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Understanding the health of people experiencing homelessness, justice involvement, substance use, sex work, and severe mental illness

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Abstract

Background: Public health research has often been dominated by a relatively narrow understanding of health inequalities, which may neglect broader aspects of social experience and the ways in which they intersect. Homelessness, involvement in the criminal justice system, problem substance use, sex work, and severe mental illness are characterised by social marginalisation and stigmatisation, and often co-occur. In this thesis, I aimed to explore health inequalities associated with these experiences, and their intersections, and to investigate the potential contribution of administrative data to this field.

Methods: This multi-method study comprised: a discourse analysis of UK health inequalities policy reviews; a systematic review of health outcomes associated with co-occurrence of the experiences of interest; the creation and characterisation of a novel electronic cohort to investigate the extent of these intersections, using linked administrative data; an analysis of premature mortality within this cohort; and an interrupted time series analysis using pharmacy data to investigate health impacts of a comprehensive smoke-free policy in Scottish prisons.

Results: The experiences of interest featured to some extent in existing health inequalities policy, but conceptual and explanatory frameworks were poorly developed. The linked cohort analysis constitutes one of the few population-based studies examining the intersections between these experiences and appears to be the first to use individual record linkage to do so. Building on the systematic review finding that multiple forms of marginalisation are associated with poorer health outcomes, the cohort analysis demonstrated a high burden of preventable and treatable mortality, including from non-communicable disease. Smoke-free prisons appeared to have positive impacts on respiratory health, suggesting scope to mitigate these inequalities through interventions in relevant settings and services.

Implications: Co-occurrence of these experiences is not uncommon and associated with profound health inequalities. Redressing these inequalities may require new approaches to services and policy, analogous to the demands of multi-morbidity in healthcare. Administrative data offer valuable opportunities for characterising needs and evaluating interventions, though this will require substantial reform to governance and infrastructure for cross-sectoral data sharing and linkage. Future work should aim to situate these experiences within broader understandings of social processes giving rise to inclusion, exclusion, and inequality.

Table of Contents

List of Tables

List of Figures

Publications and other outputs

The following publications, conference presentations, and briefings have resulted from the research described in this thesis. My specific contribution to each element of the project is described in detail on pages 12 and 13.

Publications

Tweed EJ, Popham F, Thomson H, Katikireddi SV (2021) Including 'inclusion health'? A discourse analysis of health inequalities policy reviews. *Critical Public Health*, doi: http://dx.doi.org/10.1080/09581596.2021.1929847

Tweed EJ, Thomson RM, Lewer D, Sumpter C, Kirolos A, Southworth PM, Purba AK, Aldridge RW, Hayward A, Story A, Hwang SW, Katikireddi SV (2021). The health of people experiencing co-occurring homelessness, imprisonment, substance use, sex work, and/or severe mental illness in high-income countries: a systematic review and meta-analysis. *Journal of Epidemiology and Community Health.* doi: http://dx.doi.org/10.1136/jech-2020-215975

Tweed EJ, Mackay DF, Boyd KA, Brown A, Byrne T, Conaglen P, Craig P, Demou E, Graham L, Leyland AH, McMeekin N, Pell JP, Sweeting H, Hunt K (2021). Evaluating of a national smoke-free prisons policy using medication dispensing: an interrupted time series analysis. *Lancet Public Health.* doi: https://doi.org/10.1016/S2468-2667(21)00163-8

Conference presentations

Tweed EJ, Thomson RM, Lewer D, Sumpter C, Kirolos A, Southworth PM, Purba AK, Aldridge RW, Hayward A, Story A, Hwang SW, Katikireddi SV. The health of people experiencing multiple forms of social exclusion: a systematic review and meta-analysis. *Society for Social Medicine and Population Health Annual Scientific Meeting and International Epidemiology Association European Congress of Epidemiology*, 5th September 2019

Tweed EJ, Popham F, Thomson H, Katikireddi SV. Inclusion health in UK-relevant policy reviews of health inequalities: a thematic, multilevel governance document analysis. *UK Public Health Science*, 29th November 2019

Tweed EJ, Leyland AH, Morrison DS, Katikireddi SV. Using cross-sectoral administrative data linkage to understand the health of people experiencing multiple exclusion*. Society for Social Medicine and Population Health Annual Scientific Meeting*, 9th September 2020

Tweed EJ, Leyland AH, Morrison DS, Katikireddi SV. Using cross-sectoral administrative data linkage to understand the health of people experiencing multiple exclusion. *World Congress on Public Health*, 13th October 2020.

Plain-language briefings

Review of published evidence about the health of people experiencing co-occurring homelessness, imprisonment, substance use, sex work and/or severe mental illness. *August 2021;*
https://www.gla.ac.uk/media/Media_804223_smxx.pdf

How did a complete smoke-free policy affect the health of people in prison in Scotland? Findings from the Tobacco in Prisons study. *Sept 2021*;
https://www.gla.ac.uk/media/Media_812345_smxx.pdf

Acknowledgements

It feels impossible to list here all the people who have helped this work reach fruition: it has been very much a team effort. I will do my best to highlight here those who have played an especially critical role; there are also specific acknowledgements sections associated with each empirical chapter.

I am indebted to the Chief Scientist Office not only for funding this research but also for their flexibility in accommodating changes to the fellowship schedule, including a phase of part-time working to enable me to return to public health practice during the initial phase of the COVID-19 pandemic. I am similarly grateful to the Inequalities programme at the MRC/CSO Social and Public Health Sciences Unit and in particular my co-supervisor Alastair Leyland for providing an additional six months' funding to help buffer delays experienced in data access and linkage.

Thank you to my supervisors - Vittal Katikireddi, Alastair Leyland, and David Morrison - for their wise advice, patience, and perseverance: it has been a pleasure working with you.

I could not have completed this work without my co-authors on the papers included here, all of whom have been excellent collaborators. I would particularly like to thank: Kate Hunt for welcoming me in to the Tobacco In Prisons study (TIPs) fold and providing ongoing encouragement and opportunities for my development; Danny Mackay for his support with the vagaries of interrupted time series analysis; and all the second-checkers on the systematic review (Amir Kirolos, Amrit Kaur Purba, Colin Sumpter, Dan Lewer, Rachel Thomson, and Paul Southworth) for their efforts on the mammoth tasks of screening, data extraction, and quality appraisal.

A number of people helped support the work to establish the cohort, first at a national level and subsequently within Glasgow City. I would like to acknowledge the efforts of Amy Tilbrook, Anthea Springbett, Charlie Mayor, Claire MacDonald, Imran Sadat, and Alison Hamilton, in relation to governance and technical processes, and for the support of Linda de Caestecker, Susanne Millar, and Jim McBride in providing institutional backing from NHS Greater Glasgow and Clyde and Glasgow City Health and Social Care Partnership.

Thank you to the members of the stakeholder advisory group, who provided invaluable feedback on the record linkage strand and whose interest and enthusiasm for the work was an important motivator when the going got tough. Thank you also to all those with lived and living experience who have shared their insights and reflections on the work throughout the project through public engagement activities: the work is much richer for your input.

Finally, I am grateful for the supportive and welcoming environment provided by SPHSU over the past five years, and for the feedback, encouragement, and companionship offered by all my colleagues there. Especially deserving of individual mentions are Rosie Seaman, for feedback on a draft version of this thesis; Rachel Thomson and Kirsten Hainey, for being brilliant (real and virtual) deskmates; Carol Nicol and Crawford Neilson, for tireless IT support; Andy Baxter and Erik Igelström, for being so generous with their R expertise; and Kirsten Lindsay, Audrey Hendry, and Helen Thompson, for administrative support throughout my fellowship.

Author’s Declaration

I declare that I am the sole author of this thesis, except where the contribution of others has been acknowledged, as below. The work in this thesis has not been submitted in any form for another degree or professional qualification at the University of Glasgow or any other institution.

Contribution statements

Chapter 4

I was responsible for conceptualisation and development of the research question; drafting the protocol and revising it with input from my co-authors (Frank Popham, Hilary Thomson, and S. Vittal Katikireddi); defining the sample; coding the documents; and leading the interpretation, with input from co-authors. I drafted the paper and revised it with input from all co-authors. Co-authors provided feedback on research questions, study protocol, data interpretation, drafting of the final manuscript, and response to reviewers’ comments.

Chapter 5

I was responsible for conceptualisation and development of the research question; writing the first draft of the protocol; and revising the protocol after feedback from all co-authors. I liaised with information specialists Paul Cannon and Valerie Wells to develop and implement search strategies, and co-ordinated screening of titles/abstracts and full texts by myself and a subset of co-authors (Rachel Thomson, Colin Sumpter, Amir Kirolos, Amrit Purba, Dan Lewer, Paul Southworth, and S. Vittal Katikireddi); these co-authors also undertook independent checking of data extraction and scoring of risk of bias. I undertook data extraction for all studies followed by narrative synthesis and meta-analysis, and wrote the first draft of the manuscript. All co-authors contributed to protocol development; provided feedback on the interpretation of results; and contributed to revising the manuscript and responding to reviewers’ comments. Audrey Hendry retrieved full texts for screening.

Chapter 6 and Chapter 7

I developed the research question; scoped the availability and suitability of relevant datasets; and drafted the applications for data access and linkage with feedback from all co-authors (Alastair Leyland, David Morrison, and S. Vittal Katikireddi). I drafted the data analysis plan with feedback from co-authors and undertook all data cleaning and analysis. I drafted the two manuscripts and revised them following feedback. Co-authors provided input on applications for data access; data analysis plan; the interpretation of results; and revisions to the draft manuscripts.

Chapter 8

I led the scoping of appropriate datasets and the development of research questions for the routine data component of the broader Tobacco in Prisons study (for which Kate Hunt was the principal investigator). I wrote the first draft of the protocol and revised it following input from all co-authors (Daniel Mackay, Kathleen Boyd, Ashley Brown, Thomas Byrne, Philip Conaglen, Peter Craig, Evangelia Demou, Lesley Graham, Alastair Leyland, Nicola McMeekin, Jill Pell, Helen Sweeting, and Kate Hunt). I co-ordinated access to datasets and undertook data cleaning and analyses, with advice on syntax from Daniel Mackay, Evangelia Demou, and Nicola McMeekin. I drafted the manuscript and revised it following feedback. Co-authors provided feedback on the protocol; interpretation of results; manuscript; and response to reviewers' comments.

Competing interests

During the period on which I was working on this thesis, I was a member of the Scottish Government Drug Deaths Taskforce subgroups on multiple and complex needs (from November 2019 until March 2020 when I stood down due to Covid-19 redeployment) and on women who use drugs (March – August 2021). I was a member of the Drugs Research Network for Scotland steering committee (July 2019 – May 2021), and of the Commission on Leadership in Public Health Research, Innovation, and Applied Evidence as part of the public health reform process in Scotland (April 2018 – April 2019). I also received funding from the National Institute of Health Research as joint principal investigator on a project investigating stakeholder attitudes to cross-sectoral data sharing and linkage (NIHR PHR ref 133585; April – December 2021).

Abbreviations

A&E	Accident & Emergency services
ACEs	Adverse Childhood Experiences
ADRN	Administrative Data Research Network
aHR	Adjusted hazard ratio
ARIMA	Autoregressive Integrated Moving Average
BBV	Blood-borne virus
CDA	Critical discourse analysis
CHI	Community Health Index
CI	Confidence interval
CJSWR	Criminal Justice Social Work Reports
COMM	Contact with community justice services, as defined by a Criminal Justice Social Work Report in the absence of imprisonment during the cohort exposure period
CUST	Experience of prison custody (whether on remand or following sentence), as defined by a PR2 record during the cohort exposure period
CVD	Cardiovascular disease
EU	European Union
HSCP	Health and Social Care Partnership
HL	Experiencing homelessness or housing insecurity
HL1	Statutory data collection on applications to and assessments by local authorities for homelessness support
HR	Hazard ratio
ICD-10	International Statistical Classification of Diseases and Related Health Problems, tenth edition
ITS	Interrupted time series
NCDs	Non-communicable diseases
NHS	National Health Service
ODep	Opioid dependence, as indicated by receipt of community-dispensed opioid substitution therapy
OST	Opioid Substitution Therapy

PBPP	Public Benefit and Privacy Panel
PiC	People in (prison) custody
PsyCIS	Psychosis Clinical Information System, a clinical registry of people with a diagnosis of psychotic disorder in contact with community mental health teams in NHS Greater Glasgow and Clyde
PROSPERO	International prospective register of systematic reviews; https://www.crd.york.ac.uk/PROSPERO/
PR	Experiencing imprisonment (with or without community justice involvement)
PR2	Dataset comprising records of all individuals received into Scottish prisons
PSY	Diagnosis of psychosis, as defined by inclusion in the PsyCIS clinical registry during the cohort exposure period
RO	Research objective
RoB	Risk of bias
SARIMA	Seasonal Autoregressive Integrated Moving Average
SG	Scottish Government
SH	Safe Haven
SIMD	Scottish Index of Multiple Deprivation
SMI	Severe mental illness
SMR	Scottish Morbidity Record
SPS	Scottish Prison Service
SSRI	Selective serotonin reuptake inhibitor
SU	Substance use
TIPs	Tobacco In Prisons study
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation
YPLL	Years of Potential Life Lost

Chapter 1 Introduction

1.1 Overview of chapter

In this introductory chapter, I briefly describe the background to the project in the context of public health research and practice, and my own work as a practitioner. I then outline the origins to the project and its development over time, before concluding with a guide to the overall thesis and its structure.

1.2 Background

There exists a substantial body of research into inequalities in health, which in the UK and Europe has primarily focused on inequalities by socioeconomic position and in the United States and Australia/New Zealand on race, ethnicity, and Indigenous status (Graham, 2009b, Scambler, 2012, Collyer and Smith, 2020, Smith et al., 2015). Inequalities related to other aspects of social experience are less well studied, and the field is only recently beginning to consider the intersection between multiple 'axes' of inequality (Hill, 2015, Bauer, 2014, Gkiouleka et al., 2018).

Moreover, the wealth of descriptive data on health inequalities has arguably not translated into effective policy action (Smith et al., 2015). One (though by no means the only) reason for this is a relative lack of evidence about measures which might be effective in addressing the inequalities described (Thomson et al., 2018, Garthwaite et al., 2016, Petticrew et al., 2004). Moreover, the public health evidence base has consistently tended towards individual-level interventions and outcomes, contributing to 'lifestyle drift' in the approaches which are funded and implemented (Rutter et al., 2017). There is a need for more and better evidence to inform 'healthy public policy': that is, how policy making across different sectors can contribute to better population health and the reduction of inequalities (Rutter et al., 2017, Academy of Medical Sciences, 2016).

The availability of relevant data is a contributing factor to both the somewhat narrow scope of health inequalities research to date and the paucity of actionable evidence. In the UK, health inequalities research has often drawn on routinely available data from vital statistics and healthcare records. Within these datasets, socioeconomic position can be measured or approximated using individual-level or, more commonly, area-level indicators like Indices of Multiple Deprivation (based on postcode of residence) (Galobardes et al., 2006). However, these datasets are less illuminating for other aspects of social position. More broadly, data from healthcare sources remain much easier to access and better-characterised than data from other sectors (Mourby et al., 2019, Public Health Research Data Forum, 2015). As a result, much public health research has a biomedical skew, and where it does deal with social context or inequalities, tends to focus on socioeconomic circumstances.

In this thesis, I consider these issues through the lens of five experiences characterised by profound social and health disadvantage, marginalisation, and stigma: homelessness, involvement in the criminal justice system, substance use, sex work, and severe mental illness. Throughout the thesis, I refer to these as the experiences of interest. These experiences are often grouped under the umbrella of ‘inclusion health’: Chapter 4 explores this term in more detail but at this stage, it can be defined as a concern with health inequalities associated with exclusion from the rights, resources, and opportunities to participate available to most people in society.

The epidemiology and lived experience of these issues are heavily influenced by policy choices: for instance, those relating to housing markets; poverty and social security; justice and sentencing policy; and civil rights and discrimination. They are therefore ideal topics for the investigation of policy levers beyond the healthcare system that might contribute to improving population health and undoing, preventing, or mitigating health inequalities (NHS Health Scotland, 2016).

To date, methodological obstacles to such research have been substantial: these experiences are rarely captured in routine healthcare data, and can create barriers to participation in primary studies (such as traditional cohorts with active follow-up) which affect those studies’ internal and external validity (Bonevski et al., 2014).

To produce the forms of evidence which might inform decision-making on healthy public policy, there is a need for a diverse range of data that goes beyond the healthcare system into other policy sectors and areas of social experience. This would not only contribute to a richer understanding of health inequalities and the social, economic, environmental and structural determinants of health, but also enable ‘real-world’ evaluations of population-scale interventions, for instance through natural experiments and decision modelling (Craig et al., 2017, Lyons et al., 2014, Meier et al., 2016).

One potential source for these data is the vast quantities of information gathered routinely as part of day-to-day activity undertaken by government departments, public services, and the third sector, usually known as administrative data (Connelly et al., 2016, McGrail et al., 2018b). This includes data from healthcare systems (such as hospitalisation records) and vital statistics registers (such as birth and death registrations), as well as data from other services such as education, housing, social security, justice and policing, and transport. Linking datasets across policy sectors can enable research into causal pathways, population need, and effective interventions for improving health and reducing inequalities. To date, progress in realising this potential has been slow and patchy, with some significant successes but also persistent barriers (Mourby et al., 2019, Harron et al., 2017a, Lugg-Widger et al., 2018).

1.3 Research motivation and journey

This section provides some background on the original inspiration for the research and how the project has developed over time. I include this material for two reasons. First, to acknowledge that this thesis reflects the evolving journey of the project and the weaving together of several research opportunities not conceived of at the outset. Second, an important motivation for the original project was to explore the feasibility of using linked administrative data in this field: the challenges encountered are therefore relevant findings and inform many of the recommendations made in the discussion (Chapter 9).

The original plan for this PhD was to use cross-sectoral administrative data linkage to create and analyse a novel electronic cohort of people from across Scotland with overlapping experiences of homelessness, involvement in the justice system, substance use, and/or psychosis. As much as the descriptive epidemiology characterising the intersection between these experiences and their association with health outcomes, I was interested in investigating the feasibility of this approach. My motivation was the prospect of future work able to evaluate the health impacts of changes in social policy: for instance, policies relating to homelessness entitlements, sentencing practices, or the legal status of controlled drugs.

As a public health specialty registrar in NHS Greater Glasgow and Clyde, I had encountered this constellation of experiences as part of my work on a major HIV outbreak, outbreaks of serious bacterial infections, and rising rates of drug-related death. This work had highlighted the challenges of understanding the health of people who are marginalised and stigmatised, particularly at the population level required to evaluate service or policy interventions. Conscious of the mismatch between our profession's aspiration to 'upstream' working, and an evidence base biased towards individual-level exposures and interventions (Rutter et al., 2017), I was keen to investigate how administrative data might contribute towards bridging this gap. In particular, I was interested in considering axes of social and health inequality beyond the dominant focus on socioeconomic position (in the UK) and race/ethnicity (in other English-speaking countries such as the US and Australia) (Hill, 2015).

The project title for which I obtained funding from the Chief Scientist Office was "Morbidity and mortality among people with experience of severe and multiple disadvantage: a retrospective cohort study using linked administrative data". I intended the PhD to comprise a Scotland-wide retrospective cohort study using administrative data from health and non-health sources to describe health outcomes associated with overlapping experiences of homelessness, imprisonment, problem substance use, and severe mental illness, comprising ambulance call-outs, Accident and Emergency department attendances, hospital admissions, secondary healthcare costs, and deaths. This would build on my co-authorship of a systematic review (Aldridge et al., 2018) which examined health outcomes associated with these experiences but did not extend to include their intersection.

Despite substantial preparatory work prior to commencing the PhD in February 2018, and the support of a range of key stakeholders, the project encountered a number of obstacles in governance and data access. These are described in more detail in Section 6.1. As a result of these challenges, the project moved away from an exclusive focus on cohort creation and analysis towards a more methodologically diverse approach that also encompassed a discourse analysis of health inequalities policy reviews (Chapter 4); a systematic review (Chapter 5); and an analysis of a different set of administrative data (this time, from prison pharmacy records) as part of a policy evaluation (Chapter 8). Nonetheless, though it makes up a much smaller component of the thesis than originally planned, it was eventually feasible to undertake cohort creation and some epidemiological analyses using local, rather than national, data (Chapter 6 and Chapter 7).

The different elements of the thesis retain a common focus on the profound health inequalities associated with experiences of marginalisation and social exclusion, and how research might contribute to addressing them, through conceptual (Chapter 4); descriptive (Chapter 5, Chapter 6, and Chapter 7); and evaluative (Chapter 8) work. The thesis can therefore be described as ‘multi-method’ in the sense that it uses diverse methodological approaches – each drawing on distinct datasets and analytical techniques – in parallel to understand different aspects of a field of study. I use multi-method here to distinguish this approach from a mixed-method one which aims to *integrate* both qualitative and quantitative methodologies within a single analysis to answer a specific research question, whilst acknowledging that the definition of these two terms is by no means settled and that this is one of multiple competing understandings (Hesse-Biber, 2015).

While I led the conceptualisation, conduct, and writing up of each part of the thesis, I also benefited from the invaluable contributions of a range of collaborators: for instance, second-checkers for the systematic review and the wider co-investigator team for the Tobacco in Prisons study. Their contribution is acknowledged in the author’s declaration that prefaces the thesis (page 12) and in the authorship statement associated with each article. The overall work has been led by me and I take full responsibility for it.

1.4 Structure of the thesis

In keeping with guidance from the College of Medical, Veterinary, and Life Sciences (University of Glasgow, 2021), I have chosen a ‘journal format’ structure for the thesis, as I was keen to publish each element as it was completed to ensure timeliness of outputs; provide concrete milestones along the way; and avoid the arduous and inefficient task of subsequently trying to condense thesis chapters into publishable articles. The thesis is therefore built around five empirical chapters, each corresponding to a published or soon-to-be submitted article.

It begins with this introduction (Chapter 1), outlining the research motivation and unifying themes, followed by a narrative review of the relevant literature (Chapter 2). Chapter 2 summarises the conceptual and empirical background of health inequalities and social determinants research; describes the evidence on the experiences of interest, their intersections, and associations with health outcomes; and introduces administrative data and record linkage, before concluding with a summary of gaps in the literature that the thesis seeks to address. This provides the foundation for the thesis aims and objectives set out in Chapter 3.

Chapters 4 to 8 each comprise an article describing the work undertaken to address the research objectives, prefaced by a foreword. The foreword aims to set them in the broader context of the thesis, by describing their relationship to the other chapters; providing additional methodological detail where relevant; and reflecting on the research process. As each article is intended to be readable as a stand-alone output, inevitably there is some degree of duplication with content covered in other parts of the thesis. Some minor formatting changes have been made to published versions in keeping with guidelines for thesis submission, and to the numbering of tables and figures.

Where the articles have already been published, the appendices at the end of the thesis provide links to online supplementary material. Where articles are as yet unpublished, supplementary material is included in full in the appendices to the thesis.

Chapter 4 describes a discourse analysis looking at how ‘inclusion health’ – an agenda seeking to draw attention to inequalities associated with experiences of social exclusion – is represented in UK health inequalities policy to date.

Chapter 5 reports a systematic review synthesising existing evidence on health outcomes associated with the intersection between experiences of homelessness, imprisonment, substance use, sex work, and severe mental illness.

Chapter 6 describes the creation of a novel electronic cohort using linked administrative data from health and non-health sources, in order to quantify the extent of overlaps between these experiences in a UK context. (Due to limitations in available data, sex work could not be included in this or the subsequent chapter).

Chapter 7 aims to address key gaps in the literature identified by the systematic review by undertaking an analysis of mortality among the cohort created in Chapter 6, with a particular focus on non-communicable diseases and avoidable causes of death.

Chapter 8 extends this descriptive work by offering an example of how administrative data can be used in evaluating potential health impacts of policy changes among one population of interest: in this case, the introduction of smoke-free prisons in Scotland and its impacts on the health of people in custody.

In Chapter 9, I conclude by summarising the thesis's key findings; strengths and limitations; and implications for policy, practice, and scholarship, including the challenges and potential of administrative data research for public health.

1.5 A note on geographical scope

The empirical chapters of the thesis differ in their geographical scope: as for many other methodological choices described here, this was informed by both theoretical and practical considerations.

The discourse analysis (Chapter 4) focused on the UK as a case study, in light of its established policy tradition in health inequalities, examining documents from multiple relevant levels of governance including Scotland, the European Union, and World Health Organisation.

High-income countries were chosen as the geography of interest for the systematic review (Chapter 5), balancing the aspiration for a comprehensive synthesis of existing evidence with the substantial differences between more and less economically advantaged countries in the extent, nature, and responses to the experiences of interest (Tipple and Speak, 2005, Jacobson et al., 2017, Csete et al., 2016, Kleinman, 2009).

The cohort study (Chapter 6 and Chapter 7) was restricted to the Glasgow City local authority area: this was largely due to data availability and access, but also reflects particular concerns on the part of local government and health providers about the scale and impacts of co-occurring experiences in this area. Both considerations are described in more detail in Section 6.1.

The policy evaluation (Chapter 8) was Scotland-wide, reflecting the scope of the intervention and the lack of suitable geographical comparator from other UK nations.

The literature review immediately following this chapter therefore limits itself to evidence from high-income countries, with a particular focus on studies from Scotland and the rest of the UK.

Chapter 2 Literature review

2.1 Overview of chapter

This chapter aims to set the scene for the thesis by describing underpinning concepts; providing an overview of the policy and practice context; and summarising the existing evidence – including key gaps – in the areas of interest.

