establishments were recruited as of February 2022, with staff in 13 establishments trained at that point. Pilot is funded to April 2023. (Source of information: general information)
Bath & North East Somerset supervised toothbrushing programme Bath & North East Somerset Council (2017) England *(Bath & North East Somerset)*	started 2017	Nursery; Primary school. 0-5 years	Nursery / school staff	Once per day; 2 minutes	1000 ppmF (0-3 years); 1350-1500 ppmF (3-5 years)	The paper described the process of setting up a 12-week trial of a supervised toothbrushing programme taking place in 4 nurseries & 2 primary schools, including feedback from stakeholders involved in the process. The guidelines for delivery recommend that the 'dry' (away from sink) model is used, although information on 'wet' brushing at sinks is also provided. Information given on amount of toothpaste to use depending on age of child. (Source of information: Delivery protocol / guidelines; Monitoring / process evaluation reports)
My Smile supervised toothbrushing programme Cambridgeshire Community Services NHS Trust (2020) England *(Bedford,*	*not provided*	Nursery. 3-4 years	Nursery staff	Once per day; *Duration not provided*	1350-1500 ppmF	Only 'dry' brushing (away from sink) was permitted during the Covid pandemic as per guidance published in August 2020 (not clear if reverted to 'wet' brushing again). Guidance includes information on using appropriate size of toothbrush and amount of toothpaste depending on age of child. (Source of information: Delivery protocol / guidelines)

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Central Bedfordshire, Cambridgeshire, Peterborough & Suffolk)						
Bradford school supervised toothbrushing programme; Bradford Babies Brush Local Government Association (2022) England *(Bradford)*	*not provided*	Nursery; Primary school. *Ages not provided*	Nursery / school staff	*not provided*	*not provided*	Supervised toothbrushing programme is delivered in targeted primary schools (targeting based on levels of dental decay; includes one-third of all primary schools in the area). The local NHS oral health improvement team trains school staff to supervise toothbrushing, supports schools and visits schools to observe delivery twice per year. In 2021 a new scheme was piloted in 11 private nurseries (Bradford Babies Brush): nursery staff were trained to supervise brushing; nurseries were provided with toothbrushing equipment; 400 children participated in the pilot. The local authority has since funded the programme: 99 private nurseries identified 36 to be recruited by August 2022. (Source of information: general information)
Healthy Smiles Brent Local Government Association (2018) England *(Brent)*	*not provided*	Nursery. 2-5 years	*not provided*	*not provided*	*not provided*	Limited information available: as of 2018, 33 settings were participating in the programme. (Source of information: general information)

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Brush Bus (Bury) Oral Health Improvement Bury (2022) England *(Bury)*	*not provided*	Nursery. 2-5 years	Nursery staff	Once per day; *Duration not provided*	1450 ppmF	Toothbrushing equipment is provided to nurseries. Nursery staff are trained to supervise brushing. No further information on delivery given. (Source of information: Delivery protocol / guidelines)
Calderdale's Toothbrushing in Schools scheme Woodall et al. (2013, 2014) England *(Calderdale)*	*not provided*	Nursery. 3-5 years	*not provided*	*not provided*	*not provided*	Qualitative feedback was gathered from stakeholders delivering the intervention in nurseries, which found that nursery staff's involvement and buy-in determined the success of the intervention, with staff turnover impacting negatively on delivery. It is noted that this programme drew on principles and learning from Childsmile. (Source of information: Monitoring / process evaluation reports)
Smile4Life Burgess-Allen et al. (2018) England *(Derby)*	started 2013	Nursery. 3-5 years	*not provided*	*not provided*	*not provided*	Purpose of study was to explore stakeholders' perceptions on delivering the pilot oral health programme in nurseries, which included supervised toothbrushing (in addition to fluoride varnish applications); results indicated that many of those involved in delivering the intervention found this difficult alongside other required activities on the curriculum. It is noted that this programme drew on principles and learning from Childsmile and Designed to Smile. (Source of information: Monitoring / process evaluation reports)
Devon supervised toothbrushing programme Allen & Witton (2021), Peninsula	started 2019	Nursery; Primary school. 3-5 years	Nursery / school staff	*not provided*	1350-1500 ppmF	Allen & Witton (2021) described the process of consolidating three existing programmes delivered in separate local authorities into one programme which was targeted at nurseries and schools in the 50% most deprived areas of Devon. However it is not clear when establishments began delivering toothbrushing or any information given on the impact of the Covid pandemic on delivery (which

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Dental (2022), Well Connected (2020) England *(Devon)*						coincided with this process taking place). The programme is delivered by a social enterprise (Peninsula Dental) and a local charity (Well Connected); it was identified that training was delivered to staff in 242 establishments (attended by 4900 children) to deliver supervised toothbrushing; with all equipment provided and quality assurance audits carried out. (Source of information: general information)
Doncaster Toothbrushing Club Doncaster Council (2022) England *(Doncaster)*	*not provided*	Nursery. 2-5 years	Nursery staff	Once per day; 2 minutes	1350-1500 ppmF	Delivery was paused during Covid pandemic but since resumed; only 'dry' brushing (away from sink) was permitted (as per guidance published in 2022). Toothbrushing equipment is provided by Doncaster Council public health team. Quality assurance is undertaken through self-evaluation by staff in nurseries plus monitored by the public health team once per year. Guidance includes information on using appropriate size of toothbrush and amount of toothpaste depending on age of child. (Source of information: Delivery protocol / guidelines)
Brush Bus (Hull) City Health Care Partnership (2011), Hull City Council (2017) England *(Hull)*	started 2006	Nursery; Primary school. *Ages not provided*	*not provided*	Once per day; *Duration not provided*	*not provided*	Limited information available: programme is a public-private partnership, supported by a private dental provider (Henry Schein Dental). As of 2016-17, 52 nurseries and 15 primary schools participated in the programme. (Source of information: general information)
Teeth Team Teeth Team Limited (2015, 2016, 2018)	started 2010	Nursery; Primary school.	Nursery / school staff	Once per day; *Duration not provided*	1450 ppmF	The programme is delivered by a not-for-profit partnership including 9 private dental providers (a salaried dental service was involved until 2013 but then withdrew). The programme was delivered in nurseries and schools in Hull and East Riding of

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
England *(Hull; North Yorkshire; Nottingham; South Humberside; Leeds; Sheffield; Kent; Birmingham; Isle of Wight)*		3-11 years				Yorkshire initially, but has expanded to other geographical areas; in 2018, it included 52 primary schools & 3 nurseries, in: Hull; North Yorkshire; Nottingham; South Humberside; Leeds; Sheffield; Kent; Birmingham; and Isle of Wight (representing an increase of 33 establishments since the previous year). Establishments are provided with toothbrushing equipment (toothbrushes, toothpaste & racks) once per year; monitoring takes place once per term. (Source of information: Monitoring / process evaluation reports; general information)
Happy Teeth, Happy Smiles Leicester City Council (2017) Akroyd (2017) England *(Leicester)*	started 2014	Nursery; Primary school. *Ages not provided*	*not provided*	Once per day; 2 minutes	1350-1500 ppmF	Guidance included using appropriate size of toothbrush and amount of toothpaste depending on age of child. Both 'wet' (at sink) and 'dry' (away from sink) models were described. In 2017 there were 17 primary schools (23% of all primary schools in area) and 77 nurseries (59% of all nurseries in the area) participating in the supervised toothbrushing programme (although all nurseries were invited to participate). (Source of information: Delivery protocol / guidelines)
Live Smart supervised toothbrushing programme Dental Wellness Trust (2021) England *(London and South-East*	*not provided*	Nursery; Primary school. 3-11 years	School staff	*not provided*	*not provided*	Delivered by a not-for-profit organisation. Reaches 3500 children in nurseries and schools in London and South-East England; settings targeted through deprivation and numbers of children experiencing dental caries. Settings are provided with toothbrushing equipment. A programme supervisor was employed in August 2019 to support establishments, provide training and audit delivery. (Source of information: Monitoring / process evaluation reports)

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
England: Luton, Newham, Brent, Westminster, Crawley, Barnet)						
Keep Smiling Wright & Robertson (2013) England *(London: Hammersmith and Fulham)*	started 2011	Nursery; Primary school. 3-7 years	*not provided*	*not provided*	*not provided*	Limited information available on this programme aside from it providing school-based brushing, fluoride varnish applications and signposting to dental practices; it was piloted in 2011/12 in 6 settings then rolled out to a further 6 settings in 2013. (Source of information: general information)
Brush Bus (Manchester) Manchester City Council (2018) England *(Manchester)*	*not provided*	Nursery; Primary school. *Ages not provided*	*not provided*	*not provided*	*not provided*	Limited information available: in 2018, 78 primary schools participated in the programme (out of 100 targeted); and 84 nurseries participated (out of 132 targeted). (Source of information: general information)
Brushing Buddies Nott'shire Nottinghamshire Oral Health Promotion Team (2019) England *(Nott'shire)*	started 2015	Nursery; Primary school. 3-6 years	School staff	Once per day; *Duration not provided*	*not provided*	As of 2019 the toothbrushing programme was delivered in 23 settings, targeted based on deprivation. It was noted that group-based 'dry' (away from sink) brushing was the most common model for delivery, with 'wet' (at sink) brushing less common. (Source of information: Monitoring / process evaluation reports)

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Brush Up Portsmouth University of Portsmouth Dental Academy (2019) England *(Portsmouth)*	started 2012	Nursery; Primary school. *Ages not provided*	*not provided*	Once per day; 2 minutes	*not provided*	The supervised toothbrushing programme is supported by University of Portsmouth dental students, alongside qualified oral health staff. The number of primary schools taking part fell from 14 in 2012 to 9 in 2019, while the number of nurseries increased from 0 in 2012 to 5 in 2019. (Source of information: Monitoring / process evaluation reports)
St Helens supervised toothbrushing programme St Helens Wellbeing (2020) England *(St Helens)*	*not provided*	Nursery. *Ages not provided*	Nursery staff	Once per day; 2 minutes	1450 ppmF	Guidance provided on accessing training for toothbrushing supervisors; using appropriate amount of toothpaste depending on age of child; process for monitoring delivery. Both 'wet' (at sink) and 'dry' (away from sink) models were described. (Source of information: Delivery protocol / guidelines)
Saving Smiles Solent NHS Trust (2020) England *(area not specified, but Solent NHS Trust covers Southampton, Portsmouth, parts of Hampshire & Isle of Wight)*	*not provided*	Nursery. *Ages not provided*	Nursery staff	Once per day; *Duration not provided*	1000 ppmF	Provides options for 'dry' (away from sink) or 'wet' (at sink) models; and advice on amount of toothpaste to use depending on age of child. (Source of information: Delivery protocol / guidelines)

Name of programme (where provided); Author, date; Country (*locality*)	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Keep Suffolk Smiling Suffolk County Council (2017, 2018) England *(Suffolk)*	started 2017	Nursery; Primary school. 3-7 years	Nursery / school staff	Once per day; *Duration not provided*	*not provided*	Guidance provided on accessing training for toothbrushing supervisors; using appropriate size of toothbrush and amount of toothpaste depending on age of child. Both 'wet' (at sink) and 'dry' (away from sink) models were described; the local authority provides all equipment required (toothbrushes, toothpaste & racks). (Source of information: Delivery protocol / guidelines)
Teesside supervised toothbrushing programme North Tees and Hartlepool NHS Foundation Trust (2020), Public Health England (2014), Olajide et al. (2017) England *(Teesside)*	*not provided*	Nursery; Primary school. 3-11 years	Nursery / school staff	Once per day; 2 minutes	1450 ppmF	Programme is offered to all nurseries & primary schools (early stage class years) although most schools located in deprived areas provided toothbrushing to all classes. In 2017 it was noted that 100 establishments were participating in this programme. Nurseries and schools are provided with toothbrushing equipment. Information given on using appropriate amount of toothpaste depending on age of child. This programme was included as a case study in Public Health England's (2014) toolkit for commissioning oral health programmes for children and young people, which noted that dental public health epidemiology data was used to monitor changes in tooth decay levels which indicated reduced levels of dental decay among children in establishments participating in the toothbrushing programme compared with non-participating establishments. (Source of information: Delivery protocol / guidelines; general information)

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Smile Squad Worcestershire Children First (2022) England *(Worc'shire)*	*not provided*	Nursery. 2-4 years	*not provided*	Once per day; *Duration not provided*	*not provided*	Supervised toothbrushing programme was established in 14 nurseries (with capacity for a further 16 nurseries to participate); limited information available on delivery of this programme. (Source of information: general information)
Smile of Mann Isle of Man Government Department of Health and Social Care (2018), Isle of Man Gov'ment	started 2018	Nursery. 3-5 years	Nursery staff	Once per day; 2 minutes	1450 ppmF	Supervised toothbrushing programme was piloted in 6 nurseries in 2017 then rolled out across Isle of Man in 2018; it is planned to offer the programme to all nurseries. As of 2022, 21 nurseries were participating in the programme. Guidance includes option of 'wet' (at sink) or 'dry' (away from sink) models (although it was noted that most settings used the dry brushing model as it was perceived as less time-consuming); and information given on using appropriate size of toothbrush and amount of toothpaste depending on age of child. Toothbrushes, toothpaste and racks are provided to settings. (Source of information: Delivery protocol / guidelines)
Happy Smiles Health and Social Care Board Northern Ireland (2016) Northern Ireland	started 2016	Nursery. *Ages not provided*	Nursery staff	Once per day; *Duration not provided*	1000 ppmF (under 3 years); 1450 ppmF (over 3 years)	The programme was launched in 2016; guidance describes both 'dry' (away from sink) and 'wet' (at sink) models. No other information on the programme was available. (Source of information: Delivery protocol / guidelines)
Designed to Smile Morgan (2014c, 2015, 2016,	started 2008	Nursery; Primary school.	Nursery / school staff	Once per day; 2 minutes	1450 ppmF (over 3s); 1000 ppmF (under 3s)	Guidance on delivery includes information on amount of toothpaste to use depending on child's age; and only the 'dry' (away from sink) model of delivery was described. Establishments are targeted based on area-based deprivation;