Section 2.2 introduces the determinants of health and health inequalities; Section 2.3 then moves on to explore inclusion, exclusion, and related concepts, as a foundation for the thesis's focus on intersecting experiences of disadvantage and the discourse analysis of health inequalities policy reviews described in Chapter 4. Section 2.4 first provides an overview of the experiences of interest and the rationale for their selection: homelessness, involvement in the criminal justice system, substance use, sex work, and severe mental illness. It then deals with each experience in turn, outlining their definition, prevalence, policy context, and association with health. This includes a description of evidence around tobacco and tobacco control measures in prisons, as background to the evaluation of Scotland's smoke-free prison policy described in Chapter 8.

In Section 2.5.22.5, I describe existing evidence relating to the overlap between the experiences of interest, as background to the systematic review in Chapter 5 and the cohort analyses in Chapter 6 and Chapter 7. Section 2.6 provides an overview of administrative data and record linkage, as methodological context for Chapters 6 to 8. In Section 2.7, I conclude by summarising the existing evidence base and highlighting the key gaps which this thesis aims to address.

2.2 The determinants of health and health inequalities

The determinants of health are all those factors which may influence the health of an individual, community, or population and which together are the concern of public health. The term 'social determinants of health' has typically been used to refer to determinants other than the inherent characteristics of an individual (such as age and genetic inheritance; Dahlgren and Whitehead, 1991, Marmot and Wilkinson, 2006). As the landmark Commission on the Social Determinants of Health put it, the social determinants of health are "the circumstances in which people grow, live, work, and age" (Commission on Social Determinants of Health, 2008).

Seen through this lens, experiences of homelessness; criminal justice involvement; substance use; sex work; and severe mental illness can be understood in terms of how they affect exposure to a range of determinants of health, from the physical/biological (exposure to elements, infectious agents, risk of violence) and psychosocial (stigma and discrimination, degree of autonomy and freedoms) to the material (adequacy and security of housing, access to the labour market) and institutional (access to healthcare and other public services). The relationship between each of these experiences and the determinants of health is explored in more detail in Section 2.4.

Unequal distribution of the determinants of health across the population gives rise to health inequalities, defined by Graham as "systematic differences in the health of people occupying unequal positions in society" (Graham, 2009b). Some authors have made a distinction between inequality, as a descriptive term referring to observed phenomena, and inequity, as a normative term implying injustice and amenability to change (Kawachi et al., 2002). However, in this thesis I will use the term inequality to encompass both descriptive and normative dimensions, in keeping with most UK and European scholarship on this topic (Smith et al., 2015) and in recognition that, in practice, these dimensions are hard to separate (Harper et al., 2010).

Health inequalities are observed across multiple 'axes' of social differentiation. By far the most studied in the UK context is socioeconomic position (variously measured by social class, occupation, education, income, or by area-based measures of deprivation), but others include gender, ethnicity, and geography (Scambler, 2012). Inequalities in health by other axes of social differentiation are less well studied, but are nevertheless substantial and vary by societal context. In recent years, several authors have argued that health inequalities research must look beyond the dominant focus on socioeconomic position, to understand other forms of social stratification, advantage and disadvantage, and the ways in which they intersect (Hill, 2015, Øversveen et al., 2017, Gkiouleka et al., 2018).

This coincides with an increasing interest in intersectionality perspectives in public health research (Hill, 2015, Bowleg, 2012, Bauer, 2014, Kapilashrami and Hankivsky, 2018). A theoretical perspective originating in Black feminist activism and scholarship (Crenshaw, 1989, Collins, 2015, Kapilashrami et al., 2015), intersectionality has no single agreed definition but is characterised by the following core tenets. First, identity, social position, and other “categories of difference” (Davis, 2008, p.68) are considered intrinsically multiple, interacting, and mutually constructing, rather than independent and unidimensional. One aspect of social position cannot capture individual experience or explain a particular outcome without reference to, and interaction with, others. Second, it holds that these aspects of individual experience at the micro level interact with structural forces at the macro level, to generate complex social inequalities. Social position is therefore understood as a “spot within a matrix of intersecting power axes” (Gkiouleka et al., 2018, p.93); something more than the sum of its parts. Third, it has a focus on social categories historically associated with marginalisation and oppression (Choo and Ferree, 2010), with a particular attention to the social, cultural and historical context in which these categories and identities, and their intersections, occur.

Acknowledging intersectionality therefore means our analyses must accommodate the multiple axes of social differentiation that give rise to health inequalities. This theme is revisited in relation to the experiences of interest in Section 2.5.

2.3 Inclusion, exclusion, and related concepts

This section explores conceptual issues relevant to the thesis, in the form of inclusion, exclusion, and related terms referring to co-occurring forms of social exclusion.

2.3.1 Definitions of inclusion and exclusion

As others have previously identified, social ‘inclusion’ and ‘exclusion’ have complex and contested meanings (Levitas, 2006, Levitas et al., 2007, Morgan et al., 2007, Houchin, 2005). These terms are generally used loosely and rarely defined, and are often associated with particular strands of political thought. In particular, their modern usage is closely associated with the European social policy agenda of the 1990s and early 2000s and with the UK’s Labour government between 1997 and 2010 (Levitas, 2006). However, there is also an active academic literature which builds on historical work by Bourdieu, Foucault, Lenoir, and others to explore the potential value of these concepts in understanding social stratification and inequalities (Lynam and Cowley, 2007, Shaw et al., 2005, Labonte, 2004, Bramley and Bailey, 2018, Dermott and Main, 2018). Within this literature, multiple definitions of social inclusion or exclusion have been proposed, along with several typologies (Levitas, 2006, Huxley et al., 2012). From these, some common themes and characteristics emerge.

First, these terms refer to an identity, status, or group membership defined in unfavourable relation to a mainstream group (Shaw et al., 2005, Wolff, 2017, Levitas, 2006).

Second, they are multidimensional (Levitas et al., 2007, Shaw et al., 2005, Bailey et al., 2017). These dimensions may refer to participation in social processes, the exercise or denial of rights, or relationship with institutions. For instance, Commins has proposed four dimensions corresponding to ‘systems of integration’ (cited in Room, 1995):

- civic, referring an individual’s position in the democratic and legal system,
- economic, referring to participation in the labour market,
- social, referring to the welfare state and other public provisions, and
- interpersonal, referring to esteem, standing, and relationships within families and communities (including processes of stigma and discrimination).

These dimensions correspond closely to those included in other typologies (Krieger, 2001, Boardman, 2006) and to the social determinants of health outlined in Section 2.2. This multidimensionality helps account for the observation that forms of exclusion often compound spatially or over time across an individual’s lifecourse (Pleace, 1998). Relatedly, several authors have argued that inclusion and exclusion should be considered a matter of degree rather than a binary status, since they may be more or less subtle or overt; individuals may be excluded in one respect and not in another; and there may be multiple reference groups rather than a single ‘mainstream’ (Wolff, 2017).

Third, processes of inclusion and exclusion can be multi-level. For instance, Houchin has distinguished between micro, meso, and macro processes of exclusion operating at, respectively, the level of the individual, the community, and the political, economic, cultural, and legal structures of society (Houchin, 2005).

Finally, they are context-specific and often dynamic: an identity or experience which might precipitate social exclusion in one place or time may be neutral or positive in another, excluded identities can be reclaimed, and individual circumstances can change (Huxley et al., 2012, Shaw et al., 2005, Room and Britton, 2006).

One disputed area is the distinction between poverty and social exclusion. These terms are sometimes used interchangeably – not least in political discourse where the latter is often seen as a more palatable term for the former (Madanipour et al., 2015, Mathieson et al., 2008). However, it has been argued that exclusion can be distinguished from poverty in its focus on forms of social differentiation not purely related to, or resulting from, material or economic factors (Madanipour et al., 2015, Morgan et al., 2007, Bramley and Bailey, 2018).

2.3.2 Multiple forms of social exclusion

More recently, the multi-dimensional aspect of social exclusion has been elaborated to account for specific combinations of experiences affecting a relatively small proportion of the population and associated with particularly poor outcomes. These combinations have variously been termed ‘deep’ or ‘multiple’ exclusion. ‘Deep exclusion’ has a political origin, in the work of New Labour’s Social Exclusion Unit, whereas ‘multiple exclusion’ sits more within the academic tradition and has become dominant in recent years, especially in relation to homelessness (Levitas et al., 2007, Burchardt et al., 2002, Fitzpatrick et al., 2011, Schneider, 2007). More recent policy discourses in the UK have used ‘multiple disadvantage’ or ‘multiple and complex needs’ to refer to the same phenomenon (Duncan and Corner, 2015); internationally, other terms, such as ‘complex co-occurring disorders’, are more commonly used (Somers et al., 2016b).

In their ‘Hard Edges’ project, Bramley and Fitzpatrick (2015) proposed the term severe and multiple disadvantage (SMD) to refer to a narrower nexus of social disadvantage combining experiences of homelessness, substance use, and offending. Subsequent work has also proposed an expanded ‘SMD5’ definition encompassing mental ill-health and domestic violence, though the three original domains remain the primary focus (Bramley et al., 2019b). The construct of SMD was developed through qualitative scoping with people with lived experience and professional stakeholders, which identified issues which overlap in practice and were felt to interact in important ways. It is also considered less individualistic and stigmatising than some of the other terms in use. ‘Severe and multiple disadvantage’ has therefore often been my preference during this project when a short-hand term for the issues of interest is required, for instance when communicating with funders and stakeholders. However, given that this project examines a slightly different set of experiences to those in ‘Hard Edges’ (including sex work, for instance, but not domestic violence) and diverges in how those experiences are defined, I have chosen not to use this term to any great extent in the thesis or associated outputs.

There has also been an increasing focus on ‘high resource users’ or ‘high resource individuals’; that is, individuals who collectively represent a small proportion of the population but account for a high proportion of service use. In Scotland, improving care pathways for ‘high resource individuals’ has been a major focus of work for Healthcare Improvement Scotland in the years following health and social care integration, with local partnerships supported to undertake targeted analysis of service utilisation and tests of change (Healthcare Improvement Scotland, 2016). Though this programme includes a much more diverse group of individuals than fall within the scope of this thesis (for instance, people coming to the end of their life or with complex long-term health conditions), people experiencing extreme social disadvantage often account for a substantial proportion of ‘high resource individuals’ and may be among the most salient or identifiable to those working in services.

It is also worth acknowledging the terms ‘hard-to-reach’ and ‘vulnerable’, which are commonly used in the context of these experiences. ‘Hard-to-reach’ has been widely used by service providers and policy makers as a label for various population groups whose use of services is perceived to be in some way problematic. However, this term incorporates an implicit normative judgement that this is the responsibility (or even failing) of the individual, and overlooks the fact that such groups often have very high levels of use of some services (Sokol et al., 2015). It also foregrounds the providers' perspective rather than that of the individual affected. Similarly, the term 'vulnerable' is a potentially disempowering label that is often used vaguely (Brown and Wincup, 2020). Given these issues, I avoid using these terms in this project, except for exploring their use by others in the discourse analysis described in Chapter 4.

Though all of these terms vary somewhat in their scope, emphasis, and usage, they are united by a focus on both *breadth* of need (i.e., multiple and interconnected) and *depth* of need (i.e., especially intense or severe), across both social and health domains. Like social inclusion and exclusion, this set of terms has found a strong foothold in policy and practice despite a lack of consensus on their definition and conceptual foundations. This is reflected in multiple publications and initiatives by governmental and non-governmental organisations alike (Page and Hilbery, 2011, Rosengard et al., 2007, Anderson, 2011). For instance, in 2015 – around the time this project began to be planned – the Scottish Government Homelessness Prevention and Strategy Group identified the issue of multiple and complex needs as a key focus for their work over the coming year (Scottish Government Homeless Prevention and Strategy Group, 2015). It has also been a particularly live concern in Glasgow, prompted by challenges meeting statutory responsibilities on homelessness, a complex HIV outbreak among people who inject drugs, high rates of drug-related deaths, and the visibility of begging and other forms of street culture in the city centre (Coltart, 2014, Tweed and Rodgers, 2016).

Policy and practice interest in this population has been motivated by long-standing concerns about a failure to meet needs, reflected by high rates of adverse outcomes; high levels of service utilisation, often via emergency settings; and wider social impacts, such as offending and 'anti-social behaviour' (Page and Hilbery, 2011, Rosengard et al., 2007, Johnson, 2013). Particular concerns have been raised about a lack of co-ordination across different relevant sectors, resulting in complex and fragmented care pathways and a lack of policy coherence (Fitzpatrick et al., 2011, Bramley et al., 2019b, Balda, 2016). As one interviewee in a recent study of stakeholder understandings of social exclusion put it; "The more kind of disadvantaged intersections you have, the fewer the resources are there for you because you will not qualify or you will fall through the cracks in a number of ways, or your particular needs probably won’t be met” (O'Donnell et al., 2021).

Interest in notions of multiple disadvantage and exclusion has also coincided with growing attention to adversity in childhood and in particular a set of traumatic events or stressors known as ‘adverse childhood experiences’ (ACEs) (Walsh, 2020). These include experiencing physical, sexual, and/or emotional abuse, or neglect; parental separation or divorce; mental ill-health in a parent; and imprisonment of a household member (McEwen and Gregerson, 2019). ACEs are common among people with the experiences of interest and especially those with more than one (Bramley and Fitzpatrick, 2015, Bramley et al., 2019b, Fitzpatrick et al., 2013, Liu et al., 2021). ACEs are closely associated with socioeconomic disadvantage during childhood (Walsh et al., 2019) and in turn with poor health and social outcomes in adulthood, including violent victimisation, self-harm, mental ill-health, and problem substance use (Hughes et al., 2017).

2.3.3 Critiques and applications

There are several critiques of inclusion, exclusion, and related terms, in addition to the issues of conceptual clarity noted above.

Identifying individuals or communities as ‘excluded’ carries the risk of stigmatisation and othering, particularly where this is conceptualised as a static condition rather than a dynamic process (Mathieson et al., 2008). This applies as much to the creation of analytic variables for epidemiological research as it does to policy discourses (Katikireddi and Valles, 2014). Neale (2008) has also highlighted the risk of assuming homogeneity among those labelled as excluded, which then becomes a catch-all term failing to reflect individual experience. Huxley et al. (2012) further points out that these terms contain a potentially problematic normative assumption that life outside some mainstream reference group is inherently undesirable. Finally, there is a potential tension between subjective and objective definitions: can exclusion be identified by others, based on quantifiable indicators, or only self-defined, through subjective experience? The former approach runs the risk of ‘lumping together’, as identified by Neale (2008), yet restricting analyses to self-acknowledged identities of exclusion may miss more subtle forms of marginalisation and discrimination and preclude large-scale quantitative analyses able to examine macro-level processes and outcomes.

Despite these critiques and definitional debates, social inclusion and exclusion have proved popular and enduring terms, particularly in policy and practice contexts (Madanipour et al., 2015). At the heart of this appears to be their face validity and practical relevance for people working in these settings. As one service provider put it in a recent interview study, “It’s definitely, ‘you know it when you see it’” (O'Donnell et al., 2021, p.5). Their popularity may also reflect their ability to capture important and distinctive aspects of social experience beyond those associated with poverty and socioeconomic disadvantage; an alternative reading highlights their political utility as an alternative to concepts such as poverty (Madanipour et al., 2015). These issues are explored further in the discourse analysis in Chapter 4.

To date, social inclusion and exclusion have had a limited application within social epidemiology. Rather than an integrated concept encompassing multiple domains, their use mostly appears to be limited to individual domains, in particular socioeconomic (in the form of constructs like deprivation) and interpersonal (as social capital or cohesion). Again, as alluded to in Section 2.2, this partly reflects a tendency within the UK public health tradition to focus on socioeconomic position and related concepts, potentially at the expense of broader aspects of social experience.

2.3.4 Application of these terms in the thesis

Despite the limitations described above, concepts of social inclusion and exclusion may offer what Mathieson et al. (2008) called ‘investigative advantage’ for understanding health inequalities. Drawing on this ‘advantage’, these concepts have influenced the work described in this thesis in two key ways.

First, the choice of experiences examined in this thesis is informed by an interest in social exclusion as an axis of social differentiation distinct from socioeconomic disadvantage alone. As described in Section 2.4, these experiences are commonly (though not universally) characterised by a lack of rights, resources, and participation across civic, economic, social, and interpersonal domains, over and above their association with material deprivation. The notion of social exclusion therefore provides a conceptual foundation for the selection of the experiences of interest, as described in Section 2.4.1. The emphasis on multiple dimensions of exclusion also informs my focus on the intersections and interactions between these experiences, in the systematic review (Chapter 5) and cohort study (Chapter 6 and Chapter 7).

In this context, it is important to be clear about what this project is and is not able to achieve. Practical constraints meant that each empirical analysis was limited in its ability to capture some of the more nuanced aspects of these definitions. In particular, the systematic review and cohort study focus on a specific set of experiences, which are operationalised as binary and static, rather than dynamic. For the review, this was necessary given the number of studies and the ways in which those studies had classified the experiences of interest; for the cohort, it reflects the proof-of-principle nature of cohort creation and analysis and the limitations of available data. These limitations are discussed in more detail in each empirical chapter and in the concluding discussion, incorporating feedback from the project’s stakeholder advisory group and public engagement activities with people with lived or living experience.

This work therefore does not claim to directly measure exclusionary processes, or how they affect health outcomes, but rather to investigate health inequalities among people affected by a set of experiences which share an association with social exclusion. Nonetheless, exploring the conceptual basis provides a standard against which to better understand the limitations of this work and consider aspirations for future work (explored in Chapter 9).

Second, partly in response to my concern about these limitations, I undertook the discourse analysis described in Chapter 4 to explore inclusion, exclusion, and related concepts in more detail and in particular to interrogate their use in health inequalities policy to date.

2.4 Experiences of interest

In this section, I describe the experiences of interest to this project as potential axes of inequality, focusing first on the rationale for their inclusion and the way in which they are operationalised in different sections of the thesis before examining the literature on prevalence, policy context, and association with health for each experience in turn.

2.4.1 Rationale for selection

The experiences of interest to this project were as follows:

- homelessness and housing insecurity;
- involvement in the criminal justice system (hereafter referred to as justice involvement);
- substance use;
- sex work;
- and severe mental illness.

These experiences were selected for this project for theoretical, empirical, and pragmatic reasons.

From a theoretical perspective, they are typically associated with profound social disadvantage, in the form of exclusion from the usual rights, resources, relationships, and activities available to most members of society. Though strongly associated with socioeconomic disadvantage, they are distinct from it and therefore merit attention in their own right as potential axes of inequality. I explore the relationship between these experiences and the concept of social exclusion in the next section.

Empirical work demonstrates that each of these experiences is associated with a greatly elevated risk of poor health outcomes, even after accounting for their association with socioeconomic disadvantage (Aldridge et al., 2018). The inequalities observed among people affected by these experiences typically dwarf the gradient in health outcomes observed across the socioeconomic spectrum, with Lewer et al using the metaphor of ‘slopes and cliffs’ to distinguish between these phenomena (Lewer et al., 2019a). This metaphor is helpful in illustrating how the overall burden of health inequalities may arise both from large numbers of people affected by small gradations in risk (such as those associated with socioeconomic deprivation), as well as from smaller numbers of people affected by very high relative risks (such as those associated with homelessness or incarceration); a point originally articulated by Rose (1985) in relation to the burden of cardiovascular disease.

The thesis is particularly interested in the health of people with more than one of these experiences, as reflected in Chapters 5 to 7. This interest is based on two observations, described in more detail in Section 2.5. First, these experiences appear to co-occur frequently, though estimates of this overlap vary by context and for the UK are scarce. Second, there are grounds for hypothesising that their co-occurrence may have important implications for health.

The experiences chosen for this project do not reflect a complete set of identities or experiences associated with social exclusion. However, with the exception of sex work, they are ones tractable to investigation through the use of existing administrative datasets in Scotland. The focus on this set of experiences therefore reflects pragmatic considerations, given that – as described above in Section 1.3 – the project was originally intended to exclusively use record linkage methods.

For similarly pragmatic reasons, sections of the thesis differ in which experiences fall within scope, and how they are defined. The discourse analysis (Chapter 4) and systematic review (Chapter 5) were able to take an inclusive approach and examine these experiences in a very broad sense, using definitions as applied in existing policy documents and research literature. In contrast, data availability meant that the cohort study (Chapter 6 and Chapter 7) had to implement narrower definitions than the review or discourse analysis: these chapters therefore focus on opioid substitution therapy as an indicator of problem substance use in the form of opioid dependence, and on clinician-diagnosed psychosis as a manifestation of severe mental illness, and omit sex work entirely. The cohort study was however able to include a broader definition of justice involvement through the availability of data from Criminal Justice Social Work Reports on people receiving community as well as custodial sentences. Chapter 8 describes an evaluation of a policy intervention in prisons so limits itself only to justice-involved people in custodial settings.

This literature review therefore takes a broad approach; subsequent analysis chapters each set out which aspects are in scope, and how the experiences are defined and operationalised for the purposes of that analysis.

2.4.2 Relationship with social exclusion

This section briefly explores the relationship between the experiences of interest and social exclusion, building on the concepts introduced in Section 2.3 and in turn laying the groundwork for subsequent discussions of their relationship with health in Sections 2.4.6 and 2.4.7.

In the social science and health literature, the experiences of interest are frequently characterised by their association with social exclusion. Indeed, some widely used indices define social exclusion at least partly on the basis of these experiences: for instance, the Bristol Social Exclusion Matrix includes measures such as having a criminal record; problems with accommodation; and/or poor mental health (Levitas et al., 2007).

For some experiences, the relationship with exclusion seems obvious. For instance, imprisonment has been described as “inherent[ly] exclusionary” (Houchin, 2005, p.83), in that its function and perceived value rests on separation from mainstream society and deprivation of usual civic, economic, social, and interpersonal rights (Coyle, 2005). Allman has extended this idea, conceptualising prisons, asylums, and similar institutions as “exclusion societies”, which segregate certain individuals or social groups from broader society (Allman, 2013, p.2).

Even outwith these institutions, qualitative and theoretical studies have documented how the experiences of interest can hinder individuals’ relationships with many of the ‘systems of integration’ described above (Section 2.3). For instance, for homeless people, the lack of fixed address can hinder participation in to the civic, economic, and interpersonal domains, by restricting access to voting, healthcare, education, employment, and opportunities to conduct social relationships and family life. In the UK, it is estimated that only 2% of homeless people are registered to vote despite lack of a fixed address not technically being a barrier to registration (Cabinet Office, 2019).

Interpersonal exclusion among these groups is also likely to be particularly strong, with experiences of stigmatisation, hostility, and discrimination being widespread: for instance, a systematic review found that on average, 65% of people with schizophrenia reported perceived stigma and 56% reported experiences of stigma; these were associated with lower quality of life and social participation (Gerlinger et al., 2013).

Different forms of exclusion may interact, via material (for instance, limited employment opportunities forcing people to resort to illegal or stigmatised forms of income generation, such as acquisitive crime or sex work); psychosocial (for instance, via compound stigma); and relational pathways (for instance, through social networks and their dominant norms). Experiences of exclusion may also be self-perpetuating: Houchin has argued that those who are socially excluded may be more likely to be imprisoned for a given criminal offence or offences than those who are not (Houchin, 2005).

These findings are corroborated by studies which have surveyed people with the experiences of interest using established indicators or indices of social exclusion (e.g., Huxley et al., 2012, Shinn, 2010, Smith and Stewart, 1997, March et al., 2006, Richter and Hoffmann, 2017). For instance, the Hard Edges Scotland project has drawn on results from the Poverty and Social Exclusion survey to show that people affected by homelessness, offending, and poor mental health are much more likely than their peers in the rest of the population to report low levels of social support and contact; limited ability to participate in social activities; and experiences of discrimination (Bramley et al., 2019b).

2.4.3 Definitions

This section describes how these experiences are defined for the purpose of the thesis as a whole and in each empirical chapter, as informed by existing literature and practical considerations relating to study design and data availability.

2.4.3.1 Homelessness

Homelessness is a term often used loosely to encompass a continuum of adverse housing states, each of which may have different implications for health. A number of formal international definitions of homelessness have been proposed – for instance by the United Nations and European Federation of Organisations Working with People who are Homeless – but to date do not appear to have been widely used in health research (FEANTSA, 2017, OHCHR, 2009, Busch-Geertsema et al., 2016). Neither do they map straightforwardly to statutory definitions of homelessness used in the UK, reflecting their international intent.

While statutory definitions often have a less well-developed theoretical basis, they are important from a pragmatic public health perspective, as they determine who is and is not entitled to specific rights and benefits; affected by policy and service change; and captured in administrative data on homelessness. For instance, in the cohort study described in Chapter 6 and Chapter 7, administrative data on people seeking support from a local authority under their statutory rights is used to define a cohort of people experiencing homelessness and housing insecurity.

In most existing literature on health and homelessness, the choice of definition is influenced by data availability. Homelessness is commonly defined on the basis of accessing relevant services, such as emergency shelters (e.g., Feodor Nilsson et al., 2014) or specialist primary care clinics (e.g., Baggett et al., 2015, Queen et al., 2017). Few studies appear to have used definitions based on statutory entitlements, though recent work from the UK using administrative data sources is an exception (Morrison, 2009, Waugh et al., 2018).

In this thesis, the definition of homelessness employed in each chapter was determined by the aim and design of each study. The discourse analysis of how issues relevant to the ‘inclusion health’ agenda feature in health inequalities policy reviews (Chapter 4) took an inclusive and iterative approach to definitions, with homelessness and unstable housing among the categories in the original coding framework. Similarly, the systematic review described in Chapter 5, which included homelessness as one of the exposures of interest, adopted a deliberately broad definition, including studies of people who are rough sleeping, unstably or marginally housed (e.g., ‘sofa surfing’, staying in single-room occupancy hotels, or ‘street-involved’). This approach maximised the likelihood of retrieving relevant evidence regardless of disciplinary- or country-specific differences in definition. However, as discussed in Section 5.7, using a broad definition may have contributed to high heterogeneity among included studies and precluded a more detailed exploration of results.