Name of programme (where provided); Author, date; Country (*locality*)	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
2018b, 2019), Morgan & Wilson (2020), Trubey & Chestnutt (2009, 2010, 2012), Welsh Government (2017), Designed to Smile Wales		3-10 years				from 2017, when the Welsh Government refocused targeting and delivery of Designed to Smile, this was based on being located in the most, second-most or middle deprivation quintiles. Monitoring reports on programme delivery for 2014-2019 reported that the number of nurseries and primary schools participating in the toothbrushing programme ranged from 1439 in 2014-15, to 1369 in 2018-19. Each year it was reported that a number of establishments had either declined to participate, or withdrawn from participation in the toothbrushing programme (from 45 in 2014-15, to 166 in 2018-19). The percentage of eligible children consented to participate was similar across the five years reported (ranging from 93.9% in 2014-15 to 93.5% in 2018-19); and the percentage of eligible children recorded as actually participating in toothbrushing also remained similar over the five-year period, ranging from 92.8% (91,290 children) in 2014-15 to 93.1% (90,602 children) in 2018-19. However, it is unclear how the number of children participating in brushing was defined or measured in any of the monitoring reports. Community dental service staff visited each establishment around every 6 weeks to carry out quality assurance assessments; 'remedial actions' were recorded, which referred to further advice given on the amount of toothpaste being used or the condition of the toothbrushes/racks, with small numbers of establishments recorded as being required to suspend delivery of the toothbrushing programme following a quality assurance assessment. Numbers of nursery and school staff trained to deliver the supervised toothbrushing programme were also reported each year. (Source of information: Delivery protocol / guidelines; Monitoring

Name of programme (where provided); **Author, date;** **Country *(locality)***	**Delivery dates**	**Setting;** **Participants' age range**	**Who supervises**	**Frequency & duration of brushing**	**Fluoride content of toothpaste**	**Further information**
						/ process evaluation reports)

Table 26 Summary of ongoing dental public health programmes including supervised toothbrushing in nurseries and schools: rest of world

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Dimitropoulos et al. (2018, 2019) Australia *(New South Wales)*	started 2015	Primary school. 5-12 years	*not provided*	*not provided*	*not provided*	These studies reported on the process of developing and implementing an oral health programme in schools, attended predominantly by Aboriginal children; it explored school staff's perceptions about setting up and delivering a supervised toothbrushing programme (both before and after it was implemented). (Source of information: Monitoring / process evaluation reports)
Happy Teeth Queensland Queensland Health (2021) Australia *(Queensland)*	started 2005	Nursery. 0-5 years	Nursery staff	Once per day; 1-2 minutes	500 ppmF (0-5 years); 1000 ppmF (6 years and over)	Guidance to support oral health promotion activities in early years settings in Queensland (known as Happy Teeth Queensland), including a supervised toothbrushing programme. Information provided included size of toothbrushes, fluoride content of toothpaste, storage of brushes (although parents are required to provided these resources). (Source of information: Delivery protocol / guidelines)
Supervised Tooth Brushing Program in Victorian Primary Schools Graesser et al. (2017) Australia *(Victoria)*	*not provided*	Primary school. *Ages not provided*	*not provided*	*not provided*	*not provided*	Purpose of study was to assess uptake and acceptability of a pilot supervised toothbrushing programme in three primary school breakfast clubs (delivered via a 'wet' model at sinks in one setting and a 'dry' model with excess toothpaste disposed of using tissues in two settings), via weekly observations of numbers of children participating in toothbrushing, plus estimated time spent toothbrushing; and qualitative interviews with school staff delivering the intervention. The programme was piloted for 5-7 weeks in the settings: participation in the setting using the 'wet' model was 60% in the

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
						first week, falling to 5% in the final week (averaging 32% participation); and the settings using the 'dry' model averaged 82-91% participation (starting at 40-65% and rising to 100% by the end of the pilot). Estimated time spent toothbrushing was higher in settings using the 'dry' model (remaining at two minutes throughout the pilot period) whereas this was lower in the 'wet' model setting, starting at 1.5 minutes and dropping to one minute by the end of the pilot. (Source of information: Monitoring / process evaluation reports)
Victoria Department of Human Services (2002) Australia *(Victoria)*	*not provided*	Nursery; Primary school. *Ages not provided*	*not provided*	*not provided*	*not provided*	Evaluation of an oral health promotion programme, including daily, supervised toothbrushing in nursery and school, aimed at indigenous people in South-Eastern Australia; this included process evaluation data collected from staff involved in delivering the intervention. (Source of information: Monitoring / process evaluation reports)
Sembrando Sonrisas Ministerio del Salud, Gobierno de Chile (2018), Carvajal Parvez & Hevia (2020), Celis (2022) Chile	started 2015	Nursery. 2-5 years	Nursery staff	1-3 times per day; 2-3 minutes	1100 ppmF	Information and guidance on implementing the 'Sembrando Sonrisas' supervised toothbrushing programme in nurseries in Chile. Nurseries are targeted for participation based on need and deprivation. Toothbrushes, toothpaste and racks and provided to nurseries and nursery staff are trained to supervise toothbrushing. Information on using appropriate amount of toothpaste depending on age of child is included in delivery guidance. In 2019, around 4500 nurseries (192,000 children) were participating in the toothbrushing programme, with 51,000 nursery staff supervising. (Source of information: Delivery protocol / guidelines; Monitoring / process evaluation reports)

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Croatian supervised toothbrushing programme in nurseries and schools Croatian Institute for Public Health (2020) Croatia	started 2020	Nursery; Primary school. *Ages not provided*	Nursery staff; School staff	Once per day; 2 minutes	1450 ppmF	Information and guidance on implementing the supervised toothbrushing in nurseries and schools in Croatia. These standards are based on those developed for Childsmile. Information provided includes that brushing take place in groups or individually; 'wet' (at sink) or 'dry' (away from sink) models of delivery; size of toothbrush and amount of toothpaste required depending on age of child. (Source of information: Delivery protocol / guidelines)
Gowda (2011) New Zealand *(Opononi, Northland)*	started 2008	Primary school. 6-13 years	School staff	*not provided*	*not provided*	Evaluation of a school-based supervised toothbrushing programme taking place in one school (in rural, deprived area) which ran for three years (not clear if programme continued beyond this). Participants' plaque index was examined at baseline and after 6, 18 & 30 months; it was found that the plaque index was 'high' at baseline (1.5), reducing to 0.7 after 6 months then plateauing at 0.7-0.9 after 18-30 months. Number of participants declined over the 3 years (attributed to absenteeism & transient nature of the population). Feedback from teachers & dental staff participating in programme delivery was also collected, at baseline and after 6, 18 & 30 months. (Source of information: Monitoring / process evaluation reports)
Reddy et al. (2019) South Africa *(KwaZulu-Natal)*	*not provided*	Primary school. *Ages not provided*	*not provided*	*not provided*	*not provided*	Qualitative study investigating school staff's experiences of delivering an oral health promotion programme, which included supervised toothbrushing, in schools. (Source of information: Monitoring / process evaluation reports)

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
MY SMILE Malmö University Oral Health Country/Area Profiles Project United Arab Emirates *(Dubai)*	started 2017	Nursery; Primary school. 4-6 years	School nurses	Once per day; *Duration not provided*	*not provided*	Description of a supervised toothbrushing programme taking place in 12 schools in Dubai, UAE, involving 1500 children. It is described as being based on the Childsmile supervised toothbrushing programme. Schools are provided with toothbrushes & toothpaste; and information on both 'wet' (at sink) and 'dry (away from sink) models of delivery is provided. (Source of information: general information)
Head Start Supervised Toothbrushing Programme University of Iowa Department of Pediatric Dentistry (2004), Indian Health Service Head Start Program, US Department of Health and Human Services (2020, 2021) USA	started 2000	Nursery. 0-5 years	Nursery staff	Once per day; 2 minutes	1000 ppmF	The Head Start Program provides pre-school education and childcare for children of low income / vulnerable families. It is aimed at children aged 0-4 years and is delivered throughout USA. Standard 1302, part 43 (relating to the programme's delivery) states that settings delivering Head Start are required to provide the opportunity for children to brush their teeth with fluoride toothpaste once per day (including assisting children to brush, where appropriate). Information provided to support delivery includes that brushing can take place while children are seated, in a group, and access to sinks is not required. While it is intended that children brush their own teeth, it is recognised that most children of this age lack manual dexterity to brush teeth adequately so nursery staff are required to coach / model correct brushing. Information also provided on amount of toothpaste to be used depending on age of child. (Source of information: Delivery protocol / guidelines; general information)

Name of programme (where provided); Author, date; Country *(locality)*	Delivery dates	Setting; Participants' age range	Who supervises	Frequency & duration of brushing	Fluoride content of toothpaste	Further information
Empower program Arizona Department of Health Services (2014) USA *(Arizona)*	started 2013	Nursery. 3-5 years	Nursery staff	Once per day; 2 minutes	*not provided*	The Empower Program is a public health program for childcare facilities in Arizona which focuses on 10 strategies to improve child health, including oral health; one of the programmes standards requires that settings implement a daily, supervised toothbrushing programme. Guidance for settings on implementing a toothbrushing programme included cross infection prevention, which equipment is required, how to introduce and demonstrate toothbrushing to children. (Source of information: Delivery protocol / guidelines)
Massachusetts supervised brushing in early years settings Office of Oral Health, Massachusetts Department of Public Health (2009) USA *(Massachusetts)*	started 2010	Nursery. *Ages not provided*	Nursery staff	Once per day; *Duration not provided*	*not provided*	Since 2010, childcare settings in Massachusetts are required to provide toothbrushing to children who are in the setting for 4 hours or more, or who have a meal while in the setting. Information provided to support settings to implement supervised toothbrushing included using appropriate size of toothbrush and amount of toothpaste depending on age of child. (Source of information: Delivery protocol / guidelines)
Gudfala Tut Skul ('Healthy Tooth School') WHO (2021), Malmö Univ. OH Country/Area Profiles Project,	started 2019	Primary school. 5-7 years	School staff	Once per day; 2 minutes	1350 ppmF	Information on the school-based supervised toothbrushing programme in Vanuatu, delivered by the country's Ministry of Health. The programme was launched in 2019; protocol for delivery was adapted from CS's Toothbrushing Standards. Schools provided with toothbrushing equipment, school staff are trained to supervise brushing. By end of 2021, the programme had been implemented in 30 settings (reaching over 3000 children). It is

Name of programme (where provided); **Author, date;** **Country** ***(locality)***	**Delivery dates**	**Setting;** **Participants' age range**	**Who supervises**	**Frequency & duration of brushing**	**Fluoride content of toothpaste**	**Further information**
Stewart et al. (2018); Vanuatu						planned to have all children aged 5–7 years participating by 2023 (a further 40 settings). (Source of information: general information)

Appendix 3: Supporting information relating to selecting an implementation research framework

Table 27 Search terms identified in relation to potential theoretical approaches

Search terms	Lead author(s)	Key papers
'Theoretical Domains Framework'; TDF; Behaviour Change Wheel; COM-B; capability, opportunity, motivation and behaviour (with relevant proximity operators)	Michie, S.	Michie, S., Johnston, M., Abraham, C., Lawton, R., Parker, D. & Walker, A. (2005) Making psychological theory useful for implementing evidence based practice: a consensus approach. *Quality & Safety in Health Care*, 14, 26-33.
		Cane, J., O'Connor, D. & Michie, S. (2012) Validation of the theoretical domains framework for use in behaviour change and implementation research. *Implementation Science*, 7.
		Francis, J. J., O'Connor, D. & Curran, J. (2012) Theories of behaviour change synthesised into a set of theoretical groupings: introducing a thematic series on the theoretical domains framework. *Implementation Science*, 7.
		Michie, S., van Stralen, M. M. & West, R. (2011) The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, 6.
'Consolidated Framework for Implementation Research'; CFIR	Damschroder, L.	Damschroder, L., Aron, D. C., Keith, R. E., Kirsh, S. R., Alexander, J. A. & Lowery, J. C. (2009) Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implementation Science*, 4
'Promoting Action on Research Implementation in Health Services';	Rycroft-Malone, J. Kitson, A. Harvey, G.	Kitson, A., Harvey, G. & McCormack, B. (1998) Enabling the implementation of evidence based practice: a conceptual framework. *Quality in Health Care*, 7**,** 149-158.

Search terms	Lead author(s)	Key papers
PARIHS		Rycroft-Malone, J., Kitson, A., Harvey, G., McCormack, B., Seers, K., Titchen, A. & Estabrooks, C. (2002) Ingredients for change: revisiting a conceptual framework. *Quality and Safety in Health Care,* 11, 174-180.
		Rycroft-Malone, J. (2004) The PARIHS Framework - A Framework for Guiding the Implementation of Evidence-Based Practice. *Journal of Nursing Care Quality*, 297-304.
		Kitson, A., Rycroft-Malone, J., Harvey, G., McCormack, B., Seers, K. & Titchen, A. (2008) Evaluating the successful implementation of evidence into practice using the PARiHS framework: theoretical and practical challenges. *Implementation Science,* 3.
		Harvey, G. & Kitson, A. (2016) PARIHS revisited: from heuristic to integrated framework for the successful implementation of knowledge into practice. *Implementation Science,* 11.
'Tailored Implementation for Chronic Diseases'; TICD	Wensing, M.	Wensing, M., Oxman, A., Baker, R., Godycki-Cwirko, M., Flottorp, S., Szecsenyi, J., Grimshaw, J. & Eccles, M. (2011) Tailored implementation for chronic diseases (TICD): A project protocol. *Implementation Science,* 6.
		Wensing, M., Huntink, E., van Lieshout, J., Godycki-Cwirko, M., Kowalczyk, A., Jäger, C., Steinhäuser, J., Aakhus, E., Flottorp, S. & Eccles, M. (2014) Tailored implementation of evidence-based practice for patients with chronic diseases. *PLoS One,* 9, e101981.