In the cohort study, described in more detail in Chapter 6 and Chapter 7, the population exposed to homelessness was identified from local authority records of applicants for statutory support who were assessed as homeless or threatened with homelessness, according to the 1987 Housing (Scotland) Act, as amended. The Act defines ‘homelessness’ as having no accommodation which it is reasonable to occupy, and ‘threatened with homelessness’ as being likely to become homeless within two months (HM Government, 1987).

2.4.3.2 Justice involvement

The criminal justice system encompasses multiple agencies and professions, including the police, courts, prosecution services, prisons, local authorities, judiciary and legal profession (Scottish Centre for Crime and Justice Research, 2019).

In this thesis, I use justice involvement as an umbrella term to include those passing through the court system and/or imprisoned, whether on remand or following conviction. My use of this term (rather than other widely used terms, such as offenders or prisoners) reflects both the fact that a proportion of those imprisoned on remand may in due course be found to have committed no offence, and a preference for ‘person-first’ language that avoids negative, stigmatising, or reductive connotations (Bedell et al., 2018).

This broad focus is reflected in the discourse analysis (Chapter 4). In keeping with the focus of the linkage project as originally conceived, and with the preceding review on which it draws, the systematic review (Chapter 5) focuses exclusively on people with a history of imprisonment. The evaluation of Scotland’s smoke-free prison policy (Chapter 8) also relates only to people in prison custody, reflecting the scope of the intervention under study. However, the cohort study based on the linked dataset (Chapter 6 and Chapter 7) was able to incorporate data from both the Scottish Prison Service and from local authority Criminal Justice Social Work Services and therefore includes justice-involved people from both custodial and community settings.

The rest of the literature review therefore describes the existing literature relevant to people in contact with both custodial and community criminal justice services.

2.4.3.3 Substance use, including opioid dependence

The use of psychoactive substances (that is, those chemicals affecting mental processes such as perception, cognition, or affect) has been a feature of most documented human societies throughout history (Stockwell, 2005). In modern times, the non-medical use of some such substances has been regulated by international and national legislation in order to reduce the risk of addiction or other harms. These substances are therefore commonly described as illicit drugs (Degenhardt and Hall, 2012, Babor et al., 2018).

When this project was originally conceived, the linked cohort was expected to draw on data from the Scottish Drugs Misuse Database to identify people with a history of problem use of illicit drugs seeking support from community treatment services. The discourse analysis (Chapter 4) and systematic review (Chapter 5) reflect this scope by applying a broad definition of substance use, though the latter aimed to exclude alcohol from the definition where feasible. This choice to exclude alcohol from this definition was informed by both conceptual and practical considerations. First, alcohol use is legal and ubiquitous in the UK and many other high-income countries, and does therefore not have as strong an association with exclusionary processes – such as stigmatisation and criminalisation – as do illicit drugs. Although problem alcohol use and related harms disproportionately affect the populations of interest to this work, and can contribute to social exclusion, use of alcohol, and even mild and moderate alcohol dependence, are very common and would therefore be less consistent with our focus on social exclusion. Moreover, problem alcohol use is harder to identify routinely from administrative data sources.

As described in Chapter 6, challenges in data access meant the cohort study focuses specifically on people with opioid dependence, based on Prescribing Information System data on opioid substitution therapy dispensing from community pharmacy settings. This narrower definition may be considered an advantage given the limited scope in this project to explore heterogeneity by substance, though it does inevitably restrict our results and their interpretation to a smaller subset of people with problem substance use.

Opioids refers to a group of substances which activate a specific class of cellular receptors, and comprise both pharmaceutical opioids (such as morphine, codeine, and fentanyl) as well as those manufactured and distributed illicitly (Strang et al., 2020). Opioid dependence is a chronic condition defined by harmful patterns of opioid use, including physiological signs of dependence (such as tolerance or withdrawal); preoccupation with and difficulties controlling use; continued use despite negative consequences; and a high propensity to relapse (Degenhardt et al., 2019, Strang et al., 2020). In the UK, heroin accounts for the majority of non-medical opioid use, though may also be accompanied by illicit use of prescribed opioids such as methadone and tramadol (Information Services Division Scotland, 2019, Advisory Council on the Misuse of Drugs, 2016).

To cover this diversity of definitions, in this thesis I will use the umbrella term ‘substance use’ when referring to the project as a whole or those elements of it which used broader definitions, ‘drug use’ when seeking to explicitly distinguish the use of illicit drugs from alcohol (for instance, for consistency with primary literature), and the narrower term ‘opioid dependence’ when discussing the cohort study specifically.

2.4.3.4 Sex work

Sex work potentially encompasses a range of activities from payment for sex to pornography and other forms of performance such as stripping (Weitzer, 2009).

For the purposes of the discourse analysis (Chapter 4), sex work was included as one of the potential issues of interest and a broad approach taken to definition, given the opportunity as part of the research to explore the ways in which this experience was conceptualised and described. In the systematic review (Chapter 5), this definition was operationalised as ‘commercial sex work’, that is the sale of sex in exchange for material resources including money, food, accommodation, and drugs, and including sexual relationships explicitly identified as transactional.

It is important to note that this is a narrower definition of sex work than is sometimes used elsewhere (Hester et al., 2019). There are important debates about the use of language in this field, especially about the legitimacy of paid sex as work and the potential pejorative dimension of terms such as ‘prostitution’. None of the terms in use is uncontested or without its strengths and limitations. I have chosen to use the term ‘sex work’ as defined above, primarily to avoid any implied negative connotations from other terms and in keeping with the predominant terminology used by organisations representing people with current active involvement in the industry, whilst also recognising that not everyone identifies with this term and that it is by no means value-free.

Sex work could not be included in the cohort study (Chapters 6 and 7) due to a lack of available administrative data (described further in Section 6.1): coverage of sex work in the following sections is therefore briefer than for the other experiences of interest.

2.4.3.5 Psychotic disorder and severe mental illness

Psychosis refers to a range of symptoms affecting perception, thought, and behaviour, such as hallucinations (sensory perceptions in the absence of an external stimulus), delusions (fixed or incorrect beliefs), and thought disturbance (disorganised patterns of cognition, speech, and behaviour) (National Institute for Health and Care Excellence, 2021). These are often accompanied by a range of ‘negative’ symptoms characterised by loss of motivation, interest, and expression; flattening of affect; loss of enjoyment; and social withdrawal (National Institute for Health and Care Excellence, 2021). Psychosis may be the secondary result of physical health conditions or substance use, or manifest as part of a primary psychiatric disorder – such as schizophrenia, bipolar disorder, or severe depression. Although some people make a full recovery, for many people psychotic disorders are long-term conditions causing repeated episodes or prolonged periods of ill-health (Owen et al., 2016).

These conditions are sometimes grouped under the terms ‘severe mental illness’, ‘serious mental illness’, ‘severe and enduring mental illness’, or ‘major mental illness’. However, there is no consensus on the scope of these terms, whether for service, policy, or research purposes, and there are multiple definitions in use (for example, Martin et al., 2014c, Martin et al., 2014b, Jacobs et al., 2015, Ruggeri et al., 2000, Kontopantelis et al., 2015, Schinnar et al., 1990, Slade et al., 1997). There is debate as to which diagnoses should be included within any such grouping and many definitions include criteria beyond just diagnosis, encompassing duration or functional impairment (Parabiaghi et al., 2006).

However, in the context of epidemiological studies, diagnosis-based definitions are common where information on duration or dysfunction is not available (Tosh et al., 2014, Kontopantelis et al., 2015, Jacobs et al., 2015). Though this approach has the major disadvantage of generalising across diagnostic categories as a proxy for severity, without taking into account the degree of functional impairment or individual impact, it is often the only feasible option when dealing with administrative data.

The definitions used in the different chapters of this thesis reflect both methodological considerations and pragmatic constraints. The iterative coding framework in the discourse analysis (Chapter 4) permitted an inclusive definition: both the umbrella terms of “serious/severe mental illness” and specific diagnoses were included in the initial framework as issues identified of *a priori* relevance to inclusion health, with the potential to broaden or amend this definition during familiarisation. The systematic review (Chapter 5) took a similarly inclusive approach, defining severe mental illness as schizophrenia spectrum disorders, other primary psychotic disorders, and/or bipolar disorder, or according to the primary study’s definition of “serious” or “severe” mental illness: the latter criterion was included to capture those studies that encompassed this population without specifying individual diagnostic categories. In contrast, the quantitative analyses based on linked administrative data (Chapter 6 and Chapter 7) used a narrower definition corresponding to that used in the PsyCIS data source, a local clinical registry of people with primary psychotic disorder in touch with local community mental health teams, which served as our means of ascertaining this exposure in the Glasgow City population. Inclusion in PsyCIS is based on ICD-10 diagnoses alone, the full list of which is provided in the Supplementary material accompanying Chapter 6.

In this thesis I use the umbrella term ‘severe mental illness’ when referring to the project as a whole or those elements of it which used broader definitions, and the narrower terms ‘psychosis’ or ‘psychotic disorder’ when discussing the cohort study specifically.

2.4.4 Incidence, prevalence, and demographic associations

Obtaining accurate data on the occurrence and demographic associations of these experiences is often challenging, given issues of stigma and criminalisation, as well as a lack of consistent definitions within and between countries. Nonetheless, this section seeks to summarise the best available data on the extent of these experiences and the characteristics of those most likely to be affected.

2.4.4.1 Homelessness

In 2005 the United Nations estimated that 100 million people worldwide were without a place to live, and many countries in Europe have seen an increase in homelessness in recent years (United Nations, 2005, Foundation Abbé Pierre/FEANTSA, 2021).

In Scotland, the main source for quantifying the extent of homelessness is administrative data collected by local authorities when discharging their statutory duties to provide housing and homelessness support for people living in their area. Until recently, there was also a question in the Scottish Household Survey on previous experiences of homelessness. However, by definition, these data include only those households seeking support (administrative data) or resident in private households (Scottish Household Survey): there is debate to the extent to which this sampling approach results in an under-estimate of the ‘true’ homeless population (Watts et al., 2021).

During 2019/20, 36,855 households in Scotland made a formal application for statutory homelessness support, of whom 31,333 – corresponding to a total of 51,365 individuals – were assessed as homeless (Scottish Government, 2020b). Of those applying, 55% of main applicants were male; 55% were aged under 35; and 86% were of white ethnicity. With regard to household type, 66% were single households, and 22% were single parents. In recent years in Scotland, there have been an estimated 10-11,000 households in temporary accommodation on the census date of 31st March; the average stay in temporary accommodation is around 180 days (Scottish Government, 2020b).

By triangulating data from administrative sources, household surveys, and surveys of people using crisis services, attempts have been made to estimate the number of people experiencing ‘core homelessness’ in Scotland (Watts et al., 2021). Core homelessness is defined as rough sleeping; sleeping in cars, tents, public transport, or occupation of non-residential buildings; staying in hostels, refuges and shelters; living in ‘unsuitable’ temporary accommodation (e.g., bed and breakfast); or sofa-surfing (i.e., staying with non-family, on a short-term basis, in overcrowded conditions). Estimates suggest the number of people experiencing core homelessness has remained largely stable between 2012 and 2019, averaging 12,050-14,250 on a typical night during this period (Watts et al., 2021).

The risk of homelessness for any given person is related to individual-level factors (above all, poverty, especially in childhood), the extent of ‘buffering’ social support (in the form of relationships with family and intimate partners), and structural forces, such as local housing markets and, to a lesser extent, labour markets, welfare regime, racism and other forms of discrimination (Bramley and Fitzpatrick, 2018, Johnson et al., 2015, Shinn, 2007). Other factors include adverse childhood experiences such as neglect or abuse; illness or disability as a working-age adult; a criminal record or previous incarceration; and previous episodes of homelessness. As a result, the extent and composition of the homeless population can vary substantially between countries, thanks to the relative prevalence and interplay of these risk factors (Shinn, 2007, Benjaminsen and Andrade, 2015).

2.4.4.2 Justice involvement

In 2018, it was estimated that more than 10 million people worldwide were in prison, almost one million of whom were in Europe (excluding Russia) (Walmsley, 2018). Scotland has a higher imprisonment rate than most other northern and western European countries, and within Scotland, Glasgow City is among the local authorities with the highest rates (Walmsley, 2018, Scottish Centre for Crime and Justice Research, 2015).

Between 2010/11 and 2013/14 (the period examined by the cohort study in Chapter 6 and Chapter 7), the total number of people spending any time in prison per year in Scotland averaged around 20,000; since then, it has declined slightly to just over 17,000 (Scottish Government, 2020c). People on remand account for a substantial proportion: around 30% of arrivals are untried or convicted awaiting sentence (Scottish Government, 2020c).

The majority of people in prison in Scotland are male (for instance, 92% on average between 2010/11 and 2013/14) (Scottish Government, 2020c). The Scottish prison population is younger on average than the Scottish population as a whole (e.g. mean age 31.8 in 2010/11); however, in recent years the prison population has shown an ageing trend, with the proportion aged 55 or older increasing from 3.3% in 2010/11 to 7.0% in 2019/20 (Scottish Government, 2020c). With regard to ethnicity, 96% of the prison population are White, a similar proportion to the population of Scotland as a whole (Scottish Government, 2020c, UK Data Explorer, 2021). There is a clear relationship between socioeconomic deprivation and imprisonment in Scotland, with the most deprived decile of areas over-represented among prison arrivals by a factor of three, with this ratio remaining fairly static over the past decade (Scottish Government, 2020c).

Fewer data are available on the characteristics of people in contact with community justice services in Scotland. The number of people proceeded against in Scottish criminal courts has been falling in recent years, from 131,000 in 2010/11 and 122,000 in 2013/14 (the first and last year of the exposure period for the cohort study described in Chapters 6 and 7), to 86,000 in 2018/19 (Scottish Government, 2021a). The overall conviction rate has remained fairly static at 86-88%; of those convicted, around 13-16% receive a custodial sentence, with the remainder receiving a financial penalty, community sentence, or other sentence (such as a verbal warning) (Scottish Government, 2021a).

2.4.4.3 Substance use, including opioid dependence

The United Nations estimates that during 2020 around 275 million people worldwide used drugs controlled under international conventions, with over 36 million of those suffering from drug use disorders (United Nations Office on Drugs and Crime, 2021).

In Scotland, capture-recapture methods are applied to data from treatment services, hospital admissions, and the justice system to produce regular estimates of the number of people with problem opioid and/or benzodiazepine use. The most recent of these estimated that that during 2015/16, between 55,8000 and 58,900 people aged 15-64 had problem use of opioids and/or benzodiazepines; approximately 2% of the population (Information Services Division Scotland, 2019). An estimated 11,900 (21%) of these people were resident in Glasgow City, with a population prevalence of 3%, the highest of any council area (Information Services Division Scotland, 2019).

With regard to demographic characteristics, an estimated 71% of those with problem opioid and/or benzodiazepine use were male. While prevalence was highest among people aged 25 to 34 years, those aged 35 to 64 years accounted for 64% of the total number (Information Services Division Scotland, 2019). This reflects a broader phenomenon observed in many high-income countries of ageing among people with problem drug use, due to declining initiation and later age at onset as well as longer periods of drug use (Beynon et al., 2010b, Johnston et al., 2017). Problem drug use is also strongly associated with socioeconomic deprivation in Scotland and elsewhere. For instance, the Scottish Burden of Disease study found that, of all disease groupings, drug use disorders showed the largest relative inequalities in burden of disease between the most and least deprived areas (17 times higher in the former compared to the latter), and were the biggest single contributor to the burden of disease in the most deprived areas (accounting for 8.1% of total Disability-Adjusted Life Years; DALYs) (ScotPHO, 2018).

2.4.4.4 Sex work

Few global estimates of the prevalence of sex work exist, and those that do are heavily contested (NSWP, 2015). A recent House of Commons inquiry estimated that there are between 60,000 and 80,000 sex workers in the UK, but this figure is subject to debate and it is unclear what definition was applied (House of Commons Home Affairs Committee, 2016). An extensive report commissioned by the UK Home Office concluded that estimating the prevalence of sex work was challenging and that such estimates should always be accompanied by caveats; it did not attempt to offer an estimate of its own, offering instead a best practice guide for local data collection (Hester et al., 2019).

Research to date in Scotland and elsewhere suggests that women appear to account for the large majority of sex workers, though this may reflect the sampling approaches employed – for instance, focusing on outdoor settings and individuals in contact with services (Scottish Centre for Crime and Justice Research, 2017).

Work to date with sex workers across the UK has found that most (though not all) were motivated by necessity and life circumstances, rather than identifying sex work as a fulfilling and positive career choice; this was echoed by practitioners working in dedicated services for sex workers (Scottish Government, 2017a, Hester et al., 2019).

2.4.4.5 Psychotic disorder and severe mental illness

A recent meta-analysis estimated the global incidence of all psychotic disorders at 27 per 100,000 person-years, with men and ethnic minority groups at higher risk (Jongsma et al., 2019). Other associations include socioeconomic disadvantage; urbanicity; and migration (Selten et al., 2020, Kirkbride et al., 2012). Worldwide, an estimated 80.4 million people are living with schizophrenia or bipolar disorder, with these conditions accounting for 1% of all-cause disability-adjusted life years (DALYs) (Whiteford et al., 2015).

Analyses of English data have estimated the prevalence of psychotic disorders at 0.9% (based on GP registers) (Public Health England, 2019) and 0.5% (based on surveys of private households) (Appleby et al., 2016). Fewer data are available for Scotland. The 2000 Psychiatric Morbidity Survey carried out by ONS reported a similar prevalence of probable psychotic disorder in Scotland compared to England (0.5% in both) but again included only people living in private households (Singleton et al., 2001). GP register data from 2015/16 (the most recent year for which data are available, following the withdrawal of QOF in April 2017) estimate the prevalence of psychotic disorders at 0.9%, the same as similar data from England (Information Services Division Scotland, 2016).

2.4.5 Policy and practice context

The following sections aim to provide a brief description of the context in which these experiences occur and efforts to respond to them through policy and services.

The context described here is especially relevant to understanding the methods and findings of the cohort study described in Chapters 6 and 7, given the extent to which the scope and content of administrative datasets depend on service provision.

The following sections therefore have a particular focus on Scotland, reflecting the geographical scope of these chapters, as well as the largely devolved nature of these policy areas in the UK.

2.4.5.1 Homelessness

In Scotland, local authorities are legally obliged to provide settled accommodation for people who find themselves homeless or likely to become so within the next two months (Watts et al., 2021). This has been described as “possibly the strongest legal framework in the world in relation to protecting people from homelessness” (Anderson and Serpa, 2013, p.15), though the extent to which these protections are realised in practice have been debated (Scottish Housing Regulator, 2014). Since 2010, statutory provision has been complemented by the more preventative ‘Housing Options’ approach, which is intended to support those in housing need or at risk of losing their home (Scottish Government, 2016).

Recent years have seen a renewed policy interest and investment in homelessness in Scotland (Watts et al., 2021). Much of this policy momentum focuses on people experiencing homelessness alongside other forms of exclusion. One example of this is the expansion of Housing First, an approach to rapid rehousing in mainstream accommodation of people with multiple disadvantage, accompanied by holistic support (Homeless Network Scotland, 2021).

Healthcare provision for homeless people in Scotland combines mainstream and specialist approaches. People without a fixed address are eligible to register with mainstream GPs using a temporary address, such as that of a friend or an organisation they are in touch with, although this right is not always realised in practice (Mental Welfare Commission for Scotland, 2017). Glasgow, Edinburgh and Aberdeen have specialist primary health care centres for people who are homeless, which are primarily aimed at people who are rough sleeping and provide a range of services including GPs, nursing, mental health, dentistry, dietetics, and addictions care (Hamlet and Hetherington, 2015). In several areas, homeless outreach teams (consisting of GPs, nurses, and/or pharmacists) also operate in hostels, night shelters, day centres, and spots known for rough sleeping. With regard to secondary care, some health board areas provide specialist homelessness liaison or ‘in-reach’ services to hospitals, which aim to assist with housing advice, discharge planning, and linkage to follow-up care.

2.4.5.2 Justice involvement

Like homelessness, criminal justice is a devolved matter in Scotland (Scottish Centre for Crime and Justice Research, 2019).

Following the detection and reporting of an alleged crime, the matter may be dealt with directly by the police (e.g. through a recorded police warning or fixed penalty); by the Crown Office and Procurator Fiscal (e.g. through a warning, fixed penalty, fine, work order, or diversion from prosecution); or proceed to prosecution in the courts (Community Justice Scotland, 2021). Where convicted or pleading guilty in the courts, an individual may be subject to a custodial sentence; community sentence; admonished (given a verbal warning); or discharged completely (Community Justice Scotland, 2021).

Local authorities are responsible for a range of criminal justice social work services, including the preparation of reports to inform sentencing, the supervision of community sentences or people released from custody on licence, and the provision of ‘throughcare’ support services to people in prison and following release (Scottish Centre for Crime and Justice Research, 2019). The preparation of criminal justice social work reports is described in more detail in Chapter 6, as background to the use of these reports as an administrative dataset for the cohort study in Glasgow City.

Prisons and young offender institutions are administered by the Scottish Prison Service, an Executive Agency of the Scottish Government (McCallum, 2017). At present, there are 15 prisons or young offender institutions in Scotland. Following a transfer of responsibilities from the Scottish Prison Service in 2011, each territorial health board in NHS Scotland is now responsible for the delivery of healthcare in the prisons within its boundaries (Scottish Parliament Health and Sport Committee, 2017).

In recent years, Scottish Government justice policy has emphasised a shift from custodial to community sentences (for instance, through a reduction in the use of short custodial sentences) and on partnership working for community justice through local arrangements (Audit Scotland, 2021). The Scottish Government has also committed to taking a ‘public health’ approach to justice, characterised by diversion of people with problem drug use from the justice system into treatment and support, efforts to improve health and wellbeing of people in prison, potential reforms to drug laws, and partnership working between policing and public health (Scottish Government, 2018, Police Scotland, 2021).

2.4.5.3 Substance use, including opioid dependence

Legislation governing the control of drugs is reserved to the UK Parliament, with the Misuse of Drugs Act 1971 and the Psychoactive Substances Act 2016 defining offences and penalties in relation to the production, possession, supply and import of specific psychoactive substances. Powers relating to law enforcement, prevention, and treatment are devolved matters under the control of the Scottish Parliament.

Current Scottish Government policy in this area is set out in ‘Rights, Respect and Recovery’, its treatment strategy for drugs and alcohol. This document builds on the ‘Road to Recovery’ strategy from 2008 to set out an ambition for a public health approach to these issues and to their relationship with the criminal justice system (Scottish Government, 2018, Scottish Government, 2008b).

Rates of drug-related death have increased markedly in Scotland in recent years, with almost five times as many deaths in 2020 compared to 2000 (National Records of Scotland, 2021a). Though international comparisons can be challenging due to differences in definitions and data collection, Scotland does appear to have a substantially higher drug-related death rate than other European countries (National Records of Scotland, 2021a). As a result, drug policy has been gathering increasing political and media attention; not least due to contention between the Scottish and UK Governments about the introduction of safer drug consumption facilities (Christie, 2021).

Treatment and support services for people with problem substance use in Scotland are provided through 30 local Alcohol and Drug Partnerships (ADPs), which are responsible for providing or commissioning services encompassing harm reduction (such as opioid substitution therapy and injecting equipment provision); detoxification and rehabilitation (on a residential or community basis); psychosocial support; and recovery (Davies, 2017).

Opioid substitution therapy (OST) – in the form of methadone and buprenorphine – is recommended for people with opioid dependence as a means of reducing the risk of death and other health and social harms (Sordo et al., 2017). It is provided in Scotland through community addiction teams or primary care, according to UK-wide guidance on clinical management of drug misuse and dependence, also known as the ‘Orange Guidelines’ (Clinical Guidelines on Drug Misuse and Dependence Update 2017 Independent Expert Working Group, 2017). OST prescribed in these settings is typically dispensed via community pharmacies (Laird et al., 2016).

2.4.5.4 Sex work

In Scotland, buying or selling sex is legal, though some related activities – such as loitering and soliciting for the sale or purchase of sex, or running a brothel – are illegal (Scottish Centre for Crime and Justice Research, 2017). In practice, regulation of sex work has varied between areas and over time, with differing agencies involved and differing approaches ranging from ‘operational tolerance’ to more assertive responses (Scottish Centre for Crime and Justice Research, 2017).

Services for sex workers in Scotland are typically limited to the four major cities (Glasgow, Edinburgh, Aberdeen, and Dundee) and involve a range of agencies including health, social work, other services such as housing, and sometimes the police (Scottish Government, 2017a). The ethos and emphasis of these services appears to vary, though most are reported to adopt a ‘harm reduction’ approach to minimise immediate risk and support workers to reduce or stop their involvement in the sex industry (Scottish Government, 2017a).

This somewhat fragmented picture means that very few data are available for understanding the prevalence, intersections, and health of people involved in sex work in Scotland. This experience was therefore omitted from the cohort study described in Chapters 6 and 7, although included in the discourse analysis and systematic review in Chapters 4 and 5 in the interests of inclusivity and of continuity with previous work on which the thesis, and Chapter 5 in particular, builds (Aldridge et al., 2018).

2.4.5.5 Psychotic disorder and severe mental illness

With regard to services for people with psychotic illnesses in Scotland, mental health care is provided in inpatient settings (usually specialist psychiatric hospitals) and outpatient settings (by community mental health teams). Since the integration of health and social care across health boards and local authorities in 2016, both have been managed by Health and Social Care Partnerships (HSCPs), which are also responsible for providing social care and other support services for people with mental illness.

Successive Scottish Government policy documents have focused on remedying under-recognition and under-treatment of mental illness, and the relative neglect of mental compared to physical health (Scottish Government, 2012a, Scottish Government, 2017b). The most recent mental health strategy has a particular emphasis on the physical wellbeing of people with mental health problems and on access to, and integration of, services (Scottish Government, 2017b).