Appendix 4: Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist

Adapted from: Tong, A., Sainsbury, P. & Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*, 19(6), 349–357.

Table 28 Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist

No.	Item	Guide questions / description	Where reported	
			Section	Page
Domain 1: Research Team and Reflexivity				
A) Personal Characteristics				
1.	Interviewer / facilitator	Which author(s) conducted the interview or focus group?	3.3	99
			4.4.3	132-133
			5.2.1	186
2.	Credentials	What were the researcher's credentials? (e.g. PhD, MD)	Title page	
3.	Occupation	What was their occupation at the time of the study?	2.2.5	94-95
4.	Gender	Was the researcher male or female?	N/A	
5.	Experience and training	What experience or training did the researcher have?	2.2.5	94-95
B) Relationship with participants				
6.	Relationship established	Was a relationship established prior to study commencement?	2.2.5	94-95
7.	Participant knowledge of the interviewer	What did the participants know about the researcher? (e.g. personal goals, reasons for doing the research)	3.3	99
			4.4.3	132-133
8.	Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? (e.g. bias, assumptions, reasons and interests in the research topic)	2.2.5	94-95

No.	Item	Guide questions / description	Where reported	
			Section	Page
Domain 2: Study Design				
A)Theoretical framework				
9.	Methodological orientation and theory	What methodological orientation was stated to underpin the study? (e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis)	2.2.2.1	68-69
B)Participant selection				
10.	Sampling	How were participants selected? (e.g. purposive, convenience, consecutive, snowball)	3.3	99
			4.4.3	132-133
11.	Method of approach	How were participants approached? (e.g. face-to-face, telephone, mail, email)	3.3	99
			4.4.3	132-133
12.	Sample size	How many participants were in the study?	3.3	99
			4.4.3	132-133
			5.2.1	186
13.	Non-participation	How many people refused to participate or dropped out? Reasons?	4.4.3	133
C)Setting				
14.	Setting of data collection	Where was the data collected? (e.g. home, clinic, workplace)	3.3	99
			4.4.3	132-133
15.	Presence of non-participants	Was anyone else present besides the participants and researchers?	N/A	
16.	Description of sample	What are the important characteristics of the sample? (e.g. demographic data, date)	3.3	99
			4.4.3	132-133
			5.2.1	186

No.	Item	Guide questions / description	Where reported	
			Section	Page
D)Data collection				
17.	Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	3.3	100
			4.4.3	132-133
			5.2.1	186
			Appendix 8	403-411
			Appendix 12	430-437
18.	Repeat interviews	Were repeat interviews carried out? If yes, how many?	4.4.3	132-133
			5.2.1	186
19.	Audio / visual recording	Did the research use audio or visual recording to collect the data?	3.3	99
			4.4.3	133
			5.2.1	186
20.	Field notes	Were field notes made during and/or after the interview or focus group?	N/A	
21.	Duration	What was the duration of the interviews or focus group?	2.2.3.3	73-74
22.	Data saturation	Was data saturation discussed?	N/A	
23.	Transcripts returned	Were transcripts returned to participants for comment and/or correction?	3.3	99
			4.4.3	133
Domain 3: Analysis and Findings				
A)Data analysis				
24.	Number of data coders	How many data coders coded the data?	4.5.2	135
			5.2.2	187
25.	Description of the coding tree	Did authors provide a description of the coding tree?	4.5.2	135
			5.2.2	188
26.	Derivation of themes	Were themes identified in advance or derived from the data?	4.5.2	135
			5.2.2	188-189
27.	Software	What software, if applicable, was used	4.5.2	135

No.	Item	Guide questions / description	Where reported	
			Section	Page
		to manage the data?	5.2.2	187
28.	Participant checking	Did participants provide feedback on the findings?	N/A	
B) ***Reporting***				
29.	Quotations presented	Were participant quotations presented to illustrate the themes / findings? Was each quotation identified? (e.g. participant number)	4.7.1-4.7.7	159-180
			5.3.1-5.3.2	191-246
30.	Data and findings consistent	Was there consistency between the data presented and the findings?	3.4.3-3.4.4	108-120
			4.6-4.7	136-180
			5.3.1-5.3.2	190-246
31.	Clarity of major themes	Were major themes clearly presented in the findings?	3.4.3-3.4.4	108-120
			4.6-4.7	136-180
			5.3.1-5.3.2	190-246
32.	Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	3.4.3-3.4.4	108-120
			4.6-4.7	136-180
			5.3.1-5.3.2	190-246

Appendix 6: Toothbrushing Logic Model Development and Refinement

Table 29 Sources consulted for documentary review

1.	Anopa et al. (2015)	Improving Child Oral Health: Cost Analysis of a National Nursery Toothbrushing Programme. *PLoS ONE*, 10(8):e0136211.
2.	Childsmile (2012)	Survey of Childsmile toothbrushing in nurseries and local 20% of primary schools with the highest need on 29 May 2012. Windygates, Fife: Childsmile.
3.	Childsmile (2015)	National Standards for Nursery and School Toothbrushing Programmes (version 3). Edinburgh: NHS Health Scotland.
4.	Childsmile (2016a)	Childsmile toothbrushing programme. Pilot count of children brushing: January - June 2016. Windygates, Fife: Childsmile.
5.	Childsmile (2016b)	Programme Manual for Childsmile Staff (version 3.1). Childsmile.
6.	Childsmile (2017)	Childsmile toothbrushing programme. Pilot count of children brushing: Year two January - June 2017. Windygates, Fife: Childsmile.
7.	Childsmile Central Evaluation and Research Team (2010)	Childsmile explication report: Building the foundations of a comprehensive evaluation. Glasgow: University of Glasgow.
8.	Deas et al. (2013)	Intelligent policy making? Key actors' perspectives on the development and implementation of an early years' initiative in Scotland's public health arena. *Social Science & Medicine*, vol. 96, pp1-8; plus secondary analysis of interview data gathered for Deas et al. (2013).
9.	Eaves and Gnich (2013)	Can programme theory be used as a 'translational tool' to optimise health service delivery in a national early years' initiative in Scotland: a case study. *BMC Health Services Research* 13:425.
10.	Education Scotland (2017a)	Curriculum for Excellence. https://www.education.gov.scot/Documents/All-experiencesoutcomes.pdf (accessed 31/10/17).

11.	Education Scotland (2017b)	Curriculum for Excellence: health and wellbeing experiences and outcomes. https://www.education.gov.scot/Documents/health-and-wellbeing-eo.pdf (accessed 31/10/17).
12.	Macpherson et al. (2010a)	Childsmile: the national child oral health improvement programme in Scotland. Part 1: establishment and development. *British Dental Journal*, 209 (2), pp73-78.
13.	Macpherson et al. (2013)	National Supervised Toothbrushing Program and Dental Decay in Scotland. *Journal of Dental Research*, 92 (2), pp109-113.
14.	Scottish Executive (2002)	Towards better oral health in children. A consultation document on children's oral health in Scotland. Edinburgh: Scottish Executive.
15.	Scottish Executive (2005a)	An action plan for improving oral health and modernising NHS dental services in Scotland. Edinburgh: Scottish Executive.
16.	Scottish Executive(2005c)	Towards Better Oral Health in Children. An Independent Analysis of Responses to the Consultation on Children's Oral Health. Edinburgh: Scottish Executive.
17.	Scottish Dental Clinical Effectiveness Programme (2010)	Prevention and Management of Dental Caries in Children. Dundee: Scottish Dental Clinical Effectiveness Programme.
18.	Scottish Dental Needs Assessment Programme (2017)	Oral health and dental services for children. Needs assessment report. Bothwell: Scottish Dental Needs Assessment Programme.
19.	Scottish Government (2008c)	Early Years Framework. Edinburgh: Scottish Government.
20.	Scottish Government (2011)	The Commission on the Future Delivery of Public Services. Edinburgh: Scottish Government.
21.	Scottish Government (2013a)	A picture of Scotland's oral health. Annual report of the Chief Dental Officer, 2012. Edinburgh: Scottish Government.
22.	Scottish Government (2016a)	A Plan for Scotland. The Government's Programme for Scotland, 2016-17. Edinburgh: Scottish Government.

23.	Scottish Government (2016b)	Early learning and childcare trials discussion paper: analysis of responses. Edinburgh: Scottish Government.
24.	Scottish Government (2016c)	Fairer Scotland Action Plan. Edinburgh: Scottish Government.
25.	Scottish Government (2016d)	National Improvement Framework for Scottish Education. 2016 Evidence Report. Edinburgh: Scottish Government.
26.	Scottish Government (2016e)	National Improvement Framework for Scottish Education. Achieving Excellence and Equity. Edinburgh: Scottish Government.
27.	Scottish Government (2016f)	National performance framework. outcome: 'improve children's dental health'; http://www.gov.scot/about/performance/scotperforms/indicator/dental (accessed 06/09/17).
28.	Scottish Government (2016g)	Scotland's Oral Health Plan. A Scottish Government Consultation Exercise on the Future of Oral Health. Edinburgh: Scottish Government.
29.	Scottish Government (2017a)	National Improvement Framework and Improvement Plan. Edinburgh: Scottish Government.
30.	Scottish Government (2017b)	A Blueprint for 2020: The Expansion of Early Learning and Childcare in Scotland. 2017-18 Action Plan. Edinburgh: Scottish Government.
31.	Scottish Government (2017c)	Scotland's Oral Health Plan. Analysis of Responses. Edinburgh: Scottish Government.
32.	Scottish Health Council (2017)	Oral Health in Scotland Gathering views on the Future of Oral Health in Scotland. Glasgow: Healthcare Improvement Scotland.
33.	Scottish Intercollegiate Guidelines Network (2014)	SIGN 138: Dental interventions to prevent caries in children. Edinburgh: Scottish Intercollegiate Guidelines Network.

Appendix 7: Information and consent form for Stage One (further developing the Theory of Change of the Childsmile nursery toothbrushing programme: strategic stakeholder interviews)

Information and consent form[17]

Stage 1: Strategic interviews

Title: Optimising delivery of the supervised toothbrushing programme in early learning and childcare (ELC) settings in Scotland

Researcher: Jennifer Eaves

Supervisors: Dr. Wendy Gnich, Dr. Andrea Sherriff

The Central Evaluation and Research Team (CERT), based in University of Glasgow's Dental School, Community Oral Health section, coordinates the national evaluation of Childsmile. This PhD study is being undertaken as part of the national CS evaluation.

You are being asked to participate in a face-to face interview. This will involve exploring the intended model of delivery and develop the Theory of Change for the toothbrushing programme in ELC settings.

The data gathered will be used to develop and refine the programme theory for the toothbrushing programme in ELC settings and a detailed logic model will be produced. This will be used to inform subsequent stages of the study (to explore whether the toothbrushing programme is being implemented as intended and to identify areas for further action to optimise delivery.

Your participation in this study is entirely voluntary. You can choose to withdraw from participating in the study at any time.

The interviews will be audio-recorded. All information gathered will be strictly confidential and held securely in accordance with the Data Protection Act 1998.

Please indicate whether you are willing to take part in an audio-taped interview by initialling the appropriate boxes below.

	Please

[17] Consent form: strategic interviews (Stage 1), 12/11/17, Version 1

	initial each box you agree with.
I have read the information above and have had the opportunity to ask questions; I agree to take part in an interview for this study.	
I give permission for the interview to be audio taped.	
I understand that anonymous quotations may be included in the final report and/or publications.	
I understand that my participation is voluntary and that I am free to withdraw at any time.	

Name:	**Designation:**
Signature:	**Date:**

Appendix 8: Topic guide for interviews with strategic-level respondents - Further developing the Theory of Change of the Childsmile nursery toothbrushing programme

Primary aim

Every three- and four-year old child attending a local authority, voluntary, private or partner provider nursery, on a full- or part-time basis, participates in supervised toothbrushing using toothpaste with an appropriate fluoride content, in their nursery setting, on a daily basis

Questions

1. Do you agree that this describes the main aim of the nursery toothbrushing programme?

    a. If no, why not?

2. Do you agree with the target group specified (i.e. three- and four- year old children attending nursery)

    a. What about two-year olds attending nurseries?

3. What do you understand 'supervised toothbrushing' to mean?

- SIGN 138: notes that there is not a clear definition of 'supervised toothbrushing' in the literature[18]:

    a. Do you agree that *"an episode of verifiable exposure to fluoride toothpaste"* is a suitable definition of supervised toothbrushing?

[18] SIGN 138: lack of consistency in the use of the term 'supervision'; not clearly defined; various interpretations, e.g. presence of an adult to ensure that brushing has taken place; close monitoring of dental hygiene techniques within controlled quadrant brushing. As such, references to 'supervised toothbrushing' within literature to be considered as "an episode of verifiable exposure to fluoride toothpaste". (page 19)

b. Is supervision of toothbrushing adequately defined / described within the programme (e.g. programme documents)?

4. Do you agree that toothbrushing in nurseries should be supervised?

    a. Why / why not?

    c. Who should supervise children while toothbrushing?

    d. How do they supervise? What does it look like?

5. SIGN 138 also notes that *"children who are unable to brush their teeth unaided should be assisted to do so"*. (page 19)

    a. Do you think 'assisted' or 'supported' toothbrushing should be included in the nursery toothbrushing programme, in addition to supervised toothbrushing?

        i. Why / why not?

        ii. What about for two-year olds attending nurseries?

    b. How would it be assessed whether a child could brush for themselves?

    c. What would be the implications of introducing assisted toothbrushing in nurseries? (e.g. training for education staff; monitoring)

6. Is it reasonable to specify that the toothpaste used should have appropriate fluoride content (i.e. at least 1000ppmF)?

    a. Why / why not?

7. Is it expected that toothbrushing will be available to children in 100% of nurseries?

    a. Why / why not?

8. Regarding the type of nurseries involved in the programme:

a. How would you define what is a local authority nursery; a private nursery; a partnership provider nursery?

b. Do you agree all of these types of nurseries are appropriate settings for the toothbrushing programme?

c. Are the expectations regarding participation the same for each type of nursery?

9. What is meant by toothbrushing 'on a daily basis'?

    a. Is each nursery expected to offer toothbrushing every day it is open?

    b. Is every child expected to toothbrush every day they attend nursery?

    c. How does this account for different attendance patterns in nurseries?

    e.g.

    - children who attend only morning sessions;
    - children who attend only afternoon sessions;
    - children who attend two full days per week.

10. Is it expected that all children attending nurseries will participate in toothbrushing?

    a. If no, why not?

    b. Which children would / would not be expected to take part?

11. Considering all points discussed: do you have any changes to make to this outcome?

Activities

Primary activity

All nurseries provide access to toothbrushing to three- and four-year old children attending, on a daily basis

Questions

12. Do you agree that this describes the primary activity of the nursery toothbrushing programme?

    a. If no, why not?

    b. Do you have any changes to make to this activity?

Supporting activities

Establish partnerships with Education (at the local authority level; with individual establishments; with individual staff members)
Education staff involved in supervising toothbrushing are trained by Childsmile staff; training covers effective toothbrushing & infection control procedures
Local Childsmile teams provide regular support to education staff to deliver toothbrushing; monitor delivery of toothbrushing in establishments (twice per year); and supply appropriate resources (toothbrushes & toothpaste)

13. Do you agree that these activities should be included in the logic model?

    a. Why / why not?

14. Are all required levels of partnership with Education covered? What about at the national level?

15. Have partnerships with Education been successfully established?

a. Have there been any difficulties in establishing relationships with education partners?

b. What have been the facilitators when establishing relationships with education partners?

16. Monitoring currently takes place twice per year:

    a. Do you think this is adequate?

    b. Should it take place more / less often?

17. CS staff use a checklist to monitor toothbrushing delivery against the toothbrushing standards *[provide respondent with copy of checklist, Appendix 1]*

    a. Do you think the items covered are appropriate?

    b. Is there anything that should be amended / added?

    c. How do you think delivery of each of these items should be monitored? (e.g. discussion with education staff; direct observation of delivery?)

    d. How do you think any issues observed during monitoring visits should be addressed? Whose responsibility is this?

18. In addition to monitoring visits, CS staff are expected to provide support to establishments:

    a. What should this consist of?

    b. How often should it be provided?

19. What do you think should be covered in the training received by education staff who supervise toothbrushing?

20. How often should education staff receive this training?

21. Should there be a standardised, national approach to training for toothbrushing supervisors?

a. Why/why not?

22. Is there anything you would change / add to the descriptions of these activities?

23. What do you feel have been the main challenges/barriers to implementing the toothbrushing programme in nurseries (as shown in the logic model)?

    a. For education staff

    b. For operational CS staff

    c. For the programme as a whole

24. Are there additional activities that should be included in the logic model for the nursery toothbrushing programme?

    - *Prompts:*

        - Additional training for nursery staff?

        - Training for children (e.g. appropriate use of equipment and toothbrushing techniques)

Short-term outcomes

Children use appropriate toothbrushing techniques and brush their teeth for at least two minutes
Children establish good oral hygiene routines within early learning & childcare settings
Toothbrushing is an integral part of health & wellbeing activities in ELC settings, with early years education professionals invested in the toothbrushing programme and effectively supporting children to maintain their oral health

Considering each short-term outcome:

25. Do you think these outcomes should be included in the logic model?

a. If no, why not?

26. Do these outcomes accurately reflect what the programme is trying to achieve?

    a. If no, why not?

27. Would you suggest any changes to these outcomes?

28. Do you think these outcomes are likely to be achieved through the activities included in the logic model?

    a. Why / why not?

    b. Are there any additional activities required to achieve these outcomes?

29. Does current training / supervision enable education staff to demonstrate and check that children use appropriate toothbrushing techniques?

    a. If yes, please give further information

    b. If no, do you think this is required? Why/why not?

Interim outcomes

More children in Scotland are exposed to appropriate levels of fluoride through brushing their teeth in ELC settings
Children develop skills and motivation to maintain their oral health

30. Do you think these outcomes should be included in the logic model?

31. Do these outcomes accurately reflect what the programme is trying to achieve?

    a. Regarding children developing skills and motivation to maintain their oral health: do you think this only applies to their behaviour in ELC settings? Or more widely (i.e. in the home)?

b. What do you think is the main mechanism of the nursery toothbrushing programme: as a vehicle to get fluoride on to children's teeth; or to produce toothbrushing skills / motivation / behaviours used outside of the nursery setting?

32. Would you suggest any changes to these outcomes?

33. Do you think these outcomes are likely to be achieved through the activities included in the logic model?

    a. Why / why not?

    b. Are there any additional activities required to achieve this?

Long-term outcomes

Prevent dental decay in children in Scotland
Fewer children (and their families) experience the negative effects of dental decay (e.g. pain, time off school/work, impact on quality of life etc)
Reduced cost of dental treatments (e.g. dental extractions under general anaesthetic)
Address oral health inequalities among children

34. Do you think these are appropriate long-term outcomes for the nursery toothbrushing programme?

35. Does this accurately reflect what the programme is trying to achieve?

36. Would you suggest any changes to these outcomes?

37. Do you think the activities included in the logic model will contribute to these outcomes?

    a. Why / why not?

    b. How will this happen?

c. Are the linkages shown between interim and long term outcomes reasonable?

Considering the logic model as a whole:

38. Do you think this vision for the nursery toothbrushing programme shared throughout the programme:

    a. with other strategic stakeholders?

    b. with operational Childsmile staff?

    c. with education staff?

39. To what extent does programme delivery in reality match the activities and outcomes set out in the logic model?

40. If programme delivery does not match:

    a. What is different?

    b. Why have these differences arisen?

41. Are you aware of any unintended consequences or outcomes (positive or negative) arising from the toothbrushing programme in nurseries?

42. Is there anything you think should have been done differently, or should now be done differently, in implementing the nursery toothbrushing programme?

    a. By strategic-level stakeholders

    b. By operational stakeholders (CS staff; education staff)

Appendix 9: Survey to quantify participation in the nursery supervised toothbrushing programme, 2019

Data Collection Form

PART A: To be completed by CS team member during visit to establishment

Establishment name:		Date completed:	
Postcode:		Completed by (CS team member):	
Unique ID:			

- Thinking of toothbrushing in your nursery, to what extent do you agree with the following statement? (please tick an answer for **each age group**)

"All children attending this nursery have the opportunity to brush their teeth every day they attend"

Under 2s	Disagree ☐	Not sure ☐	Agree ☐	N/A: under 2s do not attend ☐
2 year olds	Disagree ☐	Not sure ☐	Agree ☐	N/A: 2 year olds do not attend ☐
3 and over	Disagree ☐	Not sure ☐	Agree ☐	

- If you answered “Disagree” or “Not Sure” for any age group in Q1:

  Please explain *when* and *why* children do not always have the opportunity to brush every day they attend (continue over the page if necessary...)

(e.g. due to outdoor play sessions one day per week; or brushing happens in the morning only therefore children attending afternoons only miss out)

- What are the main challenges to offering toothbrushing to children attending your nursery?

- What helps you to offer toothbrushing to children attending your nursery?

PART B: To be completed by member of staff in the establishment, on the date indicated

Establishment name:	
Postcode:	
Unique ID:	

Date to undertake count:	
Completed by (establishment staff member):	

	How many children[19] are expected to attend on the day of the count?[20]	How many children are present on the day of the count?	How many children brushed on the day of the count?	How many children present on the day of the count were opted out of toothbrushing?
Under 2s				
2 year olds				
3 and over				

[19] For each column, this should be a combined total for all children who usually attend on the day of the count (e.g. if there are separate morning and afternoon sessions, information for both sessions should be recorded). Each child should be recorded only once.

[20] This number should include children who are recorded as absent, but who would usually attend on the day of the count.

Guidance for Childsmile staff

A key aim of the Childsmile nursery toothbrushing programme is that every child has the opportunity to brush their teeth, every day they attend nursery. However, we are aware from process evaluation data that not all children have the opportunity to brush their teeth every day they attend.

To make programme improvements to support nurseries to deliver the toothbrushing programme, we want to gather further information on the challenges and facilitators to delivering toothbrushing to every child, every day they attend. In addition, the Scottish Government has requested data on the numbers of children toothbrushing in nurseries and schools every day, throughout Scotland.

Instructions for completion

Part A

This should be completed by the CS team member during a visit to the establishment, between the **start of spring term in January 2019 and the end of summer term in June/July 2019**

Inform nursery staff that the purpose of this exercise is to inform programme improvements and that identifiable data for individual nurseries will not be shared with the Scottish Government or Care Inspectorate.

Complete the establishment details (name, postcode, unique ID as recorded on HIC); date completed; and your name.

Q1: For each age group, ask the nursery staff member to what extent they agree with the statement *"All children attending this nursery have the opportunity to brush their teeth every day they attend"* and record the answer 'Disagree', 'Not Sure' or 'Agree'

If there are no under 2s or 2 year olds attending the nursery, please circle the appropriate 'N/A' box.

Q2: If the nursery staff member answered 'Disagree' or 'Not Sure' for any age group in Q1, ask when and why children do not always have the opportunity to brush their teeth every day they attend the nursery. (The examples given relate to outdoor play sessions or toothbrushing only happening at one point during the day, but please record all reasons given by the nursery staff.)

Q3: Ask about the main challenges to offering toothbrushing to children attending the nursery.

Q4: Ask about what helps nursery staff to offer toothbrushing to children attending the nursery.

For questions 2, 3 & 4: please record the answers given by nursery staff accurately and in full.

Part B

This should be left with the establishment to complete.

The Childsmile team member should pre-complete the establishment name, postcode, unique ID, and date for which the numbers should be recorded - this should be the day following your visit to the establishment (for visits on a Friday, the date should be the following Monday).

The Childsmile team member should go through this section of the form with the nursery staff member during their visit, to ensure that they understand the information to be recorded, i.e.:

- Number of children expected to attend on the specified date (which should include children who are recorded as absent, but who would usually attend on the day of the count);

- Number of children present on the specified date

- Number of children who brushed their teeth on the specified date.

- Number of children opted out of the toothbrushing programme.

For each of these, the combined total for all children who usually attend on the specified date should be recorded (e.g. information for both morning and afternoon sessions should be recorded); each child should be recorded only once.

If necessary, follow up with the establishment to ensure they have completed Part B of the form and remind them to return it.

Returning completed forms

Part A should be returned to your Childsmile coordinator after your visit to the establishment.

Nursery staff should return Part B per local procedures (to be agreed with your Childsmile coordinator); please ensure that nursery staff know how to return this information.

Guidance for nurseries

A key aim of the Childsmile nursery toothbrushing programme is that every child has the opportunity to brush their teeth, every day they attend nursery. However, we are aware from process evaluation data that not all children have the opportunity to brush their teeth every day they attend.

To make programme improvements to support nurseries to deliver the toothbrushing programme, we want to gather further information on the challenges and facilitators to delivering toothbrushing to every child, every day they attend. In addition, the Scottish Government has requested data on the numbers of children toothbrushing in nurseries and schools every day, throughout Scotland.

The Childsmile team member linked to your establishment will discuss these questions with you (Part A of the form) and record your answers.

We would encourage all establishments to use this opportunity to provide feedback to the Childsmile programme in order that we can identify programme improvements that are required.

Part B of the form will be left with you, to complete numbers of children expected to attend, who actually attended, who brushed their teeth, and who were opted out of the toothbrushing programme, on the date specified. (The Childsmile team member will provide an explanation of the data sought, and the date for which this information should be collected, during their visit.)

Once you have completed the form, please return it to your local Childsmile team via *[to be added by CS coordinator depending on local procedure]*.

Data collected through this exercise will be used for purposes of programme development and improvement only. All identifiable information will be removed before the data are aggregated and no identifying data will be shared with our partners (e.g. Scottish Government or Care Inspectorate).

If you have any questions about how this data will be used, please contact:

Jenny Eaves, Childsmile Regional Researcher jennifer.eaves@nhs.net

Completeness of form one data (survey to quantify participation in the nursery supervised toothbrushing programme)

The purpose of form one used in the survey to quantity nurseries' participation in the toothbrushing programme was to gather information from individual nurseries on whether all children were offered the opportunity to brush their teeth, every day they attended, alongside the main challenges and facilitators to delivering the nursery supervised toothbrushing programme. Taking each question from form two in turn, the following completed data were received and included in analyses:

Table 30 Completion of toothbrushing survey data: Form one

		No. of potential responses	Completed responses received and included in analyses	
		P	*No.*	*% of P*
Q1: **To what extent do you agree with the statement: *"All children attending this nursery have the opportunity to brush their teeth every day they attend"***	*Under-twos*	813	725	89.2
	Two-year-olds	1305	1211	92.8
	Three-year-olds and over	2583	2492	96.5
Q2: **Please explain when and why children do not always have the opportunity to brush every day they attend**		389[21]	385	99.0
Q3. **What are the main challenges to offering toothbrushing to children attending the nursery?**		2610	2189	83.9
Q4: **What helps you to offer toothbrushing to children attending the nursery?**		2610	2296	88.0

[21] The number of potential responses is all nurseries indicating '*Disagree*' or '*Not Sure'*, for any age group, in response to Q1 ('To what extent do you agree with the statement: *"All children attending this nursery have the opportunity to brush their teeth every day they attend*" ')

Appendix 10: Post-pandemic survey of nurseries

Survey questions

Remobilising the Childsmile Nursery Supervised Toothbrushing Programme

1. What is the name of your nursery?
2. What is the postcode of your nursery?
3. Thinking of toothbrushing in your nursery, to what extent do you agree with the following statement?