2.4.6 Health outcomes: theoretical pathways

This section describes in general terms the mechanisms by which the five experiences of interest may influence health, as a precursor to the following section, which examines in more detail the empirical evidence on the association between each experience and health outcomes.

This section draws on qualitative studies of the lived experience of people affected by these issues, as well as relevant theoretical frameworks such as the social determinants of health (Dahlgren and Whitehead, 1991); the socio-ecological model of health (Golden and Earp, 2012); and Rhodes' 'risk environment' framework (Rhodes, 2002, Rhodes, 2009). I also draw on social models of disability, particularly in relation to severe mental illness, to understand how negative outcomes can arise as the result of disabling social processes rather than being inherent to the condition itself (Mulvany, 2000). The emphasis placed by these frameworks on the importance of wider processes and contexts is especially valuable for this thesis, much of which explores how the health of people with any one of the experiences of interest is influenced by their broader life circumstances in the form of intersecting disadvantages.

Figure 1 illustrates potential pathways through which the experiences of interest may influence health, under the following broad categories: physical hazards, material resources, psychosocial, relational, and institutional factors. Using a social determinants lens, it presents these experiences – and their association with social inclusion and exclusion – in terms of exposure to a constellation of risk or protective factors that may influence health. It notes the importance of the operation of these processes across the lifecourse in determining individual health and wellbeing, and the potential for effect modification by factors such as age, gender, ethnicity, and policy context.

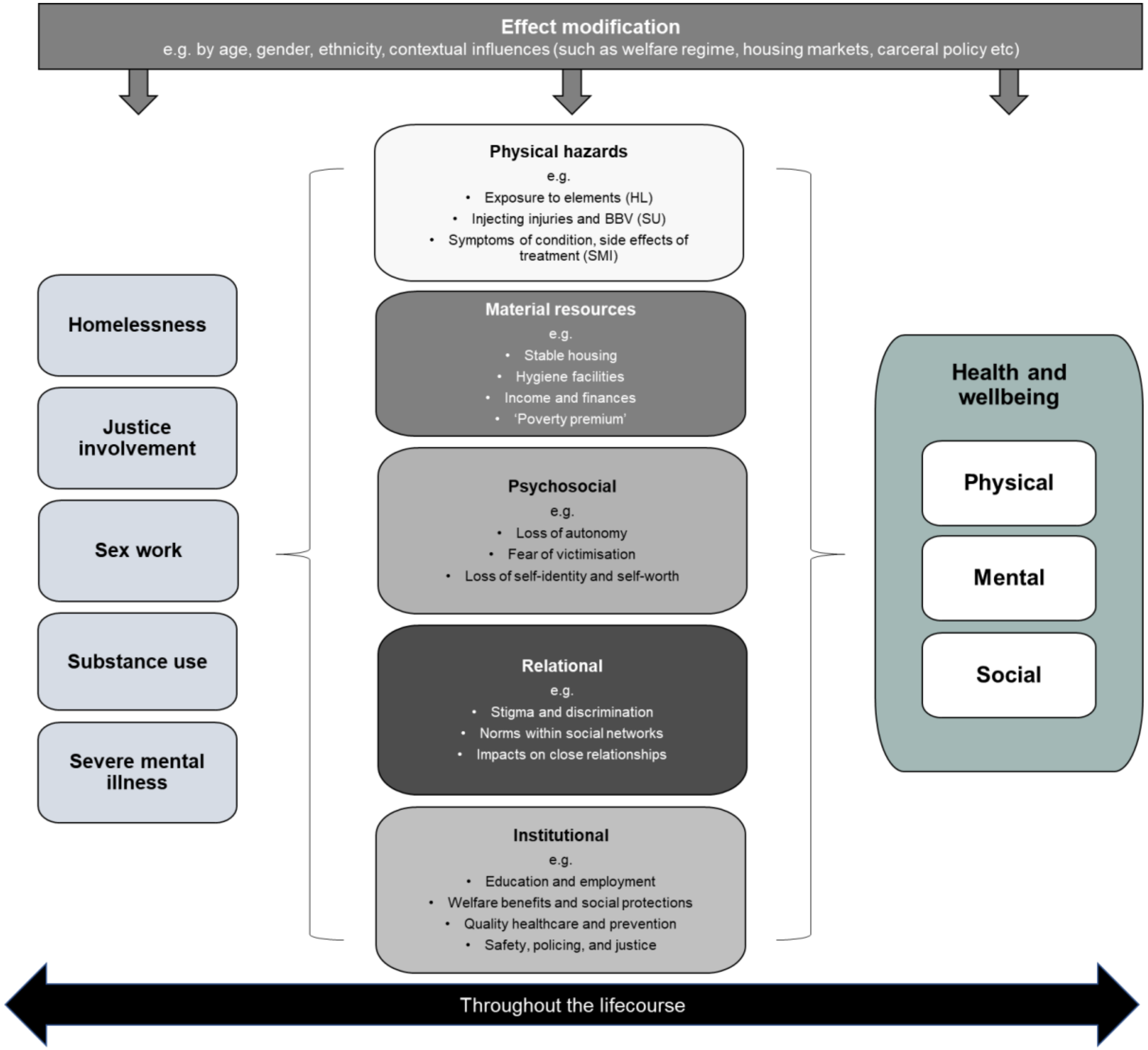
Many of these experiences are associated with specific physical hazards; for instance, excessive cold, heat, or damp among people who are homeless (Cusack et al., 2013); the risk of communicable diseases in congregate settings such as prisons or shelters (Simpson and Butler, 2020, Raoult et al., 2001, Massoglia, 2008); or the cardiometabolic side effects of many treatments for psychosis (Nielsen et al., 2021).

The other pathways of influence tend to be common – to a greater or lesser extent – across all the experiences of interest. For instance, stigma and discrimination are extremely prevalent among people with these experiences, and have a reciprocal relationship with other forms of disadvantage (Mathieson et al., 2008). A sense of disempowerment is commonly described as part of people’s lived experience of each of these issues but may be especially acute in institutional settings such as prisons and inpatient psychiatric care. Disempowerment can impact directly on people’s mental and physical health as well as indirectly by contributing to escapist activities such as problem substance use (Coyle, 2005, Meanwell, 2012).

Material resources refer to the impact of these experiences on people’s monetary or physical resources as individuals. For instance, these experiences often make it difficult for people to find and maintain stable housing, whether due to limited or unreliable income, a lack of suitable opportunities, or the impacts of physical and mental health problems on managing bills and maintenance (Zolnierek, 2011, Wildeman and Wang, 2017). Many of these challenges also apply to employment, resulting in long-term unemployment and under-employment, or restriction to low-paid, insecure, or hazardous work, which in turn negatively impacts on health

(Lester and Tritter, 2005, The Schizophrenia Commission, 2012, Massoglia and Pridemore, 2015). In particular, imprisonment – and above all recurrent short sentences – is recognised for its disruptive impacts on these material circumstances of everyday life (Dumont et al., 2012).

Figure 1. Simplified schematic model of pathways by which the experiences of interest may affect health



As well as material circumstances, these experiences also affect people's interaction with societal institutions and their ability to access shared goods and resources. In particular, difficulties accessing healthcare are extensively documented for people experiencing all of these forms of disadvantage, even in countries with universal healthcare systems such as the UK (Elwell-Sutton et al., 2017, Ginn, 2012, Neale et al., 2008, Mastrocola et al., 2015, Lester and Tritter, 2005). Such difficulties may arise from problems in registration; problems in travelling to services; challenges in understanding and navigating the system; concerns about stigma, discrimination, and coercion; competing demands which take priority; and low expectations for health and life prospects more generally (Liu and Hwang, 2021, Perry et al., 2020, Neale et al., 2008, Ginn, 2012). In some instances, periods of institutionalisation – such as imprisonment – may offer an opportunity to improve access to healthcare services, but there are frequently other challenges to face such as disruption to continuity of care; lack of harm reduction provision (such as safe injecting equipment); and difficulties in accessing specialist healthcare (Fazel and Baillargeon, 2011).

Relationships with other societal institutions may also be fraught. For instance, sex workers may be discouraged from seeking help from police following victimisation or violence by concerns ranging from dismissal or disinterest to criminalisation or coercion, potentially compounding their vulnerability to these harms; trauma; and sense of isolation and exclusion (Weitzer, 2009, Scottish Government, 2017a).

Although they are not explored in detail in the empirical work in this thesis, it is important to acknowledge pathways with potential positive impacts on health, where they may exist: for instance, the role of substance use in supporting social relationships and alleviating physical or mental distress (Ivsins and Yake, 2018), or the observed short-term reduction in mortality among young men during periods of imprisonment (e.g., Patterson, 2010, Graham et al., 2015).

It is also important to acknowledge the potential interactions between the different pathways illustrated in Figure 1. For instance, the risk of violence and victimisation – extremely high among people affected by the experiences of interest – are heightened by people's material circumstances (for instance, lack of physical protection among people who are homeless or insecurely housed) as well as the interpersonal context of stigma and discrimination, and in turn are likely to have impacts on psychosocial determinants of health (Nilsson et al., 2020, Richardson et al., 2015, de Vries et al., 2019). This interplay illustrates how the health effects of these experiences depend on multiple interacting processes at the individual, community, and societal levels.

However, despite the rich theoretical evidence of potential pathways between the experiences of interest and health, there are challenges to establishing whether causal relationships exist (Hwang, 2002, Kinner et al., 2013, Schnittker and John, 2007). These challenges reflect potentially complex causal pathways operating across the lifecourse as well as the risk of reverse causality and confounding within existing studies, many of which are cross-sectional in nature. Nonetheless, even in the absence of causal certainty, the observation that people affected by these issues experience profound health disadvantages can be used to inform services and policies that may help redress this inequity. This is explored further in the discussion (Chapter 9).

2.4.7 Health outcomes: empirical evidence

This section aims to summarise existing empirical evidence on the association of each experience with health, with a particular focus on the specific outcomes examined in Chapter 7, namely all-cause mortality; cause-specific mortality from non-communicable diseases (NCDs); and avoidable mortality. I also allude to existing literature on self-rated health and quality of life, one of the outcomes examined in the systematic review in Chapter 5.

For the purposes of this summary, NCDs are defined according to the NCD4 category used in the World Health Organisation Global Action Plan on NCDs, comprising cancer, cardiovascular disease, chronic respiratory disease, and diabetes mellitus (World Health Organisation, 2014b). The rationale for this choice is several-fold:

- These conditions share similar proximal risk factors – such as diet, physical activity, exposure to tobacco smoke and other airborne pollutants. Use of this grouping therefore enables clearer inferences about prevention efforts than broader definitions with more diverse aetiologies.

- These conditions share a requirement for ongoing monitoring and treatment, which has implications for health system responses and individual experiences of illness and care.

- It has been estimated that these conditions – sometimes referred to as NCD4 – account for 80% of the burden of total NCDs globally; this proportion is higher in high-income countries such as the UK (Bennett et al., 2020).

A focus on NCD4 therefore provides conceptual clarity and consistency whilst accounting for the vast majority of overall NCD burden.

Avoidable mortality, defined as deaths from causes considered treatable through healthcare intervention or preventable through public health action, is a metric originally developed for benchmarking purposes in the context of healthcare quality improvement (Castelli and Nizalova, 2011). Since then, it has increasingly been applied to understand inequalities in excess mortality within and between populations; its definition and use are discussed further in Chapter 7.

2.4.7.1 Homelessness

There is a substantial body of empirical literature describing the health experiences of people who are homeless, as summarised in systematic reviews by Fazel et al. (2014) and Aldridge et al. (2018).

With regard to mortality, multiple studies have demonstrated an increased risk of death among people who are homeless compared to the general population (Fazel et al., 2014, Aldridge et al., 2018). Standardised mortality ratios in published studies vary from 2 to 6, with relative risk higher among women and younger people. These findings are reproduced in UK studies of people experiencing homelessness, including those using population-based administrative data sources (Morrison, 2009, Waugh et al., 2018).

Rates of unintentional injury, violence, self-harm, and infections (such as HIV, TB, and blood-borne viruses) appear to be particularly high among people who are homeless, though there is significant heterogeneity between different countries

(Fazel et al., 2014, Frencher et al., 2010, Aldridge et al., 2018, Beijer et al., 2012, Raven et al., 2017, Hammig et al., 2014).

However, much less has been published about the prevalence and outcomes of NCDs among people who are homeless (Aldridge et al., 2018).

A review by Asgary (2018) identified a lack of studies on cancer burden and mortality among homeless people: where data did exist, it appeared to suggest higher incidence, more advanced stage at diagnosis, and higher mortality rates.

A systematic review found only 17 studies of cardiovascular disease (CVD) among homeless people compared to housed counterparts (Al-Shakarchi et al., 2020), of which only one was carried out in the UK (Morrison, 2009). The review estimated that homeless people were around three times more likely to experience cardiovascular disease compared to their housed peers, with almost all studies finding an elevated mortality risk as well. These findings have been corroborated by a recent study which found a higher prevalence and incidence of CVD among people recorded as homeless in routine primary care data in England compared to housed controls (an almost 2-fold difference in both cases), as well as higher mortality (Nanjo et al., 2020). This differential is lower than observed in some survey studies of people in contact with services for rough sleepers (e.g.,Lewer et al., 2019a, which found a prevalence ratio of 3.8 for self-reported 'heart problems' compared to the housed population), emphasising the heterogeneity of the homeless population and the value of population-based studies with large samples.

There is some evidence to suggest a higher burden of chronic respiratory disease among people experiencing homelessness compared to their housed peers. In the linkage study undertaken in Glasgow by Morrison (2008), rates of emergency hospital admission and death from respiratory disease were substantially elevated among people accessing local authority homelessness support versus people living in the most deprived areas. Marked inequalities were also observed in Lewer et al’s survey of people with a history of homelessness in London, which found that chronic obstructive pulmonary disease (COPD) and asthma had the highest self-reported prevalence of the six chronic conditions examined (14% and 18% respectively), and that COPD showed the greatest relative difference compared to housed controls (prevalence ratio 10.4; for asthma the figure was 3.2) (Lewer et al., 2019a). These prevalence estimates are similar to those reported by other cross-sectional surveys in England and North America (Snyder and Eisner, 2004, Nikoo et al., 2015, Homeless Link, 2014).

With regard to diabetes, there is a paucity of relevant evidence from UK settings. A systematic review of data from the US found no difference in diabetes prevalence between the housed and homeless population (Bernstein et al., 2014); this coincides with a survey by Lewer et al, in which the self-reported prevalence of diabetes among homeless people in London was similar to that of the housed population living in the most deprived quintile, at 4% (Lewer et al., 2019a). Studies of mortality among homeless populations have typically reported findings for the overall ICD category of ‘endocrine, nutritional and metabolic’, which encompasses multiple conditions with diverse causative factors, so offer little insight into the mortality burden associated with diabetes as a chronic non-communicable disease (Aldridge et al., 2019, Morrison, 2008).

People with experience of homelessness also appear to have lower access to preventative interventions for chronic conditions, such as cancer screening, and more limited capacity to effectively manage these conditions (Fazel et al., 2014, Asgary, 2018).

In the last few years, national statistical agencies in the UK have begun to publish preliminary data on deaths among homeless people, using information from death records to identify those who were sleeping rough or living in temporary accommodation at the time of their death, supplemented by capture-recapture analysis (Office for National Statistics, 2020b, National Records of Scotland, 2021b). These are limited by a narrow definition of homelessness and a lack of information on the broader homeless population at risk, but have nonetheless yielded some interesting insights. For instance, the Scottish analysis found circulatory diseases and neoplasms to be the second and fourth most common causes of death respectively, accounting for 7-14% and 5-6% of deaths in recent years (National Records of Scotland, 2021b). Furthermore, the crude rate of homeless deaths seems to be substantially higher in Scotland than England or Wales, despite similar methodology (52 per million population aged 15-74 versus 18 per million and 14 per million respectively) – though the use of a general population, rather than homeless population, denominator complicates the interpretation of such comparisons (National Records of Scotland, 2021b).

There is as yet little research examining avoidable causes of mortality among people experiencing homelessness. A study from Canada, which used census data to follow up residents of congregate housing, found that these individuals were more than 3 times more likely to die from causes amenable to medical intervention (age-adjusted rate ratio 3.16; absolute difference of 113 deaths per 100,000 person-years) compared to the general population cohort sampled from the census (Hwang et al., 2009). More recently, Aldridge et al. (2019) estimated that 30% of deaths among a cohort of homeless people recently admitted to hospital in England were from causes amenable to healthcare intervention, compared to 23% of deaths in a sample of people living in the most deprived quintile of areas: however, these results may be limited by selection bias given the hospitalisation criterion of the sampling strategy. In New Zealand, Charvin-Fabre et al (2020) used coroner’s records to estimate that 76% of deaths among people of “no fixed abode” were considered amenable to healthcare intervention, though this study was limited by a lack of population denominator and the restriction to only those deaths referred for coronial investigation. No studies appear to have analysed avoidable mortality among homeless people in terms of both preventable and treatable components; and no population-based studies of any component of this metric appear to have been undertaken in the UK.

Finally, and perhaps unsurprisingly given the inequalities in morbidity and mortality documented above, there is some evidence from a number of countries that people who are homeless tend to have lower health-related quality of life (Sun et al., 2012, Lewer et al., 2019a).

2.4.7.2 Justice involvement

The following section summarises existing empirical evidence on the health of people with justice involvement, before moving on to consider in more detail the issue of tobacco smoking among people in prison as background to the policy evaluation described in Chapter 8.

International evidence suggests that people with experience of prison bear a disproportionate burden of physical and mental ill-health (Fazel and Baillargeon, 2011), although this evidence has largely accumulated on a piecemeal basis from studies of specific health conditions, rather than through a systematic appraisal of the burden of disease in this population (Kinner and Wang, 2014). Moreover, the majority of studies are cross-sectional and focus on people currently incarcerated; there is less research which is longitudinal in design or which takes a broader view of involvement in the justice system.

Previous studies – including several using record linkage – have documented substantial excess mortality among people released from prison (Kinner et al., 2013, Zlodre and Fazel, 2012, Aldridge et al., 2018). For instance, Graham et al. (2015) found that people released from prison in Scotland between 1996 and 2007 had a 2.3 (men) to 5.7 (women) times higher mortality than their peers of the same age and sex, even after accounting for socioeconomic position. Excess mortality is particularly high during the period immediately after release – which is likely to be mediated by both physiological (e.g., loss of tolerance among people who use opioids) and social factors (e.g., lack of stable housing, employment, and relationships) (Merrall et al., 2010, Kinner et al., 2013, Graham et al., 2015, Zlodre and Fazel, 2012). People with recurrent short sentences were also at significantly increased risk in Graham et al's Scottish study, though this is not a universal finding in the broader literature (Patterson, 2013, Binswanger et al., 2011, Graham et al., 2015). It is also unclear to what extent this finding reflects a causal effect of the upheavals associated with reception and release, or whether recurrent short sentences are a proxy for other characteristics (such as problem drug use) which are themselves risk factors for mortality.

It is worth noting that *during* incarceration, mortality rates are generally similar or lower compared to the population at liberty or justice-involved people in the community; this may reflect a potential protective effect from hazards such as violence, accidental injury, or drug overdose (Patterson, 2010, Graham et al., 2015, Spaulding et al., 2011). However, it is not observed across all population groups or causes of death, and over the life course of most people with experience of imprisonment, time spent in prison is greatly outweighed by time post-release – when mortality risk is substantially increased (Kinner and Young, 2018).

Most studies find that drug-related causes and suicide are the biggest single causes of death among people with experience of prison, but that the contribution of NCDs is also substantial (Aldridge et al., 2018, Graham et al., 2015). Most present relative rather than absolute measures of the contribution of different causes (such as standardised mortality ratios), which tend to emphasise conditions uncommon in the broader population for which relative risks are high, such as external causes. Moreover, the relative contribution of different causes of death varies with the duration of follow-up, with drug-related deaths accounting for a much smaller proportion of deaths in studies with follow-up beyond one year.

Fewer studies have examined the burden of disease among people with experience of prison: this literature is dominated by infectious diseases (especially blood-borne viruses) and mental ill-health, with less known about the prevalence of common chronic conditions (Kinner and Young, 2018, Aldridge et al., 2018, Fazel et al., 2016). A recent systematic review suggested that NCDs may be more common among older people in prison compared to their age-matched peers in the community (Munday et al., 2019), yet access to diagnosis, monitoring, self-care and specialist care in prisons is often inadequate (World Health Organisation, 2014a).

Much less is known about health outcomes among justice-involved people not receiving custodial sentences (Sirdifield et al., 2019). A recent systematic review among estimated that people receiving community sentences had 2.4 to 2.8 times higher odds of mortality during follow up compared to non-justice involved populations, compared to 4.5 among people with a history of imprisonment (Skinner and Farrington, 2020). It also found that relative risks for ‘natural’ causes of death (including common non-communicable diseases) were high, though varied between study setting (Skinner and Farrington, 2020). However, this review excluded people with a history of mental illness and noted that existing literature on community justice is dominated by long-term follow-up of young people involved in offending or deemed otherwise ‘delinquent’; generalisability to the wider population of justice-involved people in the community is therefore questionable.

Relatively few of the studies to date from community justice settings originate from the UK. One exception is Sattar’s study of people under community supervision or in prison in England and Wales during 1996/7, which found that people under community supervision had a standardised mortality ratio of between 3.6 and 3.8, compared to 2.8-3.6 among people released from prison, with higher rates of death from ‘natural causes’ than the general population even without accounting for age (Sattar, 2001). Even less is known about health outcomes other than mortality, though several local surveys and service evaluations in England have suggested that people on probation (comprising people under community supervision who may or may not have been to prison) have significantly poorer self-reported health compared to the broader population, including a relatively high prevalence of limiting long-term illness (Sirdifield et al., 2019, Carnie et al., 2017).

While some previous research has attempted to quantify the relative contribution of individual causes to the excess mortality observed among people with justice involvement, no studies could be identified that used the metric of avoidable mortality (or its sub-components of amenable and treatable mortality) among people with experience of prison or community sentences.

With regard to health-related quality of life and self-rated health among justice-involved people, most research to date has focused on people in prison selected on the basis of specific health conditions or tested in response to targeted interventions. Within unselected prison samples, self-rated health and health-related quality of life appear to be lower than population norms, reflecting a high prevalence of chronic conditions and mental ill-health (Butler et al., 2004, Plugge et al., 2011, Alves and Costa Maia, 2017, Fazel et al., 2001).

Tobacco smoking among people in prison

Given the focus in Chapter 8 on the issue of smoking in prisons, this section briefly summarises the existing evidence on tobacco use and smoking-related illnesses among people in prison.

Internationally, tobacco smoking is extremely common in people in prison (Spaulding et al., 2018). This remains the case despite substantial declines in the overall population prevalence of smoking in many countries. In Scotland, the prevalence of smoking among people in prison in 2017 was more than three times higher than people living in the community, at 68% compared to 18%; smoking prevalence among people in prison at that point was therefore comparable to population prevalence in the 1950s (Carnie et al., 2017, Cancer Research UK, 2021).

High prevalence of smoking, and resulting high levels of second-hand smoke, are likely to be among the many factors contributing to extremely poor health outcomes among people with a history of imprisonment (Spaulding et al., 2018, Binswanger et al., 2014).

Tobacco has traditionally played an important role in prison culture, fulfilling many purposes, from a means of dealing with boredom to a social ‘glue’ and informal currency (Woodall and Tattersfield, 2018, Richmond et al., 2009, Brown et al., 2019a). However, there have been long-standing concerns about the impacts on the health of both staff and the people in their care, and the UK has seen several high-profile legal challenges to prison smoking policy brought by non-smoking residents (Scottish Prison Service, 2016a, Bowcott, 2017).

There is a substantial body of evidence to suggest population health benefits from policies restricting smoking in public places, such as pubs, bars, and restaurants (Frazer et al., 2016a, Mackay et al., 2010b, Been et al., 2014). For instance, in Scotland, routine healthcare data have been used to demonstrate that the 2006 introduction of legislation on smoke-free public places reduced rates of hospitalisation for acute coronary syndromes and asthma, and of preterm delivery (Pell et al., 2008, Mackay et al., 2010a, Mackay et al., 2012). In the UK, prisons have had partial exemption from smoke-free legislation and until recently, smoking has continued to be permitted in some indoor and outdoor areas (e.g. in Scotland, cells and some areas within exercise yards) (Sweeting and Hunt, 2015).

Several countries have introduced smoke-free policies in prison settings, which vary in scope and comprehensiveness (Spaulding et al., 2018).

In comparison to community settings, evidence on the health impacts of smoke-free policies in prisons and other institutions is limited. Previous evaluations of potential health impacts have largely focused on self reports of health status and smoking-related symptoms, finding that implementation was associated with improvements in these subjective measures (Sweeting and Hunt, 2015). Fewer studies have investigated the occurrence or severity of specific smoking-related illnesses, or healthcare utilisation, as a marker of health impacts among people in prison.

In their 2016 Cochrane review, Frazer et al concluded that the evidence base on smoke-free policies in prisons was limited and of low quality, and called for more robust studies including both pre- and post-ban data and follow-up for more than six months (Frazer et al., 2016b).

Alongside the limited evidence of positive impacts, there are also concerns about potential negative unintended consequences of prison smoking bans (Frazer et al., 2016b, Sweeting and Hunt, 2015). These include an increase in assaults due to greater aggression, hostility and violence within the prison environment, or a worsening of mental health among people in prison. There is little evidence to date on these important outcomes.

2.4.7.3 Substance use, including opioid dependence

A number of systematic reviews on mortality among people who use drugs have been published to date (Degenhardt et al., 2011, Mathers et al., 2013, Bahji et al., 2020, Singleton et al., 2009, Aldridge et al., 2018). These are summarised below, supplemented by specific studies examining mortality in the UK context.

Studies to date universally conclude that the risk of mortality among people with problem drug use is substantially increased compared to their non-drug using peers. For instance, in their meta-analysis of mortality among regular or dependent users of heroin and other opioids, Degenhardt et al. (2011) found a pooled standardised mortality ratio of 14.7 (95% CI 12.6 – 16.5).

With regard to cause-specific mortality, much of the evidence to date has focused on a narrow set of causes closely associated with drug use, such as overdose, other external causes, and infectious diseases, for which the relative risks of mortality compared to people without drug use are highest (Aldridge et al., 2018).

Only more recently have studies emerged which take a broader view of the conditions associated with excess mortality among people who use drugs. These indicate that although drug-related deaths (usually defined as those caused by the acute effects of drugs, such as overdose) appear to be the single largest cause of death in cohorts of people with opioid use, they generally account for 50% or less of all deaths (Lewer et al., 2019b, Gao et al., 2019, Merrall et al., 2012, Pierce et al., 2015). This finding is consistent across multiple cohorts identified via drug treatment services, prescribing records, or criminal justice sources. For instance, among people receiving at least one methadone prescription in Scotland between 2009 and 2015, non-drug related deaths accounted for 59% of all deaths (Gao et al., 2019). The most common causes of death in this cohort were cancer (21% of non-DRDs), external causes (17%), circulatory diseases (15%), digestive diseases (16%), and respiratory diseases (11%). In these and other cohorts, the relative contribution of chronic medical conditions to mortality has been found to substantially increase with age (Gao et al., 2019, Pierce et al., 2015, Beynon et al., 2010a). Yet a number of studies have described missed opportunities and poor standards of care in the prevention and treatment of common NCDs among people who use drugs, whether in generalist healthcare settings or specialist services for addiction (Neale et al., 2008, Mitchell et al., 2009).

Together, these studies suggest a substantial - and often overlooked - mortality burden from NCDs among people who use drugs. This is increasingly pertinent in the context of population ageing among people with problem drug use in many countries, which is likely to increase mortality not directly attributable to the acute effects of drug use (Johnston et al., 2017, Scottish Drugs Forum, 2017).

Relatively few studies to date – and none that could be identified from the UK – have investigated mortality from avoidable causes among people who use drugs. Degenhardt et al. (2014b) estimated that 88% of deaths among a cohort of people registered for opioid substitution treatment in New South Wales, Australia, between 1985 and 2006 were potentially avoidable, though did not distinguish between preventable and treatable causes. Onyeka et al. (2015) found a similar proportion of avoidable deaths in their follow-up of people seeking treatment for illicit drug use in Finland between 1997 and 2010.

With regard to morbidity, adverse health outcomes associated with substance use vary according to substance-specific, individual, community, and societal factors (Babor et al., 2018). Blood-borne viruses such as hepatitis C and HIV are among the most-studied health conditions associated with drug use (Degenhardt and Hall, 2012, Aldridge et al., 2018), with especially high rates among people who inject drugs; other infectious diseases are also important causes of morbidity (Public Health England and Ireland., 2020, Lewer et al., 2020b). External causes and non-drug related mental health problems also account for a substantial morbidity burden (Lewer et al., 2020a), though the contribution of chronic long-term conditions such as cardiovascular and respiratory disease is increasingly recognised (Lewer et al., 2019b, Merrall et al., 2013, Leung et al., 2015, Kelty and Hulse, 2018). Qualitative studies among older people who use drugs have identified respiratory problems, cardiovascular disease, anxiety and depression, and chronic pain as priority conditions (Matheson et al., 2017, Beynon et al., 2009, Roe et al., 2010).

A number of studies from the UK and elsewhere have found that people with problem drug use have lower health-related quality of life and poorer self-rated health compared to population norms (Rand et al., 2020, McDonald et al., 2013, Nosyk et al., 2011, Fischer et al., 2013, Dalgard et al., 2004).

2.4.7.4 Sex work

Of the experiences of interest in this thesis, the health of people involved in sex work is the least well studied (Aldridge et al., 2018). Where evidence does exist, it is dominated by sexual health concerns – especially HIV infection – and to a lesser extent, mental health and external causes of ill-health and death (including sexual and/or physical violence) (Minichiello et al., 2015, Rekart, 2005, Vanwesenbeeck, 2001, Das and Horton, 2015). Though this is the case for most of the experiences of interest, this narrowness of focus is especially pronounced for sex work (Aldridge et al., 2018, Goldenberg et al., 2021).

The research that does exist on this topic suggests that people involved in sex work experience substantial health inequality, with qualitative and quantitative evidence indicating a high prevalence of physical and mental health problems and poor self-rated health (Mellor and Lovell, 2012, Rekart, 2015, Aldridge et al., 2018). For instance, a health needs assessment of 71 street-based sex workers in Bristol found that all reported at least one chronic illness, compared to 22% of women of a similar age interviewed via the General Household Survey (Jeal and Salisbury, 2004).

However, it is important to acknowledge that research to date is largely limited to specific subtypes of sex work and contexts (particularly outdoor, street-based sex work) and may therefore not capture the diversity of experiences among sex workers in terms of activities, work environments, and life circumstances (Goldenberg et al., 2021, Platt et al., 2018).

2.4.7.5 Psychotic disorder and severe mental illness

Multiple systematic reviews have found elevated rates of all-cause mortality among people with psychotic disorders compared to the general population (Liu et al., 2017). For instance, Oakley et al. (2018) estimated a standardised mortality ratio of 3.1 among people with psychoses; Walker et al. (2015) estimated a relative risk of 2.5; and Hjorthøj et al. (2017) estimated the average years of potential life lost at 14.5 years. Several studies – including some in the UK – have also suggested growing relative inequalities in mortality between people with and without schizophrenia over recent decades (Saha et al., 2007, Nielsen et al., 2013, Oakley et al., 2018, Hoang et al., 2011, Hayes et al., 2017, Høye et al., 2011).

A large number of studies in different high-income countries have documented that excess mortality among people with severe mental illness is largely the result of long-term physical conditions, such as cardiovascular disease, cancer, chronic respiratory disease and diabetes, rather than suicide or other external causes (Lawrence et al., 2013, Hayes et al., 2017, Roshanaei-Moghaddam and Katon, 2009, Kessing et al., 2015, Olfson et al., 2015). These findings appear to reflect both a higher prevalence of chronic conditions – such as cardiovascular disease and the metabolic syndrome – and inequalities in access to prevention and treatment, such as cardiovascular risk monitoring, anti-hypertensive and statin prescribing, and coronary revascularisation (Correll et al., 2017, Liu et al., 2017, Mitchell et al., 2009, Nielsen et al., 2021).

In their systematic review from 2015, Walker and colleagues found that the relative inequality between those with mental disorders and the rest of the population was most pronounced for external causes, but the much greater frequency of ‘natural’ causes meant that the absolute burden from these conditions was greater (Walker et al., 2015). In one English study of people with psychotic disorders dying within the first year after discharge from psychiatric inpatient care, natural causes accounted for approximately 75% of deaths (Hoang et al., 2011). A subsequent analysis by the same authors found that approximately 30% of deaths were deemed to be amenable (i.e. avoidable through high-quality healthcare; also referred to as treatable) and 50% preventable (i.e. avoidable through broader public health interventions) (Hoang et al., 2012). The overall estimate for avoidable mortality was 60% of all deaths in schizophrenia and 59% in bipolar disorder. This coincides with studies from other countries which have also found high rates of deaths from potentially avoidable causes among people with severe mental illness (Lumme et al., 2016, Björkenstam et al., 2012, Amaddeo et al., 2007).

Health-related quality of life also appears to be lower among people with severe mental illness compared to their unaffected peers, especially for people diagnosed with schizophrenia, though the validity of existing constructs and measurement tools in this population has been questioned (Nevarez-Flores et al., 2021, Saarni et al., 2010, IsHak et al., 2012, Neil et al., 2018).

2.5 Intersections between the experiences of interest

After having introduced the experiences of interest in the preceding section, I now move on to consider them in combination. In this section, I aim to summarise existing evidence on the extent to which these experiences intersect; describe why this might be; and identify potential mechanisms by which these intersections may impact upon health.

2.5.1 To what extent do these experiences intersect?

The intersection between these experiences is widely recognised by staff working in relevant services, and to some extent in policy (Balda, 2016, Bramley et al., 2019b, Rosengard et al., 2007, Duncan and Corner, 2015, Scottish Government Homeless Prevention and Strategy Group, 2015). However, relatively few systematic attempts have been made to quantify the extent of their overlap across the population (McCarthy et al., 2020).

To date, researchers have primarily described the co-occurrence of these experiences by identifying a cohort of people with at least one of the experiences of interest and subsequently quantifying the prevalence and associations of other, overlapping experiences within this cohort. Examples include work by Somers et al. (2016b), Krawczyk et al. (2020), and Herbert et al. (2015) on co-occurring experiences among justice-involved people; by Oliver et al. (2010), Degenhardt et al. (2014a), and Krebs et al. (2017) with people with problem drug use; by Swanson et al. (2013) among people with severe mental illness; Metraux and Culhane (2006) and Bird et al. (2002) with people experiencing homelessness; and Robertson et al. (2018) and Olsson et al. (2015) among people with substance use and at least one other co-occurring experience.

Relatively few studies have begun with a population-based sample and examined the prevalence and intersections of relevant experiences within this unselected sample.

There is a useful analogy here with the distinction between co-morbidity and multi-morbidity. Co-morbidity is generally used to describe additional health conditions among people with an index condition of interest, whereas multi-morbidity is generally used to describe the overlap between different conditions without prioritising any single one (Almirall and Fortin, 2013, Nicholson et al., 2019).

We can apply this distinction to the experiences of interest, substituting adversity for morbidity. The ‘co-adversity’ approach may have some utility for planning within a given service. For example, as a local authority housing officer, it may be useful to understand what proportion of the people encountering your homelessness service are likely to have justice involvement, substance use problems, sex work involvement, and/or severe mental illness. The dominance within research of this approach – in which intersecting forms of disadvantage are assessed by starting with a specific index condition of interest – has some parallels with the observation that services and policy tend to deal with these experiences through specific professional or disciplinary lenses.

However, for the purposes of public health practice and healthy public policy, quantifying ‘multi-adversity’ through a population view – which provides overall prevalence estimates and examines all intersections simultaneously – is likely to be more informative. By providing information on the scale of these experiences across the population, rather than in a selected sub-group, and looking beyond a specific disciplinary or service focus, this approach is likely to better capture the reality of lived experience and yield information more useful for service development, policy prioritisation, and resource allocation. It also ensures, where these cross-sectional descriptions are extended into longitudinal studies, the existence of an appropriate ‘unexposed’ comparison group for following up outcomes over time (e.g., as in Gan et al., 2021).

In the UK, the main precedent for a population-based approach to quantifying the intersections between these experiences has been the ‘Hard Edges’ project (Bramley et al., 2019b, Bramley et al., 2020). This work aimed to estimate the prevalence of severe and multiple disadvantage – defined as the intersection of homelessness, offending, and problem substance use – using comparisons across existing survey and administrative datasets. Of note, however, it did not include individual-level record linkage, instead combining self-report data on the prevalence of different experiences across multiple datasets, with a particular focus on household and population surveys. Across Scotland as a whole, this project estimated that 875,000 people had experienced one of the disadvantage domains of interest, 226,000 had experienced two, and 21,000 all three (Bramley et al., 2019b).

‘Hard Edges’ has been influential in shaping policy and service understandings of the intersections of these experiences. However, the authors acknowledge a number of methodological challenges, including different definitions of core experiences between datasets, under-reporting in surveys (especially of stigmatised issues like substance use), and difficulties in the choice of weights for combining multiple different datasets (Bramley et al., 2019a). Using record linkage between administrative datasets as an alternative approach may provide further insight into the validity of these estimates and the relative strengths and weaknesses of different approaches. Moreover, individual-level linkage provides the possibility of following up the cohort over time to investigate outcomes, beyond just cross-sectional characterisation. The use of administrative data for research and their application to the experiences of interest in this thesis are explored further below in Section 2.6.

2.5.2 Why do these experiences intersect?

The observation – from services and, to a lesser extent, the research literature – that these experiences frequently overlap in the population may be explained in a number of ways.

First, these experiences share several common causes. As described in Section 2.4.4, socioeconomic disadvantage is a key determinant of the likelihood of experiencing any of the experiences of interest, as is childhood trauma (Bramley et al., 2019b). In many contexts, urbanicity and minority ethnic status are also potential drivers (Bramley and Fitzpatrick, 2018, Kirkbride et al., 2012, Scottish Centre for Crime and Justice Research, 2015).

Second, one may cause or exacerbate another. An obvious example is the risk of justice involvement among people with problem use of illegal drugs, but other more subtle and indirect pathways exist, such as housing instability precipitated by imprisonment (e.g., Dore, 2015), or substance use as a form of self-medication among people experiencing adversity, especially mental illness and homelessness (e.g. Ivsins and Yake, 2018). The pathways by which people come to experience multiple disadvantage are therefore complex and multi-directional.

These pathways also appear to be context-dependent, emphasising the need for local and national estimates of their overlap. For instance, Stephens and Fitzpatrick's 'dual hypothesis' suggests that in countries with more generous welfare entitlements, the prevalence of homelessness is lower but is more closely associated with mental health and substance use problems than in countries with more limited welfare provision, where homelessness is more common and is primarily a problem of poverty and housing availability (Fitzpatrick and Stephens, 2014, Benjaminsen and Andrade, 2015). Similarly, the extent to which drug use is criminalised, and the availability and quality of treatment and support, is likely to be an important contextual influence on its intersection with justice involvement and homelessness (Room and Reuter, 2012, Greer et al., 2021).

2.5.3 What are the implications for health?

This section briefly summarises why the intersection of the experiences of interest might be relevant for health, as a justification for investigating this association in the systematic review (Chapter 5) and cohort study (Chapter 6 and Chapter 7).

Findings from qualitative studies suggest that overlapping experiences of disadvantage can interact in powerful ways to affect health (Harland et al., 2021, Perry et al., 2020, Rosengard et al., 2007, Bramley et al., 2019b). Revisiting the schematic model in Figure 1 (Section 2.4.6), these interactions can occur via physical, material, psychosocial, relational, or institutional pathways. For instance, considering the relationship between substance use and involvement in the justice system:

- Physical – reduced access to opioids during imprisonment can reduce physiological tolerance and therefore increase risk of overdose; in the community, fear of arrest can encourage unsafe consumption practices such as rushed injecting;

- Material – need for recourse to illegal or risky activities to finance drug use, which may themselves have the potential to harm health, such as sex work or acquisitive crime;

- Relational – compound stigma of two marginalised identities; disruption to personal relationships and recovery capital during periods of imprisonment;

- Psychosocial – impacts of increased risk of violence, since illicit markets have limited recourse to other forms of dispute resolution; unstable living conditions as a hindrance to recovery;

- Institutional – access to harm reduction and treatment interventions during periods of imprisonment; challenges of navigating multiple services and systems.

Harms may be additive (i.e., equivalent to the summed risks of each individual experience) or multiplicative (i.e., synergising such that their combined risk is greater than the sum). Alternatively, the presence of multiple disadvantages may have a paradoxical beneficial effect – for instance, where additional needs confer additional entitlements or access to services (especially where these are based on a threshold of need) – or have no further impact, especially where the ‘baseline’ risk associated with one experience is high. Finally, poor outcomes may simply reflect other forms of cumulative adversity with harmful effects on health, such as poverty, rather than being caused directly by the experiences of interest here.

At this point, it is worth revisiting the concept of intersectionality introduced in Section 2.2. An intersectionality lens informs this thesis’s focus on multiple overlapping forms of disadvantage and on the possibility that different combinations of disadvantage have unique relationships with health. In keeping with intersectionality perspectives, the pathways outlined above suggest how the individual experiences of interest may interact with each other and with societal structures such that their co-occurrence is ‘more than the sum of its parts’. Though the application of intersectionality to public health research has as yet been limited, other studies in this field have recently begun to acknowledge it as a relevant conceptual framework (Sullivan et al., 2019, Bauer, 2014). Some recent attempts to challenge exclusion in health services have been critiqued for their lack of attention to intersectionality (Bourke et al., 2021, Freeman et al., 2020).

However, the application of intersectionality to the analytical strategy of this project is constrained by the limitations of the available data – for instance, using administrative and/or legal definitions rather than self-defined identities, and classifying exposures as static social groupings rather than processes. It therefore adopts what McCall identifies as an intercategorical approach, using existing categories on a pragmatic basis to investigate inequality whilst maintaining a critical stance towards these categories’ limitations (McCall, 2005).

To elaborate on the institutional domain above, the breadth and depth of need that typically accompany the intersection between these experiences pose particular challenges for designing and delivering effective services and policy. Previous reviews have highlighted that narrow remits for specific services or policy departments, organised around a single need or response, mean that people with multiple intersecting disadvantages are poorly served (Rosengard et al., 2007, Anderson, 2011, Cornes et al., 2011). They may be in contact with multiple services with little co-ordination between those interactions. As a result, they may experience difficulties in navigating between services; a high time and emotional ‘burden’ associated with service engagement; potentially different responses from services with different professional and organisational cultures, strategic goals, and targets; and key services being missed from care planning.

A quotation from the review by Rosengard et al illustrates the problem with a mechanical metaphor:

> “Imagine trying to get your car fixed after it breaks down and finding that you have to take it to a different garage to fix each part – one to change the brake cable, another to fix the windscreen, a third to change the tyres and so on. Even worse, each garage is in a different area and none of them share information, so you have to repeatedly explain the problem and fill out separate forms at each visit.” (p. 31, Rosengard et al., 2007)

This ‘silo’ working can also occur in policy, where people may be affected by policies and legislation spanning multiple departments which may lack co-ordination or even be directly contradictory.

Other barriers to service engagement encountered by people with multiple forms of disadvantage include (Anderson, 2011, Cornes et al., 2011, Rosengard et al., 2007):

- (explicit or implicit) eligibility thresholds or criteria, such as people with problem substance use being excluded from mental health services, or being deemed too challenging for a particular service;

- a focus on immediate needs and crisis management that is reactive, rather than a proactive person-centred approach which seeks to identify and address the underlying issues;

- inflexibility in service delivery, for instance in opening hours, appointment systems, registration requirements, and responses to missed appointments or non-engagement.

These organisational and institutional issues are exacerbated by the daily challenges of living with multiple disadvantage and the impacts of previous and ongoing trauma (Harland et al., 2021). These can affect the ways in which people engage with services, due to the impacts on relationships, expectations, perceptions of safety, and trust in institutions (Cornes et al., 2011, Theodorou et al., 2021, Anderson, 2011). As a result, people with multiple forms of disadvantage may be more vulnerable to weaknesses or gaps in systems of care, such as waiting lists; complicated pathways for access; and points of transition between services.

These insights from qualitative studies, practitioner experience, and theory are supported by quantitative studies suggesting poorer outcomes among people with multiple co-occurring experiences. For instance, among people who inject drugs, imprisonment is associated with reduced chances of cessation and greatly increased risk of death (Kimber et al., 2010, Merrall et al., 2010).However, the association between multiple disadvantage and poorer outcomes is not a universal finding in the literature (e.g., Chang et al., 2015, Spittal et al., 2019), suggesting a need for a comprehensive synthesis of existing evidence on this topic.

To date, the literature on health outcomes among people affected by more than one of the experiences of interest has not been systematically reviewed. This is the focus of Chapter 5. As that review highlights, much of the existing research on the health of people affected by more than one of the experiences of interest suffers from similar limitations to those identified for research on the individual experiences of interest, including a reliance on cross-sectional designs and heavily selected samples. There is a lack of longitudinal population-based studies, especially from the UK, examining a range of exposure combinations and outcomes.

2.6 Administrative data and record linkage

Having summarised existing literature relating to the topic of interest, I now move on to methodological considerations relating to administrative data and record linkage, as background to the cohort study described in Chapters 6 and 7 and the policy evaluation described in Chapter 8.

This section first provides a definition of administrative data and describes their potential strengths and weaknesses for public health research, before moving on to briefly consider their application to the experiences of interest. This provides the foundation for a more detailed discussion of specific datasets and methods as part of each empirical paper (Chapters 6 to 8).

Administrative data can be defined as information collected as a matter of course by organisations or services as part of their everyday activities (Hand, 2018). It is also sometimes referred to as routine data, or by the broader umbrella terms of secondary data (meaning data already collected, regardless of original purpose or intent) or big data (typically used to refer to data characterised by sheer scale; for instance, of volume, velocity, and variety) (Connelly et al., 2016).

Although administrative data are, by definition, not collected for the purposes of research, they can nonetheless be extremely useful to that end, for several reasons (Jutte et al., 2011). Administrative datasets are generally:

- Large, providing sufficient statistical power to enable analysis of rare exposures or outcomes, or of heterogeneity within populations

- Comprehensive, reducing selection and response biases: for instance, data may cover an entire population rather than relying on a sample. This is especially valuable given downward trends in response rates to population surveys in many countries (Keyes et al., 2018)

- Consistent across time and space, facilitating large-scale longitudinal analyses

- Generalisable, given their basis in real-world activities rather than research settings

- Time- and cost-effective, compared to the resources required to collect primary data of the same scale.

In addition, administrative data may be enhanced by linkage with other datasets to identify units of analysis common to each (usually individuals, but sometimes households or geographical areas), about which different datasets can provide different information. These other datasets may themselves originate from administrative processes or from primary data collection methods such as trials, surveys, cohort studies, disease registries, and censuses.

The potential for linkage is particularly valuable in the context of studying the social determinants of health described in Section 2.2, as datasets on ‘upstream’ exposures (such as housing, education, welfare benefits, or the physical environment) can be linked to those recording health outcomes to facilitate observational studies and natural experiments, and enrich trials of interventions (e.g., Katikireddi et al., 2020, Butler et al., 2020, Rodgers et al., 2018, Hollinghurst et al., 2020, Somers et al., 2013). For these reasons, linked administrative data from across different sectors of society offer valuable opportunities to inform healthy public policy and redress biases in existing evidence towards individual-level and biomedical approaches to improving health (Rutter et al., 2017, Lyons et al., 2014).

Qualitative studies examining the acceptability of using administrative data and record linkage for research have generally found strong public support for these practices where they are expected to provide some form of societal benefit and where safeguards are in place to ensure confidentiality and appropriate use (Aitken et al., 2016).

Nonetheless, there are some disadvantages and potential pitfalls to the use of administrative data for research.

As the collection of administrative data is not primarily motivated by research, the researcher has no influence over data structure, content, or format and therefore is dependent on what is available, rather than what might be ideal (Hand, 2018). Data may require extensive cleaning and re-structuring before they are useable for research, yet meta-data to inform this process may be lacking. Missing values may threaten validity.

Whilst the use of administrative data can reduce selection biases associated with likelihood of participating in research, it may nonetheless be subject to selection biases of its own relating to the processes by which individuals come to interact with the services or institutions of interest, or to linkage biases arising from differential matching based on data quality or completeness (Harron et al., 2017a, Harron et al., 2017b). Variation in service scope, eligibility, user pathways, and data recording over time or between areas may affect internal and external validity, particularly where poorly documented (Hand, 2018).

Although technical safeguards for ensuring data protection and individual privacy are now well established, organisational and cultural barriers to data sharing and lack of capacity in existing linkage infrastructure remain major challenges to realising the potential of administrative data research (Mourby et al., 2019, Lugg-Widger et al., 2018, van Panhuis et al., 2014). These are discussed in more detail in Chapter 9.

2.6.1 Use of administrative data in understanding the experiences of interest

The application of administrative data may be particularly beneficial for understanding the health experiences of people affected by the experiences of interest to this thesis.

Participation in primary research can be difficult for people experiencing social disadvantage or marginalisation for a range of reasons, including time, financial, and cognitive burden associated with research participation; stigma; previous negative experiences which affect trust in institutions and sources of formal authority; residential mobility; or research ‘fatigue’ (Woodall et al., 2010, Clark, 2008, Barratt et al., 2007, Bonevski et al., 2014). This affects study recruitment, retention, and ultimately validity.

Administrative data research can address some of these barriers. Experiences that cause difficulties in participating in primary research are often associated with high levels of need for – and therefore contact with – public services, such that affected people are often well-represented within administrative data. The scale of administrative datasets means that larger and more representative groups of people can be included in studies than would otherwise be the case with primary data collection. Where longitudinal in nature, administrative data can enable passive follow-up of specific outcomes (such as service contacts) that poses no burden for participants and offers a high degree of accuracy without the risk of recall error or bias. Finally, it has been argued that greater cross-sectoral integration of data is likely to provide most benefit to those with complex needs spanning different public services and policy areas (Culhane, 2016).

2.7 Summary of research to date and key gaps in the evidence

In this section, I close the literature review by summarising the evidence described in preceding sections and identifying the contributions this thesis will make to addressing the gaps identified.

Public health research to date has often been dominated by a relatively narrow understanding of the ‘axes’ of social differentiation across which inequalities may arise. In the UK, socioeconomic position has been the primary lens through which inequalities have been conceptualised and quantified, though there is an increasing interest in other forms of social differentiation and their intersection. Investigating inequalities according to other dimensions of social experience and identity may provide a richer picture of unfair variations in health across the population and how they can be addressed. This provides the basis for the thesis’s overarching focus on the experiences of interest and for the exploration of their role in health inequalities policy documents (Chapter 4).

Notions of inclusion and exclusion have been much debated in the academic literature but remain popular in practice, especially in recent years through the use of terms such as multiple exclusion and severe and multiple disadvantage, and through their application to health through the inclusion health agenda. The increasing prominence of this agenda means that inclusion health – and its role in health inequalities policy to date – merits critical attention. This provides the second key motivation for the discourse analysis described in Chapter 4.

Experiences of homelessness, justice involvement, substance use, sex work, and severe mental illness are often associated with exclusion from the rights, resources, relationships and activities that most people in society enjoy. Previous work has demonstrated that each of these experiences individually is associated with profound inequalities in health, over and above their association with socioeconomic disadvantage. There are theoretical and empirical grounds for hypothesising that the intersection of these experiences is also likely to matter for health. However, health outcomes among people affected by than more than one of these experiences have not previously been systematically reviewed. This is the focus of Chapter 5.