   "Children in this age group, attending this nursery, have the opportunity to brush their teeth every day they attend"

Under 2s:	Disagree	☐	Agree	☐	Not sure	☐	N/A: under 2s do not attend	☐
2-year-olds:	Disagree	☐	Agree	☐	Not sure	☐	N/A: 2-year-olds do not attend	☐
3-year-olds and over:	Disagree	☐	Agree	☐	Not sure	☐	N/A: 3-year-olds and over do not attend	☐

4. If you have selected **'Disagree'** or **'Not sure'** for any age group:

Please indicate why this age group does not have the opportunity to brush every day they attend

(otherwise please leave blank and continue to next question)

	Add **X** to all that apply
Challenging to fit into nursery's routines	
Lack of staffing	
Children's attendance patterns	
Children requiring additional support (e.g. due to developmental stage, additional support needs, behavioural needs)	
Number of children attending	
Limited space or facilities	
Toothbrushing is incompatible with other guidance / policies	
Concerns about hygiene and cross-infection	
Other	
If you selected 'Other': please specify:	

5. What are the main challenges to offering toothbrushing to children attending your nursery?

	Add **X** to all that apply
Children's attendance patterns	
Children are reluctant or refuse to take part	
Children requiring additional support (e.g. due to developmental stage, additional support needs, behavioural needs)	
Parents/carers do not support the toothbrushing programme	
Lack of staffing available in the nursery	
Limited space/facilities available in the nursery	
Number of children attending makes it unmanageable	
Nursery staff feel unable to deliver toothbrushing programme	
Problems receiving adequate/sufficient toothbrushing resources (toothbrushes/toothpaste/racks)	
Challenging to fit into the nursery routine	
Toothbrushing is not a priority within the nursery routine	
Toothbrushing is too time-consuming	
Keeping track of who has brushed is challenging	
Toothbrushing is incompatible with advice/guidance from other organisations	
Concerns about hygiene and cross-infection	
Other	
If you selected 'Other': please specify:	

6. Has the Covid-19 pandemic added any other barriers to offering toothbrushing in your nursery?

Yes ☐ **No** ☐

If yes:

Please provide details of the impact of the Covid-19 pandemic on delivering the supervised toothbrushing programme.

7. What helps you to offer toothbrushing to children attending your nursery?

	Add **X** to all that apply
Children's attendance patterns	
Children are keen to take part	
Parents/carers support the toothbrushing programme	
Sufficient staffing available in the nursery	
Nursery has appropriate facilities/space	
Number of children attending makes it manageable	
Nursery staff feel able to deliver toothbrushing programme	
Nursery staff have received training to support toothbrushing	
Adequate/sufficient toothbrushing resources (toothbrushes/toothpaste/racks) are provided	
Toothbrushing resources are provided free-of-charge	
Toothbrushing is established as part of the nursery routine	
Support provided by Childsmile staff	
Other	
If you selected 'Other': please specify:	

8. Do you have any other comments on the challenges or facilitators to delivering the supervised toothbrushing programme in your nursery?

Characteristics of nurseries returning data

Table 31 sets out the characteristics of nurseries completing the post-pandemic survey in relation to type of nursery (local authority or private/voluntary sector); range of age groups attending (only one age group; or multiple age groups); area-based deprivation of nursery (identified using the 2020 version 2 SIMD); and geographical health board area in which the nursery is based.

Table 31 Characteristics of nurseries completing the survey (post-pandemic)

Category		N	% of all nurseries completing survey (n=654)
Type of nursery	Local authority	436	66.7
	Private / voluntary sector	217	33.2
Age range attending nursery [22]	One only [23]	312	47.7
	More than one [24]	342	52.3
Area-based deprivation (SIMD quintile)	1 (most deprived)	125	19.1
	2	136	20.8
	3	152	23.2
	4	128	19.6
	5 (least deprived)	109	16.7
	not known	4	0.6
Geographical area (health board) [25]	A&A	26	4.0
	Borders	27	4.1

[22] Overall, 231 (35.3%) nurseries had under 2s attending; 333 (50.9%) nurseries had 2-year-olds attending; and 649 (99.2%) nurseries had three-year-olds and over attending.

[23] All 312 nurseries with only one age group had only three-year-olds and over attending.

[24] Of nurseries with more than one age group attending: 63.5% (217) had all three age groups (under-twos; two-year-olds; and three-year-olds and over) attending; 32.5% (111) had two-year-olds and three-year-olds and over attending; 1.5% (5) had under-twos and two-year-olds attending; and 2.6% (9) had both under-twos and three-year-olds and over attending.

[25] No responses were received from nurseries in NHS Fife or NHS Tayside health board areas.

Category		N	% of all nurseries completing survey (n=654)
	D&G	40	6.1
	Forth Valley	34	5.2
	Grampian	116	17.7
	GGC	165	25.2
	Highland	58	8.9
	Lanarkshire	88	13.5
	Lothian	79	12.1
	Islands (Orkney, Shetland, Western Isles)	21	3.2

Appendix 11: Overview of the Childsmile Process Evaluation

Table 32 Overview of Childsmile process evaluation fieldwork, tranches 1-6 (2010-2016)

Tranche	Period covered in data collection	Participants	Topics covered
1	August 2010-July 2011	CS coordinators (14 health boards) DHSWs (14 health boards) EDDNs (9 health boards, West & North regions) CS Executive members (1 Director; 3 programme managers)	*Programme implementation* *Staffing* *Contextual factors* *Logic model activities* *Potential impacts on intended outcomes*
2	August 2011-July 2012	CS coordinators (14 health boards) CS Executive (3 programme managers)	*Programme implementation & delivery* *Barriers & facilitators* *Fidelity to the logic model*
3	August 2012-July 2013	CS coordinators (14 health boards) CS Executive (3 programme managers)	*Programme implementation & delivery* *Barriers & facilitators* *Fidelity to the logic model*
4	August 2013-July 2014	CS coordinators (14 health boards) DHSWs (14 health boards) EDDNs (14 health boards) CS Executive (2 Directors; 3 programme managers)	*Programme implementation & delivery* *Barriers & facilitators* *Fidelity to the logic model*

Tranche	Period covered in data collection	Participants	Topics covered
5	August 2014-July 2015	CS coordinators CS Executive (2 Directors; 2 programme managers)	*Programme implementation & delivery* *Barriers & facilitators* *Fidelity to the logic model*
6	August 2015-July 2016	CS coordinators (14 health boards) *(No interviews with CS Executive members carried out for this tranche)*	*Programme implementation & delivery* *Barriers & facilitators* *Contextual factors* *Fidelity to the logic model* *Programme outcomes*

Coding framework for Childsmile Process Evaluation data

Relevant sections of data were coded to each node-level shown in Figure 14, to reflect: i) the a priori themes (derived from the aims of the process evaluation); ii) emergent themes derived from the data; iii) the programme component that the section of data referred to; and iv) the role(s) referred to within the section of data. Figure 14 provides further detail on the nodes included in each level.

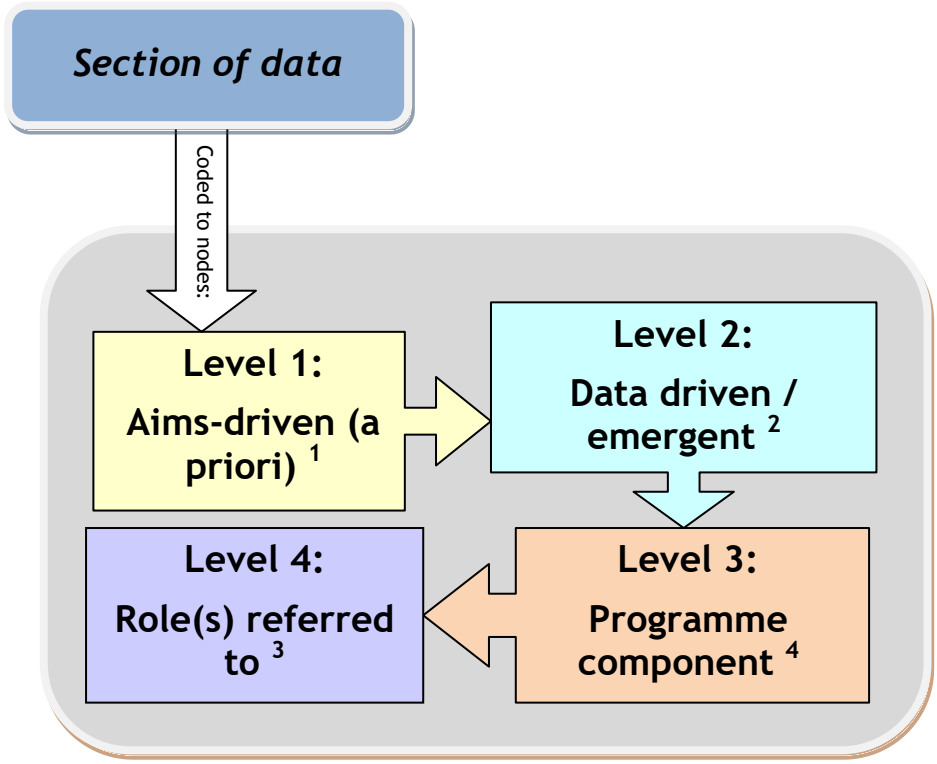

Figure 14 Node levels used for coding Childsmile Process Evaluation data

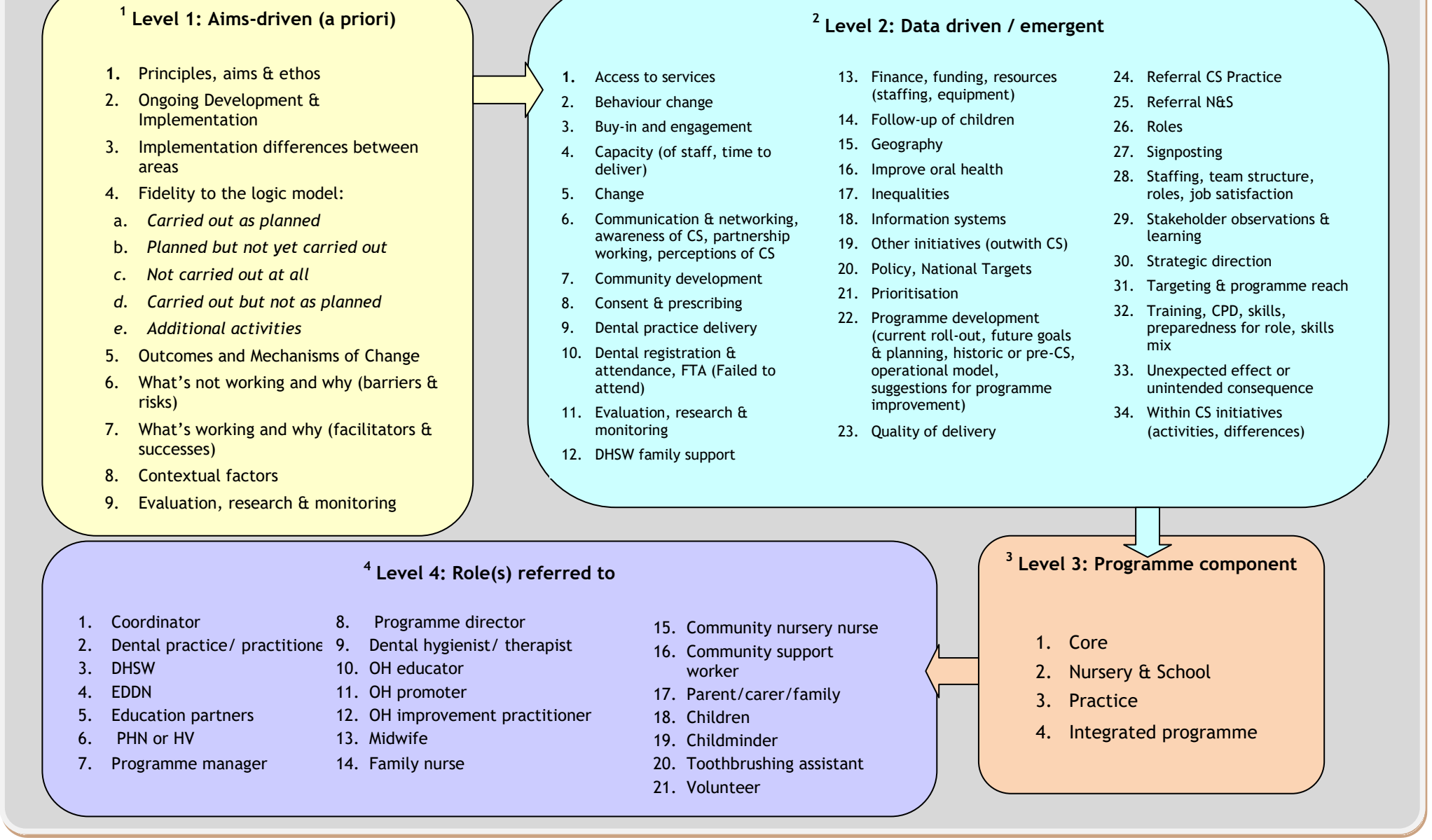

Figure 15 Details of nodes included in each level of the Childsmile Process Evaluation coding framework

Appendix 12: Exploring delivery of the nursery supervised toothbrushing programme in reality (compared with intended Theory of Change)

Interview Topic Guide for Childsmile Coordinators:

Exploring delivery of the nursery supervised toothbrushing programme in reality (compared with intended programme theory)

The purpose of these interviews is to map out how the toothbrushing programme in early learning & childcare settings is delivered in each health board; and to identify factors affecting its delivery in each area.