The linkage of administrative data from health and non-health sources offers unique potential for understanding the wider social, economic, political, institutional, and environmental determinants of health. This approach may be particularly valuable when researching experiences which by their nature make it difficult for people to participate in primary research – such as those of interest to this thesis. Chapter 6 and Chapter 7 address this issue by describing the feasibility and value of using cross-sectoral administrative data linkage to undertake an observational epidemiological study on the intersection between the experiences of interest.

Although the co-occurrence of these experiences is widely recognised on an anecdotal basis, there is limited evidence from population-based studies on their overlap, particularly from the UK. Chapter 6 seeks to address this gap through the use of linked administrative data covering four of the experiences of interest: homelessness, justice involvement, substance use, and severe mental illness.

The narrative review in this chapter, and its systematic companion in Chapter 5, identified a need for studies on the health of people with the experiences of interest that: are population-based and as representative as possible; are longitudinal rather than cross-sectional in design; investigate a broad range of exposure combinations and outcomes, especially non-communicable diseases; and have large sample sizes, to enable the latter. Chapter 7 builds on the cohort described in Chapter 6 to address this gap: it describes an analysis of premature mortality associated with the overlap between the experiences of interest, with a particular focus on NCDs and avoidable causes of death.

One particularly promising opportunity afforded by administrative data is the evaluation of policy changes with the potential to impact on population health. The final empirical chapter of the thesis (Chapter 8) provides an example of how administrative data (on this occasion, from a single source, used without further linkage) can be used to this end: in this case, to evaluate potential health impacts of the introduction of a comprehensive smoke-free policy in Scottish prisons.

Chapter 3 Aim and objectives

3.1 Thesis aim

The aim of this thesis was to explore health inequalities associated with experiences of homelessness, justice involvement, substance use, sex work, and severe mental illness – and in particular, their intersections – using a multi-method approach. A secondary aim was to investigate the potential contribution of administrative data to the understanding and redress of these inequalities.

3.2 Thesis objectives

RO1	To examine whether and how the concept of ‘inclusion health’ is reflected in policy discourses on health inequalities in the UK, through analysis of flagship policy reviews.	**Chapter 4**
RO2	To synthesise existing evidence from high-income countries on the association between lifetime exposure to more than one of the following: homelessness, imprisonment, substance use, sex work, or severe mental illness, and the following outcomes: 1) all-cause and cause-specific mortality 2) morbidity 3) self-rated health or quality of life	**Chapter 5**
RO3	To use cross-sectoral administrative record linkage using datasets from healthcare services, local government, and the prison system, to create a novel cohort containing information on exposure to homelessness, justice involvement, opioid dependence, and/or psychosis among residents of Glasgow City	**Chapter 6**

RO4	To use the cohort created in RO3 to characterise the prevalence of different combinations of these experiences, and their demographic associations	**Chapter 6**
RO5	To build on cohort creation and description (RO3 & 4) to address a key evidence gap identified in the systematic review (RO2): the association between different combinations of experiences and premature mortality, including mortality from avoidable causes and non-communicable diseases.	**Chapter 7**
RO6	To use administrative data on medication dispensing to evaluate the health impacts of a comprehensive national smoke-free prisons policy in Scotland, as part of the Tobacco In Prisons study (TIPs).	**Chapter 8**

Chapter 4 Including 'inclusion health'? A discourse analysis of health inequalities policy reviews

4.1 Foreword

In this section, I provide some background to the choice of research question and methods for the article which follows, and some reflections on their strengths and limitations.

Health inequalities are inherently political, and their roots lie in multiple policy sectors (McCartney et al., 2013). By examining the policy context in which health inequalities research takes place, researchers can better understand the potential explanations for our findings; their implications; and how they will potentially be received and, perhaps, acted upon.

To complement the systematic review and quantitative analyses utilising administrative data, I wanted to approach the experiences of interest from a qualitative perspective to understand where they sat within broader policy debates on health inequalities. By investigating the visibility and positioning of this topic in health inequalities policy documents to date, I was able to explore questions I was asking myself about the appropriate focus and scope of public health research and practice; the value of the ‘inclusion health’ label; and the limitations of the quantitative analyses.

A document analysis was the natural choice, given the importance of written text to the formulation, communication, and implementation of policy: as Freeman (2006) has claimed, “government is a text-based medium”. There was also the pragmatic consideration of the limited time and financial resources available to undertake this element of the project, which precluded a more in-depth approach encompassing other methods such as stakeholder interviews. In limiting its scope to document content, this analysis was therefore unable to consider production and consumption: these are important considerations for future work, given that documents are not static artefacts but dynamic social processes of communication and representation (Prior, 2003). As well as extending the analysis beyond content alone, future work would also benefit from examining other sources of discourse on inclusion health, such as meetings, public-facing information, statements by key stakeholders, and policy documents from other jurisdictions.

I chose discourse analysis for its underlying assumption that language actively shapes the social world, reflecting and reinforcing power structures and ideologies (Fairclough, 2001). In this approach, flagship policy reviews were of interest for their role in reproducing and sustaining dominant understandings of health inequalities that shape policy action (Freeman, 2006).

The sampling strategy was purposive, incorporating both a systematic search of government agency websites and discussion among the authorship team in order to capture ‘paradigmatic cases’ in the form of high-profile reviews with an explicit focus on health inequalities, from the multiple levels of governance relevant to health inequalities policy in Scotland and the UK. In doing so, I aimed to avoid any (methodologically fraught) attempt to be representative in favour of analysing the dominant framings of health inequalities – whilst still being able to capture potential variation by geographical and political context, and level of government. Although I had initially hoped to capture variation over time, most of the documents considered for inclusion were published within several years of each other: few more recent documents were identified.

In the interests of reliability and richness of interpretation, I made multiple passes through each document (for coding) and through each framework matrix (for interpretation) as part of the analytic process. The analysis did not include any second-coding of the sample by another researcher, due to limitations on capacity among co-authors. It is worth noting here that the value of multiple coding is somewhat contentious, despite its inclusion in some quality assessment checklists and journal guidelines (Barbour, 2001, Morse, 2015, O’Connor and Joffe, 2020). Instead, I regularly presented emerging results to co-authors to allow for discussions of alternative interpretations and made other efforts to enhance transparency of the coding and interpretation process, such as publishing the mind-maps as supplementary material to the paper.

The analysis did not start from an *a priori* assumption about the most appropriate scope and definition of health inequalities: instead, I set out to describe the existing positions and reflect on their potential implications for policy, both positive and negative. The implications of my findings for the broader project of work are explored in the Discussion in Chapter 9.

4.2 Title, authorship, and publication details

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4.3 Abstract

The ‘inclusion health’ agenda aims to draw attention to health disadvantages accompanying experiences putatively characterised by social exclusion, such as homelessness, problem substance use, or imprisonment. However, its increasing prominence has surfaced conceptual uncertainties and potential tensions with other understandings of health inequalities.

We undertook a discourse analysis of how recent health inequalities policy documents describe, explain, and make recommendations relating to inclusion health. Using the UK as a case study, and with reference to public health accounts of multi-level governance theory, we selected five recent health inequalities policy reviews covering Scotland, UK, European Union, and the World Health Organisation.

All documents referred to some inclusion health concerns, though their relative emphasis differed between documents. Terms like inclusion, exclusion, and vulnerability were commonly used, but ill-defined and often ambiguous. Explanatory discourses were diverse, with a particular focus on intergenerational cycles and disproportionate exposure to risk, with a varying emphasis on individual versus structural factors. Few documents provided coherent explanatory accounts for the relationship between the issues of interest to inclusion health, their associations with poor health, and other axes of inequality.

Our results suggest that health inequalities policymaking in a multi-level context may benefit from comprehensive conceptual frameworks which encompass diverse forms of social stratification, advantage, and disadvantage, and acknowledge potential tensions and trade-offs between different understandings. This may necessitate further theoretical and empirical work for inclusion health on its definitions, bounds, and how its scope of interest interacts with other forms of social and health inequality.

Key words: health inequalities, discourse analysis, social exclusion, social inclusion

4.4 Introduction

The question of how to define, measure, and redress health inequalities is not straightforward and inevitably involves decisions and value judgements (Graham, 2009a, Wistow et al., 2015). Policy discourses on health inequalities do not always reflect the available evidence; are utilised for different political purposes; and are often internally inconsistent between statements of the problem and recommendations for action (Smith et al., 2009, Graham, 2009a, Lynch, 2017). Understanding such discourses is therefore important, since they simultaneously reflect and influence how the problem is conceptualised, how it should be tackled, and how success is defined.

Health inequalities are shaped by inter-dependent policy processes operating at sub-state, central state, and supra-state levels and include a multiplicity of actors from individuals and local communities to commercial, governmental, and civil society organisations: an example of multi-level governance in action, as described by other public health accounts (Katikireddi et al., 2016, Wilson, 2004). More than perhaps any other public health challenge, health inequalities require cross-cutting collaboration and co-ordination across levels and actors, but – in contrast to other topics (such as tobacco control or infectious disease) (Asare et al., 2009, Studlar and Cairney, 2019, Wilson, 2004) – suffer from a lack of common understanding of the problem or agreed roles and responsibilities (Harrington et al., 2009).

Recently, there has been increasing interest in policy, practice, and academic circles in ‘inclusion health’ (Marmot, 2018, Montague, 2018). There is at present no accepted definition or conceptual framework for inclusion health, though the most-widely cited paper on the topic defines it as ‘a research, service, and policy agenda that aims to prevent and redress health and social inequities among people in extremely poor health due to poverty, marginalisation, and multimorbidity’ (Aldridge et al., 2018). That is, it refers to efforts to improve the health of people experiencing social exclusion. Despite a long history of policy and academic interest in inclusion and exclusion in the UK and elsewhere, there is no consensus definition of these terms (Labonte, 2004, Levitas, 2006). Reflecting this, inclusion health discourses to date have encompassed a disparate range of experiences (including homelessness, imprisonment, substance use, sex work, severe mental illness, migration, and refugee/asylum seeker status) and identities (such as Indigenous, Gypsy/Traveller, or LGBT+ – lesbian, gay, bisexual, transgender, and other sexualities and gender identities).

Inclusion health may represent another conceptual iteration of the health inequalities problem, as well as a resurrection of the concept of 'inclusion' in policy discourses, after periods in and out of fashion (Levitas, 2006, Welshman, 2013). While it has arguably been successful in mobilising and unifying a community of practitioners, researchers, and advocates (Academy of Medical Royal Colleges & Faculty for Homeless and Inclusion Health, 2017, Luchenski et al., 2018, Davis and Lovegrove, 2015), a greater emphasis on inclusion health within health inequalities policy is not without risks. Focusing on specific experiences like homelessness and substance use may cause health inequalities to be seen as a problem of an identifiable, disadvantaged minority, rather than a pervasive societal phenomenon: this risks stigmatising individuals and obscuring underlying structural drivers (Katikireddi and Valles, 2014).

The recent rise of inclusion health up the policy and service agenda is also potentially at odds with dominant understandings of health inequalities in terms of a socioeconomic gradient, since it draws attention to extreme health disadvantages experienced by a relatively small number of people: a tension akin to Rose's 'sick individuals' versus 'sick populations' (Fisher et al., 2016, Graham, 2004, Rose, 1985, Vallgårda, 2008, Smith et al., 2009).

There exist varying discourses within inclusion health about the role of socioeconomic position. Though the definition above explicitly identifies poverty as a causal factor, it has also been argued that the health inequalities with which inclusion health is concerned are at least partly independent of, or poorly captured by, conventional measures of socioeconomic position (Aldridge et al., 2018, Lewer et al., 2019a). These understandings are not necessarily mutually exclusive: for instance, if social exclusion is conceptualised as a manifestation of extreme poverty, as per Marmot's description of 'deprivation upon stilts' (Marmot, 2018). Alternative models might position socioeconomic disadvantage as a mediator between experiences of social exclusion and ill-health, an approach which has been influential in research on ethnic inequalities in health (Nazroo, 2003).

Though previous work has examined the construction of health inequalities in policy documents, it has largely focused on health inequalities defined by socioeconomic position (in the UK and Europe) or race/ethnicity/Indigenous status (in the United States and Australia/New Zealand) (Hill, 2015, Mackenbach and Bakker, 2003, Smith et al., 2009, Whitehead, 1998). However, there have been few attempts to study whether and how other forms of inequality feature in policy documents relating to health inequalities, or how relationships between different forms of inequality are understood.

Since the increasing prominence of inclusion health has surfaced conceptual uncertainties and potential tensions with other understandings of inequality, it is timely to examine whether and how this agenda has featured in health inequalities policy to date. We undertook a document analysis of flagship health inequalities policy reviews with the intention of identifying discourses deployed in: (1) describing health inequalities associated with the inclusion health agenda, (2) explaining them, and (3) making recommendations for action.

4.5 Methods

We undertook a document analysis given the importance of written text to the formulation, communication, and implementation of policy (Prior, 2003). The UK is a suitable case study for this purpose given its established policy tradition and international influence in the field of health inequalities (Bartley and Blane, 2015, Mackenbach and Bakker, 2003). Our primary analytical approach was critical discourse analysis (CDA), which seeks to address social issues (in this case health inequalities) through critical readings of the relationship between language, social practices, and power relations (Fairclough, 2001).

Selection of texts

Our focus was policy reviews produced or commissioned by governments or intergovernmental organisations to summarise existing evidence on health inequalities and make recommendations for policy. Freeman (2006) has described these publications as the ‘principal vehicle’ of the politics of health inequality, embodying and perpetuating dominant discourses of health inequalities.

In identifying the sample, we were informed by public health accounts of multi-level governance and therefore sought to reflect the different levels influencing UK health inequalities policy:

- a devolved administration, in this case the Scottish Government: powers for health and some related policy areas (such as housing, justice, and education);
- the UK Government: in addition to responsibility for England, retains power across the UK for reserved matters relevant to health inequalities such as employment, trade, and most social security policy;
- the European Union (EU), of which the UK was still a member at the time this project was initiated: supports member state activity and co-operation in several relevant policy areas and can adopt legislation in relation to public health and social policy in member states
- the World Health Organisation (WHO): global co-ordinating and influencing role, but does not mandate individual governments.

After searching government and public health agency websites (using terms listed in Table S2, Supplementary material accompanying Chapter 4), we used existing research literature relating to UK health inequalities policy and discussion among the project team to identify ‘paradigmatic cases’ from each level of governance (Pavlich, 2010). These were defined as the most recent flagship policy review with an explicit focus on health inequalities, as indicated by either the title or subtitle. To be considered for inclusion, documents had to be published since 1998 and include both a statement of the problem and recommendations for action. Similar approaches to purposive sampling have been used in other research examining the policy construction of health inequalities (Fisher et al., 2016, Graham, 2004, Smith et al., 2009). This restriction enabled us to undertake close reading and in-depth analysis of each document, whilst still being able to identify the prevailing policy discourses in each jurisdiction.

The final sample consisted of the following documents:

- Scotland – Equally Well: Report of the Ministerial Task Force on Health Inequalities (Scottish Government, 2008a), and subsequent review (Scottish Government, 2010a) – referred to hereafter as ‘Equally Well 2008’ and ‘Equally Well 2010’

- UK – Fair Society, Healthy Lives: Strategic Review of Health Inequalities in England post-2010 (Marmot, 2010) – referred to hereafter as ‘the Marmot Review’

- EU – Solidarity in Health: Reducing Health Inequalities in the EU (Commission of the European Communities, 2010) – main Communication and the section on ‘Statement of problem’ in the Impact Assessment – referred to hereafter as ‘Solidarity in Health’

- WHO –

    - European region: Review of social determinants of health and the health divide in the WHO-European region (World Health Organisation Regional Office for Europe, 2014) – referred to hereafter as ‘Review for WHO-Europe’

    - Global: Closing the Gap in a Generation: Commission on the Social Determinants of Health (Commission on Social Determinants of Health, 2008) – referred to hereafter as ‘Closing the Gap’

Only one of our sample was published within the previous five years: this may reflect diminished policy attention to health inequalities, a lesser role in policymaking for such reviews, or the mainstreaming of inequality concerns into wider policymaking. However, in the absence of more recent documents, these reviews remain influential and are the most pragmatic source of data.

Analysis

Our choice of CDA meant that in reading the texts, we focused on latent as well as manifest meanings, tensions in the construction of health inequalities, and relations of power within the documents (Fairclough, 2001). CDA informed our understanding the construction of health inequalities as a social practice, in which these documents participate through their creation and reproduction of different discourses about what health inequalities are, what causes them, and what should be done in response: in turn, these discourses exert power by determining policy options, research agendas, and broader societal perceptions of justice and injustice.

Since discourse analysis is a theoretical framework rather than a specific technique and is frequently used in combination with other approaches (Fairclough, 2001, Potter and Wetherell, 1987), we applied CDA using the framework method, to enable constant comparison; iteration during analysis; and transparency of interpretation (Spencer and Ritchie, 2002).

During familiarisation, an initial coding framework based on our research questions was iterated to develop a final version agreed by all authors (Supplementary material accompanying Chapter 4). We operationalised topics of interest as those identified as the focus of existing inclusion health activity to date (Academy of Medical Royal Colleges & Faculty for Homeless and Inclusion Health, 2017, Luchenski et al., 2018, Department of Health, 2010), as well as additional experiences or identities identified during familiarisation. The first author then used the framework to guide line-by-line coding of source documents in NVivo 11. Results of coding were charted using the framework matrix function, accompanied by a second review of the source documents for completeness. Mind-maps were used to support discussion and collaborative interpretation within the study team, which drew on our understanding of the context and level of governance in which each document was situated (as described in Table S2, Supplementary material accompanying Chapter 4). Illustrative quotations are included under ‘Results’, with underlining to highlight specific discursive devices or effects.

4.6 Results

Table S2 in Supplementary material accompanying Chapter 4 summarises the included documents. Two were official governmental or intergovernmental publications (Equally Well and Solidarity in Health), while the remaining three were independently published, commissioned reviews (Closing the Gap, the Marmot Review, and Review for WHO-Europe).

How did the inclusion health agenda, and the experiences within its remit, feature in the documents' descriptions of health inequalities?

This section first describes how inclusion, exclusion, and related terms were described or defined within the documents, before moving on to examine how documents described health inequalities associated with these experiences.

How were inclusion, exclusion, and related terms defined in the documents?

Socioeconomic position dominated constructions of health inequality in most documents. No document made explicit reference to the inclusion health agenda, though all referred to some of the experiences typically considered within its remit (summarised in Figure S2 in Supplementary material accompanying Chapter 4).

Generic statements about people or groups as 'excluded', 'vulnerable', 'disadvantaged', or 'hard to reach' were common throughout the documents. These terms were rarely defined further; often used interchangeably; and frequently ambiguous in scope. A variety of specific examples were cited, including people experiencing homelessness, people with disabilities, some ethnic minority groups, migrants, unemployed people or people in precarious work, lone parents, and 'multiply deprived' families and communities. More implicit definitions appeared to be variously based on socioeconomic position, labour market participation, household type, health status, population norms, a lack of basic rights or services, a need for specific services, or combinations of these. Multiple possible readings of these terms were often evident within a single document.

Similarly, definitions of 'inclusion' and 'exclusion' varied. For instance, the Marmot Review used these terms in both in a narrow financial sense and a broader multi-dimensional sense relative to some normative group:

> National target for social inclusion: It is proposed that there be a national target that progressively increases the proportion of households that have an <u>income, after tax and benefits,</u> that is sufficient for healthy living.
>
> (Marmot Review, p166)

> It [social exclusion] is the multiple disadvantages experienced by particular groups and individuals existing outside the 'mainstream' of society.
>
> (Marmot Review, p137)

In contrast to the rest of the sample, the most recent document, Review for WHO-Europe, was unique in explicitly distancing itself from the perceived shortcomings of these 'labels':

> From the perspective of the social determinants of health, it is important to understand exclusion, vulnerability and resilience as dynamic multidimensional processes operating through relationships of power. Previously, exclusion has too often been approached by focusing on the attributes of specific excluded groups.
>
> (Review for WHO-Europe, p xxix)

This definition of social exclusion as a continuum created by processes, rather than a binary state based on normative thresholds, allowed the Review to integrate exclusion into dominant conceptualisations of health inequalities as a social gradient, by arguing that the latter was the result of both 'socioeconomic processes (such as social stratification) and those that are exclusionary (unequal access to resources, capabilities, and rights)' (p8). However, it also sought to preserve continuity with social exclusion discourses which emphasise its distinctiveness from socioeconomic position by arguing that the social gradient in health was not linear for the 'most disadvantaged social groups and communities'.

How were health inequalities associated with the experiences typically featuring in the inclusion health agenda described?

Descriptions were generally dominated by medical and epidemiological discourses, with health a quantitative construct defined by the presence or absence of disease or other negative outcomes; as illustrated by the quotations below. Broader understandings – based on wellbeing, quality of life, and self-reported measures – were less evident.

> Vulnerable groups suffer a particularly greater burden of mortality and disease…
>
> Solidarity in Health, Impact Assessment (p10)

> Asthma and TB [tuberculosis] are common among homeless people, and a drug-resistant form of TB has emerged among homeless and other marginalized populations across Europe.
>
> Review for WHO-Europe (p100)

Specific conditions were often associated with specific population groups: for instance, infections or mental ill-health among people with experience of imprisonment or homelessness. In relation to the health of people involved in offending or substance use, discourses of societal burden and harms to others – particularly children – were prominent, as in this example from Equally Well:

> The health and wellbeing of offenders impacts not only on their individual life circumstances, but also on the wider health of families. The intergenerational impact of offending is clear. Approximately 15,500 children in Scotland lose a parent to prison per year. This impacts on the health, social and educational prospects of these children.
>
> (Equally Well 2010, unnumbered page)

What explanations were proposed for health inequalities relevant to the inclusion health agenda?

This section briefly describes some of the overarching themes identified within explanatory discourses in terms of the presence or absence of explicit explanatory accounts; interactions between exclusion/inclusion and socioeconomic position; and references to intersections. It then moves on to examine in more detail discourses of lifecourse and intergenerational effects, and individual versus structural causes. The results of this section are summarised in schematic form in Figure S3 in Supplementary material accompanying Chapter 4.

Though implicit claims were common, few documents provided coherent explanatory accounts for the relationship between the issues of interest to inclusion health, health inequalities, and broader social processes. One exception was Review for WHO-Europe which explained social exclusion as dynamic (dip in and out of vulnerable contexts'); continuous rather than binary ('continuums of inclusion and exclusion and vulnerability'); context-specific ('exclusionary processes and vulnerabilities vary among groups and societies over time'); and rooted in structural inequalities ('historical and social processes operating through relationships of power'). The emphasis given to this conceptual and explanatory model is consistent with the document's later argument that 'conceptual failure' contributes to a lack of policy progress on health inequalities.

Most documents alluded to potential interactions of socioeconomic position with other aspects of social identity and experience, in particular gender, ethnicity, migration, and disability. The Review for WHO-Europe went further in attempting to integrate socioeconomic understandings of health inequalities with those based on social exclusion, identifying a bidirectional relationship in which 'poverty may result from, and contribute to, the processes of social exclusion'. The term 'intersect' was often used as a verb in this context, though it was not clear if these references were directly informed by intersectionality as a theoretical framework (Gkiouleka et al., 2018):

> Other inequalities <u>intersect</u> in important and complex ways with socioeconomic position in shaping people's health status.
>
> (Marmot Review, p88-89)
>
> Social inequity manifests across various <u>intersecting social categories</u> such as class, education, gender, age, ethnicity, disability, and geography.
>
> (Closing the Gap, p18)

Intergenerational and lifecourse explanations

One explanatory discourse evident in most documents but particularly prominent within Equally Well, was intergenerational transmission or 'cycles' of exclusion and disadvantage. For instance, a case study in Equally Well invoked generational unemployment (‘an extended family none of whom have ever worked’); non-nuclear family structures (‘three “uncles” have convictions for serious violence’); parenting behaviours (‘outwith parental control’); and personal responsibility (‘his family resist offers of help’; p31) in describing a young man’s path to violent offending. However, the same document also referred to structural explanations, identifying ‘poverty, poor educational attainment, and lack of opportunities for young people’ as ‘the fundamental causes’ of violence, drug and alcohol misuse, and health inequalities more broadly (p33).

These were part of a broader set of discourses about lifecourse influences on health, especially prominent in the Marmot Review, which alluded to the importance of the early years; to the accumulation of disadvantages; and to potential differing impacts of inequality and exclusion at different stages of life.

Individual and structural discourses

More generally, the relative prominence of individual and structural discourses varied between documents and between explanatory factors. For instance, explanations focusing on healthcare access or quality generally gave prominence to systemic causes – such as marketisation and conditionality – though in some cases responsibility was attributed more to individuals, with the Marmot Review referring to barriers created by patients’ ‘capability’ and ‘chaotic lives’. In contrast, although stigma and discrimination were widely cited as causes of poor health, only Review for WHO-Europe provided a structural account of these processes, describing how anti-migrant sentiment could be shaped by institutional and policy environments. This document and Closing the Gap were unique among the documents in explaining some processes of social exclusion as deliberate political choices:

> Active processes [of exclusion, disadvantage and vulnerability] are the direct and intended result of policy or discriminatory action including, for example, withholding political, economic, and social rights from migrant groups…
>
> (Review for WHO-Europe, p102)

> Important features of the Nordic experience include commitment to universalist policies based on equality of rights to benefits and services, full employment, gender equity, and low levels of social exclusion.
>
> (Closing the Gap, p33)

What recommendations were made?

Recommendations relating to the scope of inclusion health are summarised in Figure S4 in Supplementary material accompanying Chapter 4. This section explores several dominant discursive themes relating to healthcare systems; intersectoral working; early intervention; and public involvement, before concluding with some reflections on each document’s concordance between explanations and recommendations.

Healthcare systems

In keeping with the dominance of biomedical and epidemiological discourses among descriptions, many of the recommendations relevant to inclusion health concerns were focused on healthcare. However, several documents did make recommendations with a broader role for health systems: for instance, Equally Well described how health services could challenge discrimination and act as an exemplar by employing ‘vulnerable groups’, while the Marmot Review recommended using the health service’s purchasing power to promote social inclusion locally.

Beyond healthcare systems

Among recommendations beyond the healthcare system, intersectoral working was commonly mentioned. Examples included general references to ‘whole of society’ approaches, as well as specific case studies involving the sharing of funding, workforce, premises, or governance and processes. As the quotation below illustrates, most references to activities associated with intersectoral working were generic rather than concrete and actionable:

> The Social Inclusion Initiative is the Government of South Australia’s response to addressing social exclusion through: facilitating joined-up

> implementation of programmes <u>across government departments, sectors, and communities</u>; sponsoring/employing innovative approaches; developing <u>partnerships</u> and <u>relationships</u> with stakeholders; and focusing on outcomes.
>
> (Closing the Gap, p161)

Early intervention was another prominent discourse, especially in relation to the early years and families but also evident more broadly, particularly in Equally Well. Such discourses are consistent with the intergenerational focus of the documents' explanations, though again there was a lack of specific examples and interventions:

> To address health inequalities it is likely that public sector resources will have to focus on <u>early interventions</u> and <u>prevention</u>, and as part of that develop a more <u>anticipatory</u> and proactive approach to working with disadvantaged groups.
>
> (Convention of Scottish Local Authorities, quoted in Equally Well 2008, p17)

Within recommendations relating to services and policy, discourses of public involvement were often present. While this was sometimes described as a means for improving the effectiveness or experience of services or policies, it was often justified in terms of benefits for individuals:

> Promotion of the active engagement of service users can serve as a springboard for <u>enhancing the lives</u> of users who might be marginalised or stigmatised, <u>enabling</u> them to exercise greater degrees of <u>control</u> and <u>responsibility</u>.
>
> (Marmot Review, p159)

A range of terms were used in this regard, including 'engagement', 'consultation', and 'ownership'. Though each of these terms imply different levels of participation and power-sharing (Wait and Nolte, 2006), they were often used interchangeably within a given document, indicating a lack of clarity about the goals and processes involved. Only Closing the Gap and Review for WHO-Europe provided detailed descriptions of how greater involvement could be achieved, referring to the role of civil society and in general terms to new approaches to governance and decision-making.

A clear distinction was seen between documents invoking discourses of involvement to those of empowerment. Equally Well referred to ‘engagement’, ‘ownership’ and the need to ‘activate Scotland’s most vulnerable communities’, implying the existence of deficits of responsibility or motivation. On the other hand, in keeping with its explanatory model, Review for WHO-Europe emphasised the need to ‘empower disadvantaged groups relative to the societal systems with which they have contact’, seeing empowerment – and exclusion – as fundamentally relational and created by societal processes and institutions.

Consistency between explanations and recommendations

Documents varied in their internal consistency between the explanations they proposed for health inequalities and the recommendations they made for action. Greater consistency was seen in those documents (Review for WHO-Europe and, to a lesser extent, Closing the Gap) which attempted to directly engage with the theoretical issues surrounding inclusion and vulnerability and which most clearly articulated with their relationship with broader societal processes and inequalities. One example of this is Review for WHO-Europe’s emphasis on empowerment, described above; another is its recommendations on reducing exposure to exclusionary processes, by tackling incarceration rates, homelessness, and the rights of migrants.

In contrast, despite invoking ‘fundamental causes’ and socioeconomic inequality in its explanations, and a rhetorical commitment to prevention, Equally Well’s recommendations primarily focused on mitigation through service delivery, joint working, and individual-level prevention, rather than concrete policy changes in devolved areas such as housing or criminal justice which might serve to ‘undo’ or ‘resist’ the health inequalities with which inclusion health is concerned (Geronimus, 2000). Similarly, while the Marmot Review’s overall recommendations addressed education, work, income, and place-making, many of those relating to inclusion health concerns focused on behavioural change, healthcare access, and targeted interventions.

4.7 Discussion

The inclusion health agenda calls attention to populations experiencing extreme health disadvantage which are not always represented in conventional understandings of health inequalities. Though the inclusion health agenda brings potential risks and tensions, the dominance of socioeconomic position within health inequalities policy to date is also problematic, as approaches focusing exclusively on this dimension of social experience may fail to reflect the other forms of social position, power, and resources which determine individual and community health (Gkiouleka et al., 2018). As Hill has argued, diverse axes of health inequality share common drivers, and a broader understanding that goes beyond purely socioeconomic dimensions is essential for an effective response (Hill, 2015).

Our analysis shows that the inclusion health perspective is reflected to some extent in flagship policy reviews. Most reviews referred to some experiences associated with the inclusion health agenda, and associated health inequalities, though few proposed coherent explanatory accounts and explanatory discourses in each report were not always consistently reflected in their recommendations. We found that this area of health inequalities policy is conceptually under-developed, with terms such as inclusion, exclusion, vulnerability, and disadvantage used ambiguously and interchangeably. This may reflect constructive ambiguity, a discursive device permitting policymakers flexibility in what ‘counts’ as action on health inequalities, especially when appetite for structural change is lacking (Carlisle, 2001). Others have argued that the term ‘vulnerable’ is used as a rhetorical device to avoid naming structural processes which put particular groups at risk; to limit the influence of such groups in policy (Stevens, 2019); and to justify responses of social control; conditionality; and responsibilisation (Brown and Wincup, 2020). This was arguably evident in the emphasis placed in some documents (particularly Equally Well) on ‘vulnerable’ families and targeted early years interventions. However, it is likely that this lack of clarity also reflects conceptual uncertainty within academic and practitioner discourses on inclusion health, particularly on the relationship between the issues of interest and other axes of inequality.

In explaining and making recommendations relating to inclusion health concerns, documents often simultaneously invoked individualistic, medicalised discourses and structural ones. For instance, health inequalities were often characterised in relation to specific diseases affecting specific populations, such as tuberculosis among people experiencing homelessness: while this may reflect the extant published research, none of the documents acknowledged potential biases within this evidence base as to which topics are studied among different populations, a phenomenon well-recognised in relation to ethnicity (Bhopal, 1997, Smith et al., 2000). The dominant role of healthcare in most documents' recommendations is perhaps unsurprising given the well-documented medicalisation of policy responses to health inequalities (Clifford et al., 2019, Embrett and Randall, 2014, Fisher et al., 2016). Whilst healthcare – and a focus on specific conditions – can have a role to play, the dominance of individualistic and biomedical approaches can distract from potentially more impactful interventions seeking to address the societal conditions which give rise to health inequalities (Douglas, 2015).

The emphasis in most reviews on the early years and lifecourse influences on health often had parallels with what Levitas has identified as 'moral underclass discourses', which attribute inequalities to behavioural or cultural norms, parenting practices, and family structures among social groups constructed as peripheral (Levitas, 2006). Moreover, social models of explanation often focused on harms to others, particularly in the case of substance use: the people who use drugs, their social experience, and their 'risk environment' were largely absent (Rhodes, 2009). Those documents with more explicit explanatory frameworks tended to place greater emphasis on structural and societal factors than those without, and to have greater consistency between explanations and recommendations, though both individualistic and structural discourses co-existed in all documents.

Throughout the recommendations, discourses of early intervention and intersectoral working were prominent. This may reflect their status as 'high valence' ideas: abstract concepts which seem intuitively appealing and hard to dispute, but challenging to define and implement in practice (Boswell et al., 2019, Cox and Béland, 2013). Research in other areas of health policy have shown that early intervention is frequently constructed as inherently positive, precluding a more nuanced discussion of potential risks or opportunity costs (Clarke, 2007, Dixon-Woods et al., 2001): criticisms which could also apply to the texts in our analysis. Similarly, achieving genuine intersectoral working on health inequalities has been found to be consistently difficult, given diffusion of responsibility; lack of accountability; and differing motivations and approaches across different actors (Exworthy, 2008). This may be especially pertinent in relation to the issues examined here – for instance, there may be conflict between public health and criminal justice perspectives on individual versus population risks and rights in relation to the use of compulsion or restriction of freedoms – yet this was rarely acknowledged. This suggests that inclusion health has been incorporated into policy in a way that replicates existing shibboleths of health inequalities discourse, whose implicit assumptions and shortcomings may hinder shared understandings and action in the wider policy system.

To this end, our results suggest a need for policy reviews and guidance on health inequalities to be underpinned by comprehensive conceptual frameworks which go beyond single axes of inequality (such as socioeconomic status or race/ethnicity) to encompass diverse forms of social stratification, advantage, and disadvantage, and their intersections. Such frameworks can form the basis for a shared understanding necessary for action on health inequalities as a multi-level and multi-sectoral policy problem, and for making explicit the inherent tensions and trade-offs between different conceptualisations. For the inclusion health field, this may necessitate further theoretical and empirical work on its definitions, bounds, and how its scope of interest interacts with other forms of social and health inequality. In particular, the inclusion health agenda may benefit from moving away from its current emphasis on specific groups (defined by experience, identity, or illness) towards underlying processes (such as discrimination, criminalisation, political disenfranchisement, and intersection with other societal power structures), to provide greater conceptual clarity and consistency and avoid reinforcing the stigma it seeks to tackle.

Declarations of interest

None

Author contributions

The study was devised by EJT and SVK. All authors contributed to planning the study with respect to sampling, coding and analysis, which were carried out by EJT. All authors contributed to interpretation of results. EJT drafted the manuscript, which was revised by all authors prior to submission.

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Chapter 5 The health of people experiencing co-occurring homelessness, imprisonment, substance use, sex work, and/or severe mental illness in high-income countries: a systematic review and meta-analysis

5.1 Foreword

This section reflects on the rationale for the systematic review which follows, and some methodological considerations.

The purpose of a systematic review is to synthesise available evidence on a defined research question in a way that is structured, transparent and reproducible (Krnic Martinic et al., 2019). Such reviews provide a summary of the nature and quality of evidence in a particular area that can be used to inform decision-making and to identify gaps where further research is required. In addition to a descriptive or ‘narrative’ synthesis[1] of study findings, they may also use meta-analysis to obtained pooled effect estimates (Popay et al., 2006, Campbell et al., 2020, Deeks et al., 2021).

I chose to undertake a systematic review of existing evidence on mortality, morbidity, and self-rated health/quality of life among people with the experiences of interest, to gain an understanding of the research landscape in this area that could inform my subsequent empirical analyses using linked administrative data.

Conceptualisation and planning of the review drew on a previous review which I co-authored, which examined mortality and morbidity among people with experience of homelessness, imprisonment, substance use disorder, or sex work but considered these experiences in isolation (Aldridge et al., 2018).

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[1] There is no consensus on what defines ‘narrative synthesis’, and a number of different approaches are described in the literature. In this thesis, I use the phrase in an inclusive way to refer to both textual description that ‘tells the story’ of the findings of included studies (in keeping with Popay et al, 2006) and non-meta-analytic synthesis methods such as effect direction plots and sign tests (as described in Campbell et al, 2020).

I aimed to build on this review in three ways:

1. Examining the exposures of interest in combination, rather than in isolation

2. Extending the exposures of interest to include severe mental illness, given that this was a focus of the planned empirical study and, like the other experiences, was often associated with profound social exclusion

3. Extending the outcomes of interest beyond morbidity and mortality into positive outcomes in the form of quality of life and self-rated health.

As in the previous review, I chose to use both narrative synthesis and meta-analytic techniques to describe the combined findings of the studies retrieved.

A number of strengths and limitations for the review are described in the published article. Building on these, in reflecting on this element of the thesis, I have identified a number of personal lessons I will carry forward in future work. First, the scope of the review was extremely broad, which constrained possibilities for exploring the results in more depth and resulted in fairly broad-brush findings, which encompassed substantial heterogeneity. In future, I would consider spending more time on initial scoping and refinement of the question. Seeking independent peer review – for instance, through the process of publishing the protocol as a stand-alone output – may also help support the process of refining and improving the review at the planning stage. Second, I experienced a tension between maintaining continuity with the previous review and making changes to refine the methodology and provide a foundation for the planned cohort analyses. Were a similar situation to arise in future, I might shift the balance in favour of independence rather than continuity (for instance, to enable a more detailed examination within a narrower scope); and where several related reviews are anticipated, plan for these from the start as a parallel rather than sequential process.

5.2 Title, authorship, and publication details

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Tweed EJ, Thomson RM, Lewer D, Sumpter C, Kirolos A, Southworth PM, Purba AK, Aldridge RW, Hayward A, Story A, Hwang SW, Katikireddi SV (2021). The health of people experiencing co-occurring homelessness, imprisonment, substance use, sex work, and/or severe mental illness in high-income countries: a systematic review and meta-analysis. *Journal of Epidemiology and Community Health.* doi: http://dx.doi.org/10.1136/jech-2020-215975

5.3 Abstract

Background

People affected by homelessness, imprisonment, substance use, sex work, or severe mental illness experience substantial excess ill-health and premature death. Though these experiences often co-occur, health outcomes associated with their overlap have not previously been reviewed. We synthesised existing evidence on mortality; morbidity; self-rated health; and quality of life among people affected by more than one of these experiences.

Methods

In this systematic review and meta-analysis, we searched Medline, Embase, and PsycINFO for peer-reviewed English-language observational studies from high-income countries published between 1/1/1998-11/06/2018. Two authors undertook independent screening, with risk of bias assessed using a modified Newcastle-Ottawa Scale. Findings were summarised by narrative synthesis and random effects meta-analysis. (PROSPERO: CRD42018097189)

Results

From 15,976 citations, 2,517 studies underwent full-text screening and 444 were included. The most common exposure combinations were imprisonment/substance use (31% of datapoints) and severe mental illness/substance use (27%); only 1% reported outcomes associated with >2 exposures. Infections were the most common outcomes studied, with blood-borne viruses accounting for 31% of all datapoints. Multiple exposures were associated with poorer outcomes in 80% of datapoints included (sign test for effect direction, $p<0.001$). Meta-analysis suggested increased all-cause mortality among people with multiple versus fewer exposures (HR 1.57, 95% CI 1.38-1.77), though heterogeneity was high.

Conclusion

People affected by multiple exclusionary processes experience profound health inequalities, though there are important gaps in the research landscape. Addressing the health needs of these populations is likely to require co-ordinated action across multiple sectors, such as healthcare, criminal justice, drug treatment, housing, and social security.

Keywords: health inequalities; homelessness; substance use; sex work; criminal justice; mental health

What is already known on this subject?

- Previous studies have shown that people experiencing homelessness, imprisonment, sex work, substance use, or severe mental illness experience high levels of ill-health and premature death.

- However, these experiences are known to overlap substantially in the population, a phenomenon variously referred to as multiple exclusion, severe and multiple disadvantage, and multiple and complex needs. There is empirical and theoretical evidence to suggest that this overlap may matter for health.

- The association between more than one of these experiences and health outcomes has not previously been systematically reviewed.

What this study adds?

- Our synthesis of existing evidence suggests that people affected by more than one of these exclusionary experiences have substantially poorer health outcomes – in terms of mortality, morbidity, and self-rated health/quality of life.

- This review has also identified important gaps in the literature. Future research in this field should prioritise longitudinal designs examining a broader range of combinations and outcomes, particularly non-communicable diseases, and exploring heterogeneity within exposures.

- While in population terms the number of people affected by multiple exclusionary processes may be relatively small, they appear to experience extreme health inequalities. Addressing these inequalities is likely to require co-ordinated action across multiple sectors.

5.4 Introduction

Social exclusion can be defined as the processes by which some individuals or social groups are deprived of resources, rights, or opportunities to participate in the activities and relationships available to most people in society (Levitas, 2006, Krieger, 2001). Homelessness, imprisonment, substance use, sex work, and severe mental illness are experiences commonly associated with social exclusion, and which often co-occur (Aldridge et al., 2018). The magnitude of this overlap varies between contexts, but as an example, recent studies from the UK estimate that approximately 1.5 per thousand people experience homelessness, justice involvement, and problem substance use in a given year (Bramley and Fitzpatrick, 2015, Bramley et al., 2019b).

People affected by any one of these experiences are known to have much higher rates of ill-health and premature death than the rest of the population (Aldridge et al., 2018). For instance, a previous review undertaken by our team found that standardised mortality ratios among people with experience of homelessness, imprisonment, substance use or sex work compared to the general population were between 8 and 12 (Aldridge et al., 2018). That review examined health outcomes associated with these experiences individually and did not investigate their co-occurrence.

There is good reason to hypothesise that multiple forms of exclusion may be associated with poorer health. First, intersectionality approaches have highlighted how overlapping forms of disadvantage can interact to influence an individual's social experience and therefore their health (Kapilashrami and Hankivsky, 2018). Second, some forms of multiple exclusion appear to be associated with adverse outcomes, whereas for others the evidence is mixed. For instance, among people released from prison, substance use – but not psychiatric history – is a consistent risk factor for mortality (Chang et al., 2015, Spittal et al., 2019).

To our knowledge, the association between multiple forms of exclusion and health outcomes has not previously been reviewed. Understanding this association is increasingly important given rising rates of homelessness, imprisonment, and drug-related harms across a number of high-income countries (Scholl et al., 2018, Organisation for Economic Co-operation and Development, 2017, Walmsley, 2018, Office for National Statistics, 2019). We aimed to synthesise evidence from high-income countries of the association between lifetime exposure to more than one of the following: homelessness, imprisonment, substance use, commercial sex work, or severe mental illness, and the following outcomes:

- all-cause and cause-specific mortality
- morbidity
- self-rated health or quality of life.

We chose to consider severe mental illness as an additional exposure to those included in our previous review, as in some contexts it overlaps substantially with the other experiences of interest (Fazel et al., 2008, Fazel et al., 2016, Buckley and Brown, 2006), and is often associated with both social exclusion (Morgan et al., 2007) and premature morbidity and mortality (Liu et al., 2017).

5.5 Methods

This systematic review and meta-analysis was conducted according to a protocol registered with PROSPERO in advance of study initiation (CRD42018097189).

Populations of interest

Exposures of interest in this review were chosen on the grounds that they are among the most extreme, and most commonly co-occurring, forms of social exclusion in high-income countries: their impacts are likely to be less variable over time and place than experiences which are more closely allied to individual identity, such as ethnicity, migration, or sexual minority status. This choice was also informed by continuity with a previous review undertaken by our team (Aldridge et al., 2018) and a forthcoming cohort study drawing on administrative data sources.

Study participants comprised people with a lifetime history of more than one of the following:

(a) Homelessness (including people who are rough sleeping or unstably/marginally housed; abbreviated to HL)

(b) Substance use (other than alcohol, cannabis, or image/performance enhancing drugs; abbreviated to SU)

(c) Imprisonment (abbreviated to PR)

(d) Sex work (including transactional sexual relationships, i.e., sex in exchange for food, accommodation, drugs; abbreviated to SW)

(e) Severe mental illness, defined as schizophrenia spectrum disorders, other psychotic disorders, and/or bipolar disorder, or according to the primary study's definition of "serious" or "severe" mental illness (abbreviated to SMI)

Alcohol was not included in the exposure definition for substance use, as the legality and ubiquity of alcohol in many high-income countries means that its use is less stigmatised and less closely associated with social exclusion (Babor et al., 2010). Cannabis was similarly excluded given the legalisation or decriminalisation of its use in many high-income countries (Csete et al., 2016). Where a study referred to substance use without distinguishing between these categories, studies were included.

Studies were excluded if participants were recruited from secondary healthcare settings or on the basis of specific health conditions or healthcare utilisation (other than for SMI or substance use). The comparator group was defined as people with fewer or none of the exposures of interest. Given the number of studies retrieved, it was decided at the full-text stage to exclude data points without any comparison group.

Outcomes

The outcomes of interest were mortality (all-cause or cause-specific, categorised according to ICD-10 chapters); morbidity (based on clinical diagnosis, hospitalisation, validated diagnostic tool, or self-report, categorised according to ICD-10); and quality of life, health-related quality of life and self-rated health (based on formal measures such as EQ-5D or SF-36). We excluded outcomes relating to the perinatal period; health behaviours; engagement with preventative health services; and prognosis or treatment success. Outcomes which clearly preceded exposures of interest (e.g., disorders of early childhood) were not eligible. Both absolute and relative outcome measures were eligible for inclusion.

Study design

Eligible study designs were cross-sectional, case-control, and cohort studies, and baseline data from interventional studies. Systematic reviews were eligible for inclusion if they had a clearly specified review question; reported a search strategy including more than one database; and used explicit inclusion criteria to select studies.

Publication characteristics

Given that the relationship between the exposures and outcomes of interest is at least partly dependent on context (e.g., social policy, healthcare provision, public attitudes, and other factors), we restricted our search to studies published in the last two decades (01/01/1998-11/06/2018) and in the English language from high-income countries (World Bank classification) (World Bank, 2017), to maximise the relevance of the evidence retrieved to current policy and practice in those countries. Conference papers; theses; correspondence; and editorials or other commentary were excluded.

Searches, screening, and data extraction

Medline, Embase and PsycINFO were searched on 11/06/2018 using a search strategy developed with an information specialist and detailed in Supplementary material accompanying Chapter 5. Screening was undertaken in Covidence, following automatic and manual de-duplication. All title/abstracts were screened for inclusion by EJT and independently by a second reviewer. A 20% sample of the resulting full-texts underwent double-screening; the remainder were single-screened by EJT. The kappa statistic for the double-screened sample was 0.93.

Data extraction of studies eligible for inclusion was undertaken by EJT and checked independently by a second reviewer using a standardised form, available as part of the supplementary material. We contacted authors where eligible data points were identified but not published in an extractable format (e.g., graphical presentation only). Risk of bias (RoB) was assessed independently by EJT and a second reviewer at the outcome level, using an adapted version of the Newcastle-Ottawa Scale for non-randomised studies (see Appendices). Screening conflicts and discrepancies in data extraction or RoB assessment were resolved by discussion and, where necessary, the adjudication of a third reviewer (SVK).

For completeness, where systematic reviews were identified, we reviewed these to identify any original studies not included in the original searches which appeared to report relevant outcomes for >1 exposure group in combination (Lefebvre, 2020). These underwent title and abstract screening followed by full text review as per studies retrieved by searches: of 104 potentially eligible studies identified in this way, only seven met inclusion criteria and were included in the final analysis.

Studies were reviewed to identify duplicate data where results from a single research study were presented in separate publications: where this occurred, the study with the largest or most representative sample size was included. Potentially overlapping data points (e.g., reporting both absolute and relative measures for the same population and outcome, or reporting the same outcome for non-mutually exclusive substance use subgroups) were de-duplicated using the criteria outlined in Supplementary material accompanying Chapter 5.

Data synthesis

Narrative synthesis of findings was undertaken according to a pre-specified protocol, summarising the characteristics of included studies; the range, direction, and size of associations reported; the results of RoB assessment; and key gaps in the literature (Campbell et al., 2020). Effect direction plots were created as a visual aid to synthesis and sign tests used to test the null hypothesis of equivalent outcomes between multiply excluded groups and comparators (Hilton-Boon and Thomson, 2019). All visualisations were created in R 3.6.3 using the packages *ggplot2* and *rworldmap*.

Meta-analyses were undertaken to compare multiple versus fewer exposures to explore the overarching review question of whether multiple exclusion is associated with poorer health. We anticipated substantial heterogeneity and therefore planned in advance to use random effects models, using the *metan* command in Stata version 15. These were carried out separately by effect measure as most studies reported only point estimates without absolute numbers, precluding synthesis across multiple effect measures. Funnel plots were used to visually assess the potential of publication bias for key outcomes reported in the manuscript.

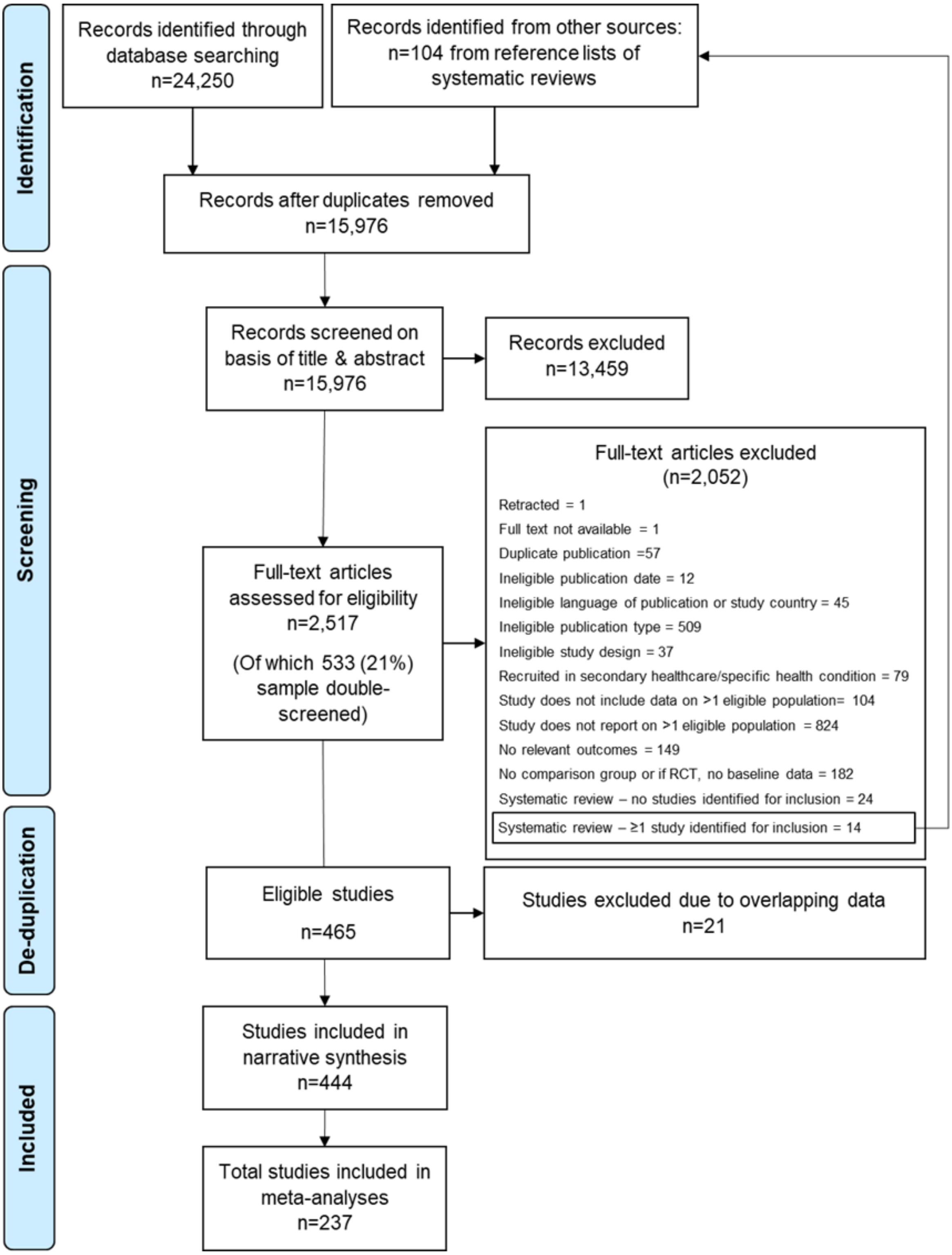
5.6 Results

Figure 2 shows the PRISMA flow chart. After de-duplication, a total of 444 studies were included, yielding 1,480 data points (i.e., effect estimates for a unique population and comparator combination) in total. Details of included studies are provided in Supplementary material accompanying Chapter 5.