1. In your view, is delivery of the toothbrushing programme in nurseries in your area taking place as shown in the logic model?
    a. If yes: what has helped you to implement and deliver toothbrushing in nurseries as intended?
    b. If no: why not?
2. What have been the main barriers to implementing and delivering toothbrushing in nurseries?
    a. e.g. Has there been any difficulties in establishing relationships with education partners?
    b. How can these barriers be addressed?
    c. Have you attempted to address these barriers? What happened?
3. What have been the main facilitators to implementing and delivering toothbrushing in nurseries?
    a. What have been the facilitators when establishing relationships with early learning and childcare partners? (e.g. at local authority level; individual nursery level)
    b. How are these relationships developed and maintained?

4. Is toothbrushing available in 100% of nurseries in your area?
    a. Why / why not?
    b. Does this include nurseries that are: local authority; private; partnership- provider? Any other early learning & childcare settings in your toothbrushing programme? (e.g. childminders)
5. Do all children attending nurseries participate in toothbrushing?
    a. If no, why not?
    b. Which children would / would not be expected to take part?
6. What do you understand 'supervised toothbrushing' to mean? (i.e. what do you think supervision of toothbrushing involves?)
    a. Is supervision of toothbrushing adequately defined / described within the programme (e.g. programme documents)?
    b. Do you think toothbrushing is being adequately supervised in participating nurseries in your area?
7. What do you understand toothbrushing 'on a daily basis' to mean?
    d. Does each nursery offer toothbrushing every day it is open?
    e. Does every child toothbrush every day they attend nursery?
    f. What impact does different attendance patterns have? (e.g. children who attend only morning sessions; children who attend only afternoon sessions; children who attend two full days per week.)
8. What age group of children attending nurseries do you include in the toothbrushing programme in your area? (i.e. limited to 3- and 4-year olds, or under-threes also included?)
    a. If under-threes are included: is delivery different for these children? (e.g. 'assisted' or 'supported' toothbrushing)

   b. What implications does this have e.g. for training nursery staff; monitoring?

9. Do you think that current arrangements for monitoring delivery of toothbrushing in nurseries are adequate?

   a. E.g. frequency (twice per year) – more or less often?

   b. Content of monitoring visits (e.g. checklist to monitor toothbrushing delivery against the toothbrushing standards) – should anything be amended / added?

10. How is delivery monitored in your area?

   a. How are issues identified during monitoring visits addressed? Whose responsibility is this?

11. In addition to monitoring visits, CS is expected to provide support and training to establishments:

   c. What does the training consist of?

   d. Do you think it should cover anything else?

   e. How often should it be provided?

Interview Topic Guide for Childsmile Coordinators: Exploring progress towards reimplementation of the toothbrushing programme

Purpose: To explore local progress towards re-implementing the Childsmile toothbrushing programme in educational establishments in Scotland, following its suspension due to the COVID-19 pandemic.

Background information

1. Could you please give your name, job title, geographical area covered and give a brief overview of your role within Childsmile.

COVID-19: impact

2. Overall, how has COVID-19 impacted on delivery of the toothbrushing programme in your area?

    a. prompt for: stopping toothbrushing prior to establishment closures; feedback received about continuing brushing at start of pandemic

3. What has been your role in working towards re-implementing the toothbrushing programme in your area?

4. What do you anticipate the key barriers will be to re-implementing the toothbrushing programme in establishments in your area?

    a. Have there been any concerns raised about reinstating the toothbrushing programme? (prompt for what the concerns are, who raised them & when)

    b. Have establishments been in contact with you to request equipment & resources, or for any other reason?

5. In your opinion, what information do you think that parents/carers; local authority education departments; establishment staff etc. will need to be reassured / have confidence about restarting the toothbrushing programme?

COVID-19: Addendum to the National Toothbrushing Standards

The addendum to the National Toothbrushing Standards (produced in response to the COVID-19 pandemic) was published on 28 July 2020. An accompanying 'Frequently Asked Questions' document to support Childsmile teams was also developed.

6. What are your views on the addendum to the toothbrushing standards and the accompanying FAQs?
    a. Do you think the advice within the addendum is appropriate?
    b. Do you think the appropriate organisations / stakeholders were included in the process?
    c. Do you have any comments about the process of developing and reviewing the addendum to the Standards?
    d. Are you assured that the guidance within the addendum is robust?
7. Does the guidance provided meet the needs you identified previously? (via the Core PE survey – completed July/August 2020)
    a. If no – which concerns are outstanding?

Utilising the addendum

8. Does the addendum / FAQs provide adequate support to communicate with your staff about re-implementing the toothbrushing programme?
    a. Have your staff given feedback on the addendum / FAQs? e.g. has this provided reassurance / increased confidence about restarting the toothbrushing programme?
    b. Do your staff feel able to utilise the guidance to support establishments with restarting the toothbrushing programme?

Communicating with local authorities / establishments about restarting toothbrushing

9. Who would you normally liaise with in local authorities in relation to the toothbrushing programme? *(prompt for how often they communicated, did this support Childsmile team in working with establishments?)*

10. Have you communicated with contacts in local authority education departments and/or individual establishments regarding the addendum or restarting toothbrushing?

    a. If yes, who did you communicate with?

    b. How did you do this?

    c. Have you followed this up with any further discussion?

11. Have you received any feedback from LA contacts and/or individual establishments regarding the addendum; restarting the toothbrushing programme more generally?

    a. If yes, please provide details;

        i. What are the LAs' / establishments' views about restarting the toothbrushing programme – perceived challenges etc

        ii. Have your LA / establishment contacts indicated their plans regarding restarting the toothbrushing programme?

    b. If no, do you have any plans to seek this feedback?

12. Are you aware of any other communication regarding the toothbrushing programme being sent to educational establishments from sources other than the Chilsmile team (e.g. local authorities)

    a. If yes, what has been communicated to establishments? Has this supported or hindered progress towards re-implementing the toothbrushing programme?

Childsmile staffing

13. *[if relevant]:* Have your staff who oversee delivery of the toothbrushing programme returned from redeployment?

    1. If no, what are your plans for having staff return to Childsmile duties?

14. Do you foresee any difficulties in relation to having adequate staffing to support reimplementation of the toothbrushing programme?

Implementing the amended model of delivery

The addendum specifies that the dry model of toothbrushing (i.e. not using sinks) should be adopted in all establishments.

15. Do you have a clear picture of what is required to re-implement the toothbrushing programme?

    a. If no, what is unclear?

16. Which model was previously used in establishments in your area? (i.e. all / mainly wet brushing; mixture of both; all / mainly dry brushing)

    a. If establishments in your area previously used the wet model of brushing – do you anticipate any difficulties in moving to the dry brushing model?

        i. If yes, please give further details.

17. Do you have plans to carry out the following activities (taking into account current restrictions e.g. limited opportunities to visit establishments in person)?

    a. Training establishment staff to deliver the amended model for toothbrushing

    b. Monitoring visits

    c. Delivering toothbrushing resources

d. General support for staff in nurseries/schools

18. Overall do you / your staff feel able to support establishments to restart the toothbrushing programme at this time?

As noted, the national Childsmile programme has developed the addendum to the National Toothbrushing Standards and an accompanying FAQs document to support reimplementation of the toothbrushing programme, with plans to develop communication with stakeholders (e.g. head teacher letters).

19. Aside from the actions noted above, is there any other support or guidance from the national Childsmile programme that you require?

20. Looking forward, what if any, long term impact do you expect COVID-19 to have on delivering the programme? (e.g. in terms of PPE, social distancing, toothbrushing standards, school attendance)

21. Is there anything else you would like to tell us about re-implementing the toothbrushing programme?

Appendix 13: Information and consent form for fieldwork with programme stakeholders during Covid-19 pandemic

PARTICIPANT INFORMATION SHEET **V2, 03/09/20**

Re-implementing the Childsmile toothbrushing programme in educational establishments in Scotland following its suspension due to the COVID-19 pandemic.

You are invited to take part in research to support the re-implementation of the Childsmile toothbrushing programme in educational establishments in Scotland. This research is being carried out to support national Childsmile programme developments as well as contributing to a PhD project. Before you decide if you would like to take part, please read the following information and ask the researcher if anything is unclear or if you would like more information. You will be given a copy of this Participant Information Sheet if you decide to take part.

What is the research about?

Preventing dental decay in children is the main focus of the Scottish Government's Childsmile programme, which includes supervised toothbrushing in educational settings throughout Scotland. The toothbrushing programme was suspended in all establishments from March 2020 due to the closure of nurseries and schools as part of the Scottish Government's response to the COVID-19 pandemic. Now that nurseries and schools have reopened and the national Childsmile programme has begun to progress plans for remobilising Childsmile delivery, we would like to find out about local plans for restarting toothbrushing as well as identify any anticipated challenges to this.

What will happen if I choose to take part?

We would like to speak with coordinators overseeing local Childsmile delivery. If you agree to take part, we may ask you to give specific, separate consent to one or more of the following activities, all of which will be carried out by the researcher named below. Giving your consent to one does not imply you consent to another activity:

- An audio-recorded, in-depth **interview**
- An audio-recorded **focus group** with colleagues
- A **direct observation** of you carrying out ordinary duties and tasks during a nursery session
- A **knowledge exchange workshop** to discuss findings and recommendations

What is the project trying to achieve?

The aim is to map progress across Scotland in re-implementing the toothbrushing programme in educational establishments and to identify potential challenges to achieving this, view to identifying strategies to optimise toothbrushing delivery in nurseries.

What will we do with the information we collect?

Please be assured that all views are welcome and all information collected from you, responses provided during interviews and focus groups or recorded during observations, will be kept strictly confidential. No identifiable data will be shared with any external organisations.

You will be identified by an ID number and all personally identifiable information (e.g. your name, workplace etc) will removed so that you cannot be recognised from it. Any data in paper form will be stored in locked cabinets in rooms with restricted access at University of Glasgow Dental School. All data in electronic format will be stored on secure, password–protected computers. No one outside of the research team or appropriate governance staff will be able to find out your name, or any other information, which could identify you. All study data will be held in accordance with the General Data Protection Regulation (2018).

What are the possible benefits of taking part?

There are no direct benefits. However, taking part in an interview or focus group will provide the opportunity to discuss issues of interest or concern and will inform the development of strategies to support the re-implementation of the Childsmile toothbrushing programme.

Do I have to take part?

No, it is up to you to decide whether or not to take part. If you do choose to take part, you will be given this information sheet to keep and be asked to sign a consent form. After deciding to take part you are still free to withdraw at any time and without giving a reason.

Contact for further information

This research is part of the national evaluation of Childsmile, funded by the Scottish Government:

Name of researcher Jennifer Eaves

Telephone 01592 226886 Email jennifer.eaves@nhs.scot

If you are willing to participate, please complete the attached consent form.

CONSENT FORM **V2, 03/09/20**

Re-implementing the Childsmile toothbrushing programme in educational establishments in Scotland following its suspension due to the COVID-19 pandemic.

	Please initial box
I confirm that I have read and understood the Participant Information Sheet (Version 2, 03/09/20)	
I have had the opportunity to think about the information and ask questions, and understand the answers I have been given	
I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected	
I confirm that I agree to the way my data will be collected and processed	
I am aware that excerpts from the focus group/interview may be included in the reports and/or publications to come from this research, with the understanding that any such quotations will be anonymous	
I understand that all data and information I provide will be kept confidential and will be seen only by study researchers and regulators whose job it is to check the work of researchers	
I agree to participate in this study	
I agree to have my focus group/interview audio-recorded	

Name of participant	Date	Signature
Researcher	Date	Signature

Appendix 14: Surveys of Childsmile coordinators and teams (during pandemic)

Initial impact of Covid-19 pandemic on the Childsmile toothbrushing programme (March-June 2020)

1. Overall, how has COVID-19 impacted on delivery of the toothbrushing programme in your area?
   E.g. including pack deliver monitoring of establishments, provision of OHE to children etc.

1. PRIOR to nurseries and schools closing in March 2020, there were reports of concerns being raised around the perceived risks associated with Coronavirus and delivery of the toothbrushing programme?
2. Who raised concerns regarding the toothbrushing programme PRIOR to school closures in March 2020?
3. What was the nature of the concerns raised about toothbrushing PRIOR to school closures (March 2020)?
4. Did nurseries and schools in your area STOP toothbrushing PRIOR to the closure of education establishments on 20th March 2020?
5. For those establishments that stopped toothbrushing PRIOR to school closures in March 2020, was this as a result of concerns raised? Please explain
6. What impact, if any, has the pausing of the programme had (or likely to have) on resources and/or storage capacity? Please explain
7. Have establishments been in contact with you during this period with requests for equipment/resources or for any other reason?
8. Please explain the reasons for which establishments have been in contact during the COVID-19 pandemic
9. Looking forward, what if any, long term impact do you expect COVID-19 to have on delivering the programme? E.g. in terms of PPE, social distancing, toothbrushing standards, school attendance patterns etc.
10. What do you anticipate the key barriers will be to re-introducing the toothbrushing programme in establishments in your area?

11. Have there been any recent concerns raised with regards to RE-INSTATING the toothbrushing programme in your area?
12. Who has raised concerns regarding the re-instatement of the toothbrushing programme?
13. Please explain further what the nature of the concerns have been regarding the re-instatement of the toothbrushing programme?
14. In your opinion, what do you think that parents/carers, education, establishment staff etc. will need to be informed about in order to be reassured and have confidence in the safe delivery of the toothbrushing programme?
15. And finally, what guidance or support can the national programme provide to help you to re establish the toothbrushing programme in your area?

Remobilisation of the Childsmile toothbrushing programme (May 2021)

1. Since we last spoke to you, there has been a resurgence of COVID-19, which led to nurseries and schools closing to all apart from vulnerable and key workers' children between January and March 2021, as well as increased demand for health services.

   Over and above the nursery and school closures: Have these developments had any impact on your ability to plan/restart the toothbrushing programme?

   If yes, please explain

2. Between the last time we spoke to you, and the school/nursery closures in January 2021, have you made any progress with your plans to restart the toothbrushing programme in nurseries and schools?

   If yes, please give details on the progress you have made

   If no, what has prevented you from progressing your plans?

3. Have you made any plans for restarting the toothbrushing programme since January 2021?

   If yes, please explain the plans you have put in place since January 2021?

   If no, what has prevented you from putting plans in place during this period?

4. Since our previous discussion, do you have any updates on establishments' views on restarting the programme?

   If yes, what feedback have you received from establishments about restarting the toothbrushing programme?

5. Since our previous discussion, have any more establishments started brushing?

   If yes, how many establishments have started brushing:

   since our previous discussion

   in total

6. What were the views of those establishments about restarting brushing?

7. Since our previous discussion, has there been any establishments that have refused to restart brushing?

   If yes, what were their reasons for not restarting brushing in the establishment?

8. Children attending nursery and Primary 1-3 returned to school on 22 February 2021 and children in P4-P7 on the 15th March 2021.

   What are your plans for revisiting the restart of the toothbrushing...

9. Have you encountered any further barriers to restarting toothbrushing from local authority education departments?

   If yes, please explain what the barriers are

10. Have you encountered any further barriers to restarting toothbrushing from individual establishments?

    If yes, please explain what the barriers are?

11. Have you encountered any further barriers to restarting toothbrushing from parents/carers?

    If yes, please explain what the barriers are?

12. Please add any facilitators/successes about restarting the programme that you would like to share below

13. Since our last discussion, have any members of your Childsmile team provided feedback about restarting the toothbrushing programme?

    If yes, please provide details

14. Since our last discussion, have any members of your team returned to Childsmile from redeployed roles?

    If yes, how have these staff adjusted to returning to their Childsmile role?

15. Following their return to Childsmile roles, have any members of your team been redeployed again due to the resurgence of the pandemic?

    If yes, how have these staff reacted to their redeployment?

16. As we move through the final term of the academic year 2020/2021, have you begun planning for the new school year 2021/2022?

If yes:

How have these plans developed?

Are the plans different to those for the current school year?

17. What do you think will be the long-term impacts of Covid-19 on the toothbrushing programme?

Appendix 15: Mapping emergent themes on to CFIR domains and constructs

The Consolidated Framework for Implementation Research (CFIR) consists of five domains, each of which comprises a number of constructs and sub-constructs related to the factors influencing implementation. Table 33 sets out how emergent themes arising from qualitative data gathered for this research were mapped to relevant CFIR domains and constructs, which are colour-coded by domain as shown in the key:

Key

	CFIR Domain
	Intervention Characteristics
	Characteristics of Individuals
	Inner Setting
	Outer Setting
	Process of Implementation

Table 33 Mapping emergent themes on to CFIR domains and constructs

Emergent themes (arising from data)	*Sub themes*	CFIR Domain	CFIR Construct	*sub-construct*
Fitting it into nursery's schedule & routines	*Time required for toothbrushing vs. time available within nursery session*	Inner Setting	Readiness for Implementation	*Available resources*
			Implementation Climate	*Compatibility*
	Staff in nurseries view toothbrushing as too time-consuming	Intervention Characteristics	Complexity	
		Characteristics of Individuals	Knowledge & Beliefs about the Intervention	
	Priority given to other activities vs. Toothbrushing; OR Toothbrushing fits well with other aspects of nursery curriculum	Inner Setting	Implementation Climate	*Relative priority*
	Toothbrushing has been established as part of nursery routine	Inner Setting	Implementation Climate	*Compatibility*
Staffing and training: in nurseries	*Lack of staff available to support toothbrushing (e.g. absence, turnover etc); OR Staff are available to support toothbrushing*	Inner Setting	Readiness for Implementation	*Available resources*
	Staff have received training to support toothbrushing	Inner Setting	Readiness for Implementation	*Access to knowledge & information*
Staffing: Childsmile teams	*Staff redeployment*	Inner Setting	Structural Characteristics	
			Readiness for	*Available resources*

Emergent themes (arising from data)	***Sub themes***	**CFIR Domain**	**CFIR Construct**	***sub-construct***
			Implementation	
Children requiring additional support	*Children with additional support needs, or children's developmental stage, affects their ability to participate in toothbrushing independently*	Outer setting	Patient Needs & Resources	
Children's response	*Children's refusal or reluctance to participate, including due to their ability / developmental stage; OR*	Outer setting	Patient Needs & Resources	
	Children are keen and/or able to participate	Outer setting	Patient Needs & Resources	
Children's attendance patterns	*Children do not attending regularly / every day; or frequent absences*	Outer setting	Patient Needs & Resources	
	Times when toothbrushing takes place during nursery sessions / no flexibility re. toothbrushing when children are present; OR Children attend regularly and are present when toothbrushing takes place	Inner Setting	Implementation Climate	*Compatibility*
Facilities and space available	*Lack of space or facilities available; OR Nursery has facilities / space appropriate for toothbrushing*	Inner Setting	Readiness for Implementation	*Available resources*
Compatibility of nursery supervised	*Policy of 'free play' given higher priority than toothbrushing*	Outer setting	External Policies& Incentives	
		Inner Setting	Implementation Climate	*Relative priority*

Emergent themes (arising from data)	*Sub themes*	CFIR Domain	CFIR Construct	*sub-construct*
toothbrushing programme with other guidance / policies (e.g. child-directed / 'free' play)				*Compatibility*
	Children's preference for free play / other activities (instead of toothbrushing)	Inner Setting	Implementation Climate	*Compatibility*
		Outer setting	Patient Needs & Resources	
Number of children attending the nursery	*Time required for toothbrushing due to number of children present*	Inner Setting	Readiness for Implementation	*Available resources*
	Number of children attending is manageable for toothbrushing	Inner Setting	Implementation Climate	*Compatibility*
Toothbrushing equipment & resources provided	*Problems with receiving sufficient toothbrushing resources (brushes/paste/racks;) OR Adequate / sufficient toothbrushing resources are provided*	Inner Setting	Readiness for Implementation	*Available resources*
	Problems with receiving adequate toothbrushing resources (brushes/paste/racks)	Intervention Characteristics	Design Quality & Packaging	
	Toothbrushing resources are provided free-of-charge	Intervention Characteristics	Cost	
Difficulties with supervising	*Time / staff required*	Inner Setting	Readiness for Implementation	*Available resources*

Emergent themes (arising from data)	*Sub themes*	CFIR Domain	CFIR Construct	*sub-construct*
toothbrushing	*Difficulties keeping track of who has brushed*	Intervention Characteristics	Complexity	
	Fitting in supervising toothbrushing with other activities in nursery	Inner Setting	Implementation Climate	*Compatibility*
Hygiene and infection control	*General comments*	Intervention Characteristics	Evidence Strength and Quality	
		Inner Setting	Networks and Communications	
		Process of Implementation	Engaging	
	Concerns about children taking the wrong brush / ability to recognise own brush / not touch others' brushes	Intervention Characteristics	Complexity	
Hygiene and infection control (continued)		Outer setting	Patient Needs & Resources	
	'Yuck' factor	Characteristics of Individuals	Knowledge & Beliefs about the Intervention	
Buy-in, willingness, attitudes, perceptions towards the supervised toothbrushing programme	*General comments*	Outer setting	Patient Needs & Resources	
		Inner Setting	Networks and Communications	
			Implementation Climate	*Relative priority*
			Readiness for Implementation	*Leadership Engagement*
				Access to knowledge & information

Emergent themes (arising from data)	***Sub themes***	**CFIR Domain**	**CFIR Construct**	***sub-construct***
		Process of Implementation	Planning	
			Engaging	
			Executing	
	Nursery staff have negative views about toothbrushing / lack of buy-in; OR Nursery staff view toothbrushing positively; good level of buy-in	Intervention Characteristics	Evidence Strength and Quality	
			Adaptability	
			Complexity	
		Characteristics of Individuals	Knowledge & Beliefs about the Intervention	
	Nursery staff feel unable to deliver toothbrushing as intended; OR Nursery staff are confident in abilities to deliver toothbrushing as intended	Characteristics of Individuals	Self-efficacy	
Support provided by Childsmile staff	*Monitoring visits & feedback*	Process of Implementation	Reflecting & Evaluating	
	General support provided by Childsmile staff	Process of Implementation	Engaging	*External Change Agents*
Communication	*With local Childsmile teams*	Intervention Characteristics	Adaptability	
		Inner Setting	Networks and Communications	
			Readiness for Implementation	*Leadership Engagement*

Emergent themes (arising from data)	*Sub themes*	CFIR Domain	CFIR Construct	*sub-construct*
				Access to knowledge & information
		Process of Implementation	Planning	
	With staff in educational establishments	Intervention Characteristics	Evidence Strength and Quality	
			Complexity	
		Outer setting	Patient Needs & Resources	
		Inner Setting	Networks and Communications	
			Implementation Climate	*Relative priority*
			Readiness for Implementation	*Leadership Engagement*
				Access to knowledge & information
		Characteristics of Individuals	Knowledge & Beliefs about the Intervention	
		Process of Implementation	Planning	
			Engaging	
			Executing	
Communication (continued)	*With local authority education departments*	Inner Setting	Networks and Communications	
			Readiness for	*Leadership*

Emergent themes (arising from data)	***Sub themes***	**CFIR Domain**	**CFIR Construct**	***sub-construct***
			Implementation	*Engagement*
		Process of Implementation	Planning	
			Engaging	
	With the Childsmile Executive (national programme)	Inner Setting	Networks and Communications	
			Readiness for Implementation	*Leadership Engagement*
				Access to knowledge & information
	With parents/carers	Process of Implementation	Engaging	
	With national partners (e.g. Scottish Government, Public Health Scotland, Care Inspectorate, others)	Inner Setting	Networks and Communications	
			Readiness for Implementation	*Leadership Engagement*
		Process of Implementation	Engaging	*External Change Agents*
Planning	*General comments*	Inner Setting	Networks and Communications	
			Readiness for Implementation	*Access to knowledge & information*
		Process of Implementation	Planning	
			Engaging	

Emergent themes (arising from data)	***Sub themes***	**CFIR Domain**	**CFIR Construct**	***sub-construct***
			Executing	
Planning (continued)	*Local*	Inner Setting	Networks and Communications	
			Readiness for Implementation	*Access to knowledge & information*
		Process of Implementation	Planning	
			Engaging	
			Executing	
	National	Inner Setting	Networks and Communications	
			Readiness for Implementation	*Leadership Engagement*
				Access to knowledge & information
		Process of Implementation	Planning	
			Engaging	
	Uncertainties	Inner Setting	Implementation Climate	
		Process of Implementation	Planning	
Progress towards implementation	General comments	Inner Setting	Networks and Communications	
			Implementation Climate	*Relative priority*
			Readiness for	*Leadership*

Emergent themes (arising from data)	***Sub themes***	**CFIR Domain**	**CFIR Construct**	***sub-construct***
			Implementation	*Engagement*
				Access to knowledge & information
Progress towards implementation (continued)	*General comments (continued)*	Process of Implementation	Planning	
			Engaging	
			Executing	
	Toothbrushing is / is not taking place as intended	Inner Setting	Implementation Climate	*Relative priority*
Covid-19 Toothbrushing Standards addendum	*Content of the addendum*	Inner Setting	Readiness for Implementation	*Access to knowledge & information*
	Interpretation of the addendum	Intervention Characteristics	Evidence Strength and Quality	
		Inner Setting	Readiness for Implementation	*Access to knowledge & information*
	Toothbrushing model used: *Dry brushing (not at a sink)*	Intervention Characteristics	Evidence Strength and Quality	
			Adaptability	
		Inner Setting	Networks and Communications	
		Characteristics of Individuals	Knowledge & Beliefs about the Intervention	
		Process of Implementation	Engaging	

Emergent themes (arising from data)	***Sub themes***	**CFIR Domain**	**CFIR Construct**	***sub-construct***
Wider context	*Restrictions affecting establishments*	Outer setting	External Policies& Incentives	

Appendix 16: Further information and definitions of Expert Recommendations for Implementing Change (ERIC) strategies mapped to the relevant CFIR constructs

The information provided in Table 34 is adapted from:

- Powell, B. J., Waltz, T. J., Chinman, M. J., Damschroder, L., Smith, J. L., Matthieu, M. M., Proctor, E. K. & Kirchner, J. E. (2015). A refined compilation of implementation strategies: results from the Expert Recommendations for Implementing Change (ERIC) project. *Implementation Science*, 10, 21;

- Waltz, T. J., Powell, B. J., Matthieu, M. M., Damschroder, L. J., Chinman, M. J., Smith, J. L., Proctor, E. K. & Kirchner, J. E. (2015). Use of concept mapping to characterize relationships among implementation strategies and assess their feasibility and importance: results from the Expert Recommendations for Implementing Change (ERIC) study. *Implementation Science,* 10**,** 109; and

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Table 34 Further information and definitions of Expert Recommendations for Implementing Change (ERIC) strategies mapped to the relevant CFIR constructs

			Interv. Char.	Outer setting		Inner Setting			Char. of Indiv.	Process of Impl'n		
Cluster	**Strategy name**	**Definitions & further information**	**Complexity**	**Patient needs & resources**	**External policies & incentives**	**Networks & communications**	**Implementation climate**	**Readiness for implementation**	**Knowledge & beliefs about interv.**	**Planning**	**Engaging**	**Executing**
Use evaluative & iterative strategies	**Conduct local needs assessment**	Definition: Collect and analyze data related to the need for the innovation Further information: This assessment could be focused on: Outcomes of usual care; Process of care; Description of usual care and its distance from evidence-based care (e.g., gaps in care); Opinions from stakeholders (including patients) on (a) barriers and facilitators to the desired outcome (e.g., recovery from mental illness), (b) the need for any innovation (i.e., tension for change), (c) the need for a specific innovation, or (d) the special considerations for delivering the innovation in the local context. If the change involves multiple sites or facilities, then it is necessary to examine practice variation across facilities, and outline strategies for the needs assessment to support a standardized approach across sites.		✓			✓	✓		✓		

			Interv. Char.	Outer setting		Inner Setting			Char. of Indiv.	Process of Impl'n		
Cluster	**Strategy name**	**Definitions & further information**	**Complexity**	**Patient needs & resources**	**External policies & incentives**	**Networks & communications**	**Implementation climate**	**Readiness for implementation**	**Knowledge & beliefs about interv.**	**Planning**	**Engaging**	**Executing**
Use evaluative & iterative strategies	**Develop a formal implementation blueprint**	Definition: The blueprint should include the following: 1) aim/purpose of the implementation; 2) scope of the change (*e.g.*, what organizational units are affected); 3) timeframe and milestones; and 4) appropriate performance/progress measures. Use and update this plan to guide the implementation effort over time Further information: The implementation blueprint or manual may be informed by one or more theories or conceptual frameworks and/or data from pre-implementation needs assessments. This blueprint can also provide a useful historical record of the implementation process, as well as provide a mechanism to track changes over time. The implementation blueprint is often useful to ensure feedback is received from prospective frontline users of the blueprint prior to implementation. Consider coordinating this strategy with the development of a fidelity monitoring tool. Issues to consider separately, especially for research purposes: Number and type of implementation strategies; Organizational levels involved (this can vary by type of intervention; it may be possible to do some interventions at the lowest level, others may require top management).	✓							✓		

			Interv. Char.	Outer setting		Inner Setting			Char. of Indiv.	Process of Impl'n		
Cluster	**Strategy name**	**Definitions & further information**	**Complexity**	**Patient needs & resources**	**External policies & incentives**	**Networks & communications**	**Implementation climate**	**Readiness for implementation**	**Knowledge & beliefs about interv.**	**Planning**	**Engaging**	**Executing**
Use evaluative & iterative strategies	**Purposely re-examine the implementation**	Definition: Monitor progress and adjust clinical practices and implementation strategies to continuously improve the quality of care Further information: It is beneficial to use a concrete schedule for monitoring rather than 'as needed.' Time-sensitive benchmarks for determining when adjustments are needed have also been found to be useful.										✓
Develop stakeholder inter-relationships	**Build a coalition**	Definition: Recruit and cultivate relationships with partners in the implementation effort Further information: Partnerships can develop around cost-sharing, shared resources, shared training, and the division of responsibilities among partners. This work may proceed naturally from local consensus discussions. Coalition members commonly have defined roles in the implementation effort.			✓	✓		✓				

			Interv. Char.	Outer setting		Inner Setting			Char. of Indiv.	Process of Impl'n		
Cluster	**Strategy name**	**Definitions & further information**	**Complexity**	**Patient needs & resources**	**External policies & incentives**	**Networks & communications**	**Implementation climate**	**Readiness for implementation**	**Knowledge & beliefs about interv.**	**Planning**	**Engaging**	**Executing**
Develop stakeholder inter-relationships	**Identify and prepare champions**	Definition: Identify and prepare individuals who dedicate themselves to supporting, marketing, and driving through an implementation, overcoming indifference or resistance that the intervention may provoke in an organization Further information: This strategy includes preparing individuals for their role as champions. Champions are primarily internal to the organization. Additional issues raised include the need for guidance regarding: a) Methods and considerations related to the selection and identification of champions. Social network theory and methods may be useful in this regard. b) Training and or providing champions support materials. c) Addressing incentives or disincentives to the champion role. d) Whether there are needs for champions at different levels of an organization (e.g., clinic, region, national). Champions are often distinguished from opinion leaders. Opinion leaders may be considered more of an objective third party with relevant expertise.							✓		✓	

			Interv. Char.	Outer setting		Inner Setting			Char. of Indiv.	Process of Impl'n		
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Develop stakeholder inter-relationships	**Identify early adopters**	Definition: Identify early adopters at the local site to learn from their experiences with the practice innovation Further information: Early adopters are a good pool for identifying implementation champions. Recruit early adopters to attend stakeholder meetings to present their experiences. Investigating the adoption chasm between early adopters and the early majority has been found to be useful. Different engagement techniques for these two groups are typically needed.					✓					

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Cluster	**Strategy name**	**Definitions & further information**	**Complexity**	**Patient needs & resources**	**External policies & incentives**	**Networks & communications**	**Implementation climate**	**Readiness for implementation**	**Knowledge & beliefs about interv.**	**Planning**	**Engaging**	**Executing**
Develop stakeholder inter-relationships	**Involve executive boards**	Definition: Involve existing governing structures (*e.g.*, boards of directors, medical staff boards of governance) in the implementation effort, including the review of data on implementation processes Further information: Other types of leadership with 'top-down' powers may be involved for settings that do not have a governing board. Examples include administrative leadership, clinical leadership, policy makers, and insurance providers or other payment systems.			✓							

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Cluster	**Strategy name**	**Definitions & further information**	**Complexity**	**Patient needs & resources**	**External policies & incentives**	**Networks & communications**	**Implementation climate**	**Readiness for implementation**	**Knowledge & beliefs about interv.**	**Planning**	**Engaging**	**Executing**
Develop stakeholder inter-relationships	**Promote network weaving**	Definition: Identify and build on existing high-quality working relationships and networks within and outside the organization, organizational units, teams, etc. to promote information sharing, collaborative problem-solving, and a shared vision/goal related to implementing the innovation Further information: Individuals functioning as network weavers usually have external links outside of the community to bring in information and ideas. An example would be nurses and doctors who staff hospitals and skilled nursing facilities, and the patients who rotate among these facilities. Networks are somewhat more organic than collaboratives and are often enduring and durable.				✓						

			Interv. Char.	Outer setting		Inner Setting			Char. of Indiv.	Process of Impl'n		
Cluster	**Strategy name**	**Definitions & further information**	**Complexity**	**Patient needs & resources**	**External policies & incentives**	**Networks & communications**	**Implementation climate**	**Readiness for implementation**	**Knowledge & beliefs about interv.**	**Planning**	**Engaging**	**Executing**
Develop stakeholder inter-relationships	**Obtain formal commitments**	Definition: Obtain written commitments from key partners that state what they will do to implement the innovation. Further information: Formal commitments should clarify roles, responsibilities, and detail tangible and non-tangible benefits (e.g., community partnerships). Ensure that key roles are supported within the organization (e.g., workload release credit for providing and receiving supervision in a new clinical practice). Formal commitments in no way diminish the importance of informal commitments to a change effort.			✓							

			Interv. Char.	Outer setting		Inner Setting			Char. of Indiv.	Process of Impl'n		
Cluster	**Strategy name**	**Definitions & further information**	**Complexity**	**Patient needs & resources**	**External policies & incentives**	**Networks & communications**	**Implementation climate**	**Readiness for implementation**	**Knowledge & beliefs about interv.**	**Planning**	**Engaging**	**Executing**
Develop stakeholder inter-relationships	**Organize clinician implementation team meetings**	Definition: Develop and support teams of clinicians who are implementing the innovation and give them protected time to reflect on the implementation effort, share lessons learned, and support one another's learning Further information: None provided.				✓						
Train & educate stakeholders	**Conduct ongoing training**	Definition: Plan for and conduct training in the clinical innovation in an ongoing way Further information: This can include follow-up training, advanced training, booster training, purposefully spaced training, training to competence, integration of off the- job and on-the-job training, structured supervision, the introduction of concepts in a specific sequence to ensure mastery, and trainings based on the level of clinician knowledge. Ongoing training efforts need to reach across shifts and	✓									

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		accommodate staff turnover, as well as rotating staff (e.g., residents). Trainings can be in-person, on the web, or technology-assisted (e.g., simulation lab training), and may focus on individuals or involve groups. When planning for ongoing training, it is important to describe the training components, including the timing and frequency of trainings. Issues related to the dynamics of training can be found in the strategy "Make training dynamic"*										
	* ***Make training dynamic***	Definition: *Vary the information delivery methods to cater to different learning styles work contexts, and shape the training in the innovation to be interactive.* Further information: *Making training dynamic includes efforts to divide material into small time intervals, the use of small group breakouts, audience response systems, and other measures, such as having learners try new skills between training sessions. Interactive components of training can be very dynamic with participants actively contributing to the training content, engaging in problem solving, and identifying solutions that can be tested.*										

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Train & educate stakeholders	**Develop educational materials**	Definition: Develop and format manuals, toolkits, and other supporting materials in ways that make it easier for stakeholders to learn about the innovation and for clinicians to learn how to deliver the clinical innovation Further information: Create eye-catching, easy-to-use educational documents. Distill complex information into easier-to-learn components. Consider teaching skills modularly. Use different forms of media, and target messages for different audiences. Educational materials should reflect principles of adult learning theory. Assessment of current, available technology infrastructure to accommodate educational media (e.g., firewalls, old hardware, old software) is merited. Consider how the educational materials will be used over time. For example, will the educational materials' primary use be to train new or rotating staff; or to refresh staff knowledge; or to be incorporated into existing supervision, competency, and performance review structures. Educational materials may be refined through the use of formative evaluation							✓			

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		feedback.										
Train & educate stakeholders	**Conduct educational meetings**	Definition: Hold meetings targeted toward different stakeholder groups (e.g., providers, administrators, other organizational stakeholders, and community, patient/consumer, and family stakeholders) to teach them about the clinical innovation. Further information: The content of the education may include information regarding what to expect as implementation moves forward. It is useful to ensure that meeting attendees are relatively homogeneous so that the education can be targeted toward the stakeholder group's needs. For example, some educational meetings may inform the stakeholder group about the clinical innovation in a way intended to increase demand, while others may preview the clinical innovation for providers and administrators. It							✓			

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		is often useful to have recordings or other materials from the educational meetings available to those who cannot attend the meetings (e.g., those covering patient care at the time of the meeting, new hires subsequent to the meeting).										
Engage consumers	**Involve patients, consumers, family members**	Definition: Engage or include patients/consumers and families in the implementation effort Further information: Feedback from stakeholders can be obtained at any stage of the implementation process depending on the needs and goals of project. Involving stakeholders in the pre-implementation phase for many innovations is advantageous. Training in the innovation, and relevant advocacy, may also be included in stakeholder involvement. Informal caregivers such as neighbours, friends, and other key sources of support may also be prudent to include.		✓								

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Engage consumers	**Obtain and use patients, consumers, family feedback**	Definition: Develop strategies to increase patient/consumer and family feedback on the implementation effort Further information: This can continue throughout the implementation effort. Strategies could include complaint forms, or methods, which funnel feedback to change managers or advisory boards. Consider whether anonymous feedback formats are appropriate.		✓								
Adapt & tailor to context	**Promote adaptability**	Definition: Identify the ways a clinical innovation can be tailored to meet local needs and clarify which elements of the innovation must be maintained to preserve fidelity Further information: Preserving fidelity to the innovation can be an uncertain process if the core elements of the innovation are not empirically defined.	✓									

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Change infrastructure	**Mandate change**	Definition: Have leadership declare the priority of the innovation and their determination to have it implemented. Further information: It is important to ensure that the individuals mandating the change have the power to do so, as implementers often lack such authority. Working with organizational leadership to develop buy-in and lobby for a change mandate is often needed. It can also be important to inform other stakeholders (e.g., auditors, groups that review services for billing) about the mandate to ensure they are on the same page.			✓							

Table 35 Amendments made to ERIC implementation strategies categorisation

Original categorisation (per Waltz et al., 2015)		*Changes made*	Revised categorisation used for this research	
Use evaluative & iterative strategies	Conduct local needs assessment	*Combined to create aggregated category*	Knowledge-gathering; describing intervention & expectations	Conduct local needs assessment
	Develop a formal implementation blueprint			Develop a formal implementation blueprint
	Purposely re-examine the implementation			Purposely re-examine the implementation
Adapt & tailor to context	Promote adaptability			Promote adaptability
Train & educate stakeholders	Conduct educational meetings	*No changes*	Train & educate stakeholders	Conduct educational meetings
	Conduct ongoing training			Conduct ongoing training
	Develop educational materials			Develop educational materials
Engage consumers	Involve patients, consumers, family members	*Amended category & strategy names to reflect specific research context*	Increase buy-in & engagement: among service users (parents, carers, children)	Involve parents, carers, children
	Obtain and use patients, consumers, family feedback			Obtain and use feedback from parents, carers, children

Original categorisation (per Waltz et al., 2015)		*Changes made*	Revised categorisation used for this research			
Develop stakeholder inter-relationships	Identify & prepare champions	*Combined to create aggregated category; specified target group(s) for strategies (operational or strategic levels); amended some strategy names to reflect specific research context*	Increase buy-in & engagement: among stakeholders	Identify & prepare champions; *identify nurseries where programme appears to be working well*	operational	strategic
	Identify early adopters			Promote network weaving		
	Promote network weaving			Organise nursery implementation team meetings		
	Organize clinician implementation team meetings			Build a coalition		
	Build a coalition			Obtain formal commitments		
	Obtain formal commitments			Involve executive boards		
	Involve executive boards			Mandate change		
Change infrastructure	Mandate change					