Thirty countries were represented (Figure A3.1 in Supplementary material accompanying Chapter 5), though the majority of studies were carried out in the United States (n=164; 37%); Canada (n=57; 13%), the United Kingdom (n=41; 9%) or Australia (n=39; 9%). Most studies were cross-sectional (n=327; 74%); only 23% studies (n=103) reported longitudinal data. With regard to risk of bias, 63% of data points (n=932/1,480) were assessed as having low risk of bias, though this varied by study design (Table A3.1 in Supplementary material accompanying Chapter 5).

The most common exposure combinations were imprisonment/substance use and severe mental illness/substance use, accounting for 31% (n=465) and 27% (n=393) of data points respectively, followed by homelessness/substance use (19%; n=283). Only four of the possible 10 combinations of three exposures had any available data points; no data points were identified relating to four or more exposures (Figure 3).

Figure 2. PRISMA flow chart for systematic review



With regard to outcomes, 77% (n=1,139) data points related to morbidity; 16% (n=239) to mortality; and 7% (n=101) to self-reported health or quality of life. The most common ICD-10 chapters were infections (chapter 1: 40%; n=587); mental and behavioural disorders (chapter 5: 16%; n=236); and external causes (chapters 19 & 20 combined: 15%; n=227).

Figure 3 shows the distribution of data points by exposure combination and outcome category (organised by ICD-10 chapter). It illustrates the dominance of a limited number of outcome types – above all, infectious diseases – and the lack of any data for some exposure combinations on common conditions such as circulatory, respiratory, and metabolic disorders. Across all exposure combinations, blood-borne viruses (BBV) accounted for 31% (n=456) of total data points (Figure A3.2 in Supplementary material accompanying Chapter 5).

Overall, 80% (n=1,190/1,480) of data points showed an association between multiple exposures and poorer health outcomes: after restricting to studies at low risk of bias, this rose to 86% (n=801/932). Sign testing of effect direction gave p values of <0.001 in both cases, providing evidence to reject the null hypothesis of no association.

Figure 3. Study design of data points included in the systematic review, stratified by exposure combination

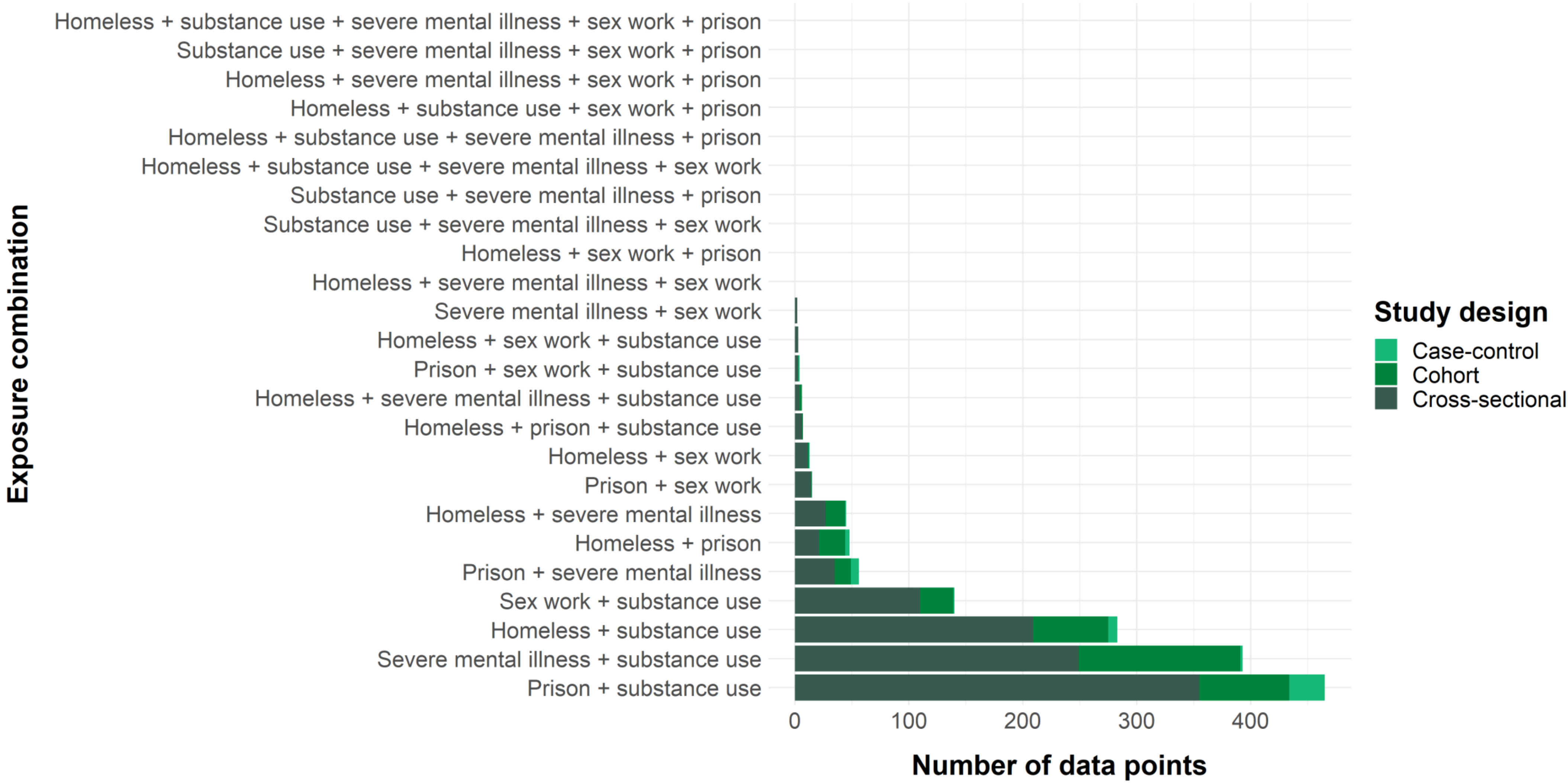
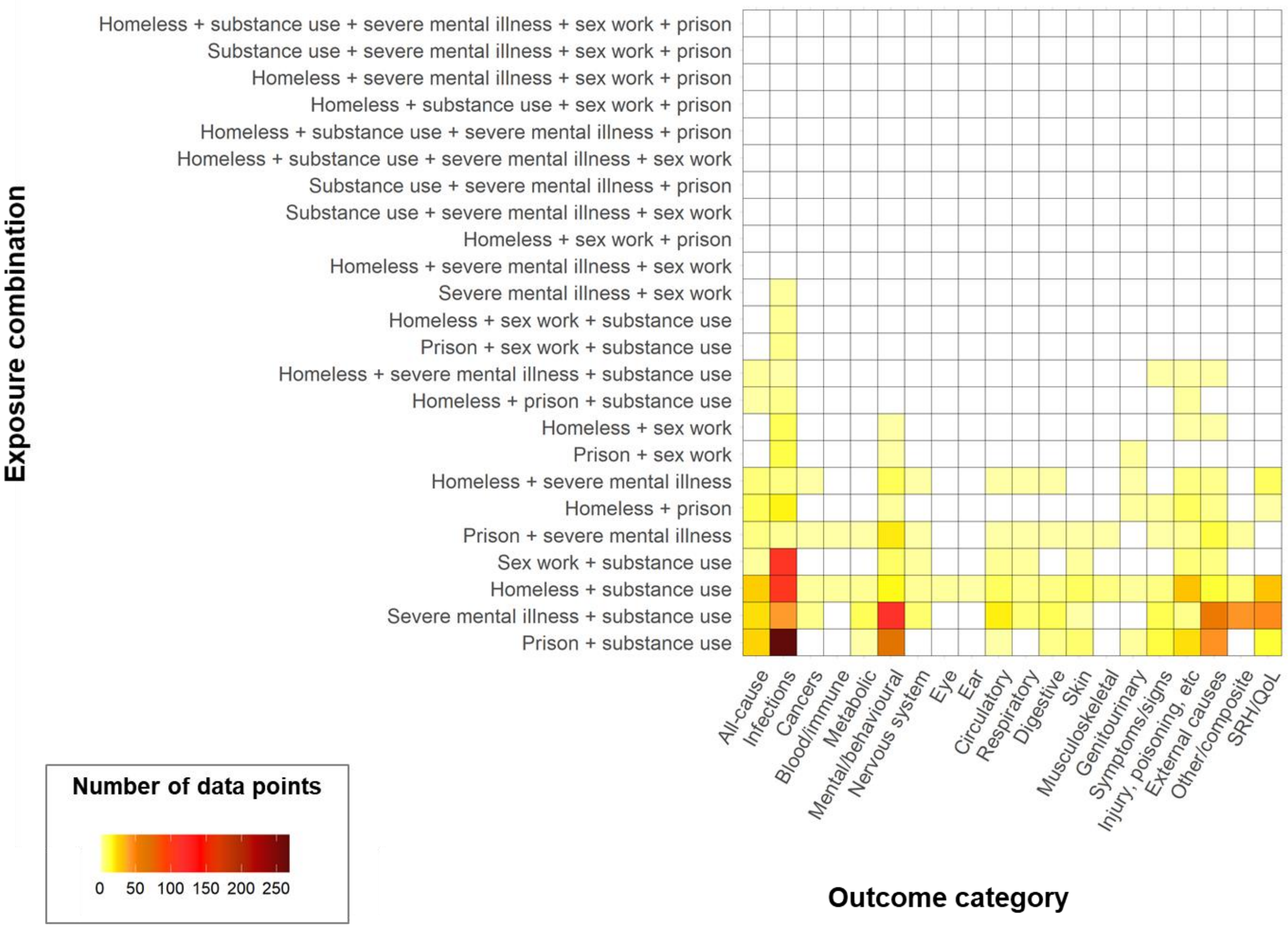


Figure 4. Heat map showing frequency of data points included in the systematic review according to exposure combination and outcome category



In presenting the results of our narrative and quantitative synthesis we focus on all-cause mortality; cause-specific mortality and morbidity from infections, external causes, and non-communicable diseases; and self-rated health and quality of life. Effect direction plots and meta-analysis results for other outcomes are shown in Supplementary material accompanying Chapter 5. Heterogeneity was high in most meta-analyses undertaken, and did not appear to be explained by assessed risk of bias.

With regard to all-cause mortality, 79% (n=75/95) data points showed an association between multiple exposures and increased risk (sign test for effect direction p<0.001; Figure 5). Figure 6 shows the pooled results for studies reporting hazard ratios, the most commonly reported effect measure. The pooled point estimate of 1·57 (95% CI 1·38-1·77) was similar to those obtained for other effect measures, and exclusion of studies at high risk of bias did not materially affect the results (Supplementary material accompanying Chapter 5).

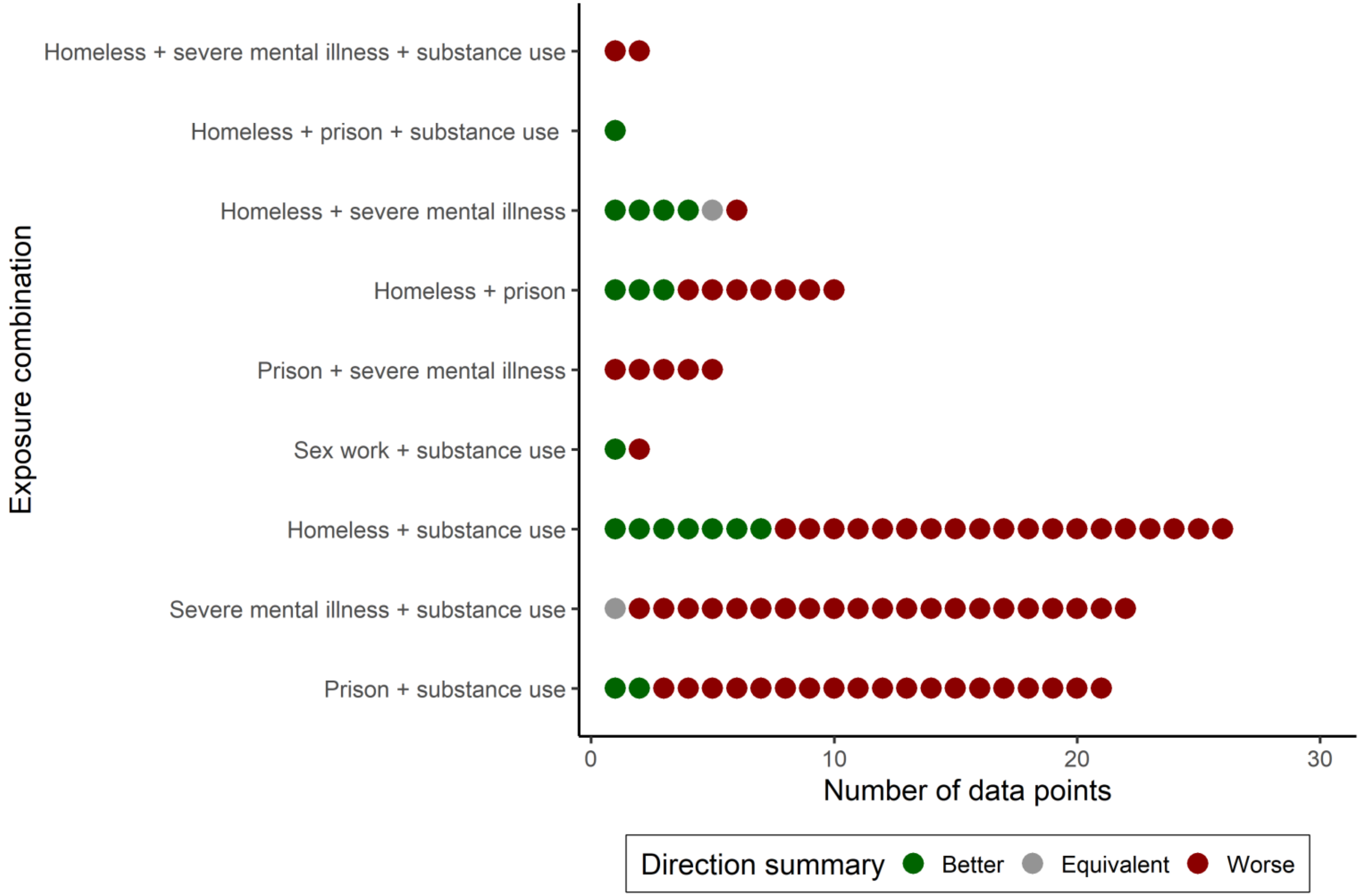
For external cause mortality (ICD-10 chapters 19 and 20), again the majority (81%; n=60/74) of data points suggested greater risk among those with multiple vs fewer exposures (sign test for effect direction p<0.001; Figure 7). Pooled measures indicated a stronger association than for all-cause mortality, evident across all exposure combinations (Figure 8). Again, results were similar across effect measures and after stratification by assessed risk of bias (Supplementary material accompanying Chapter 5). Similarly, with regard to BBV prevalence, 87% (n=394/452) data points showed an association between multiple exposures and higher prevalence (sign test for effect direction p<0.001; supplementary material). Pooled measures indicated a strong association including after stratification by assessed risk of bias (Supplementary material accompanying Chapter 5).

Fewer data points were available for non-communicable diseases (NCDs): effect direction plots and sign testing did not identify an association between multiple exclusion and NCDs overall (Supplementary material accompanying Chapter 5), though the burden of respiratory disease did appear to be significantly higher (sign test p=0.016). Variation in outcome measures and time periods meant that meta-analyses were small and potentially underpowered, but showed similar results (Supplementary material accompanying Chapter 5). Only one study examined metrics relating to avoidable mortality: Lumme et al. (2016) found that rate ratios for mortality amenable to healthcare were generally substantially higher among people with severe mental illness and substance use compared to those with severe mental illness alone, across multiple time periods and both men and women.

With regard to self-rated health and quality of life, 71% (n=71/100) data points for this outcome type suggested poorer outcomes among people experiencing multiple exclusion (sign test $p<0.001$), but this proportion varied by exposure combinations (Supplementary material accompanying Chapter 5). Meta-analysis of these outcomes was not possible due to variation in the instruments used and limitations in reporting.

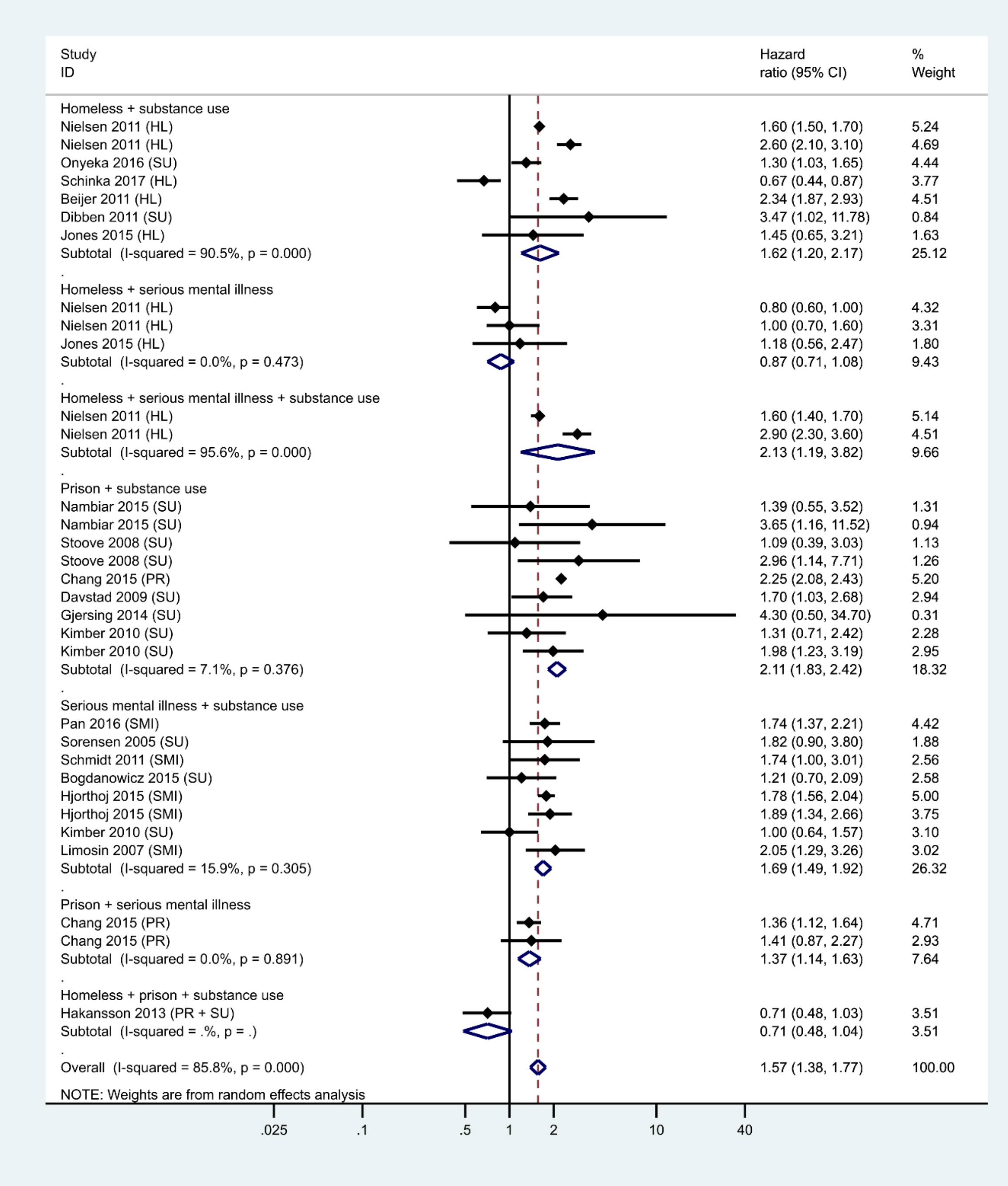
Relatively few data points were available for gender-stratified analyses. Exploratory analyses did not suggest a consistent difference between genders in associations between multiple exclusion and health outcomes (Supplementary material accompanying Chapter 5).

Figure 5. Summary effect direction plot for all-cause mortality, by exposure combination



Note that effect direction and forest plots omit combinations for which no data points were identified.

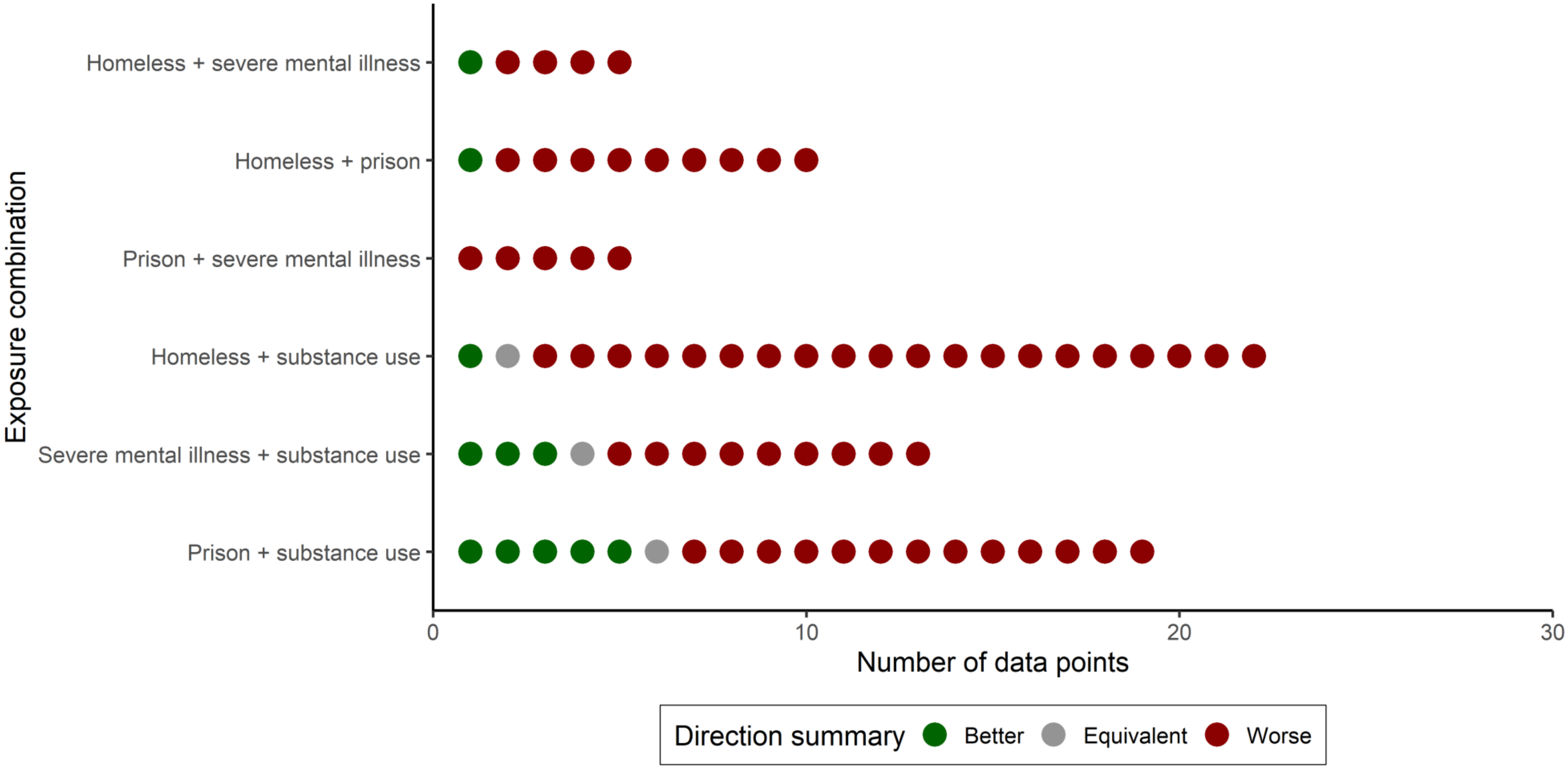
Figure 6. Forest plot for meta-analysis of data points reporting all-cause mortality using hazard ratios, by exposure combination



HL – homelessness and housing insecurity; SU – substance use; PR – prison; SW – sex work; SMI – severe mental illness. (Information in brackets indicates comparator group).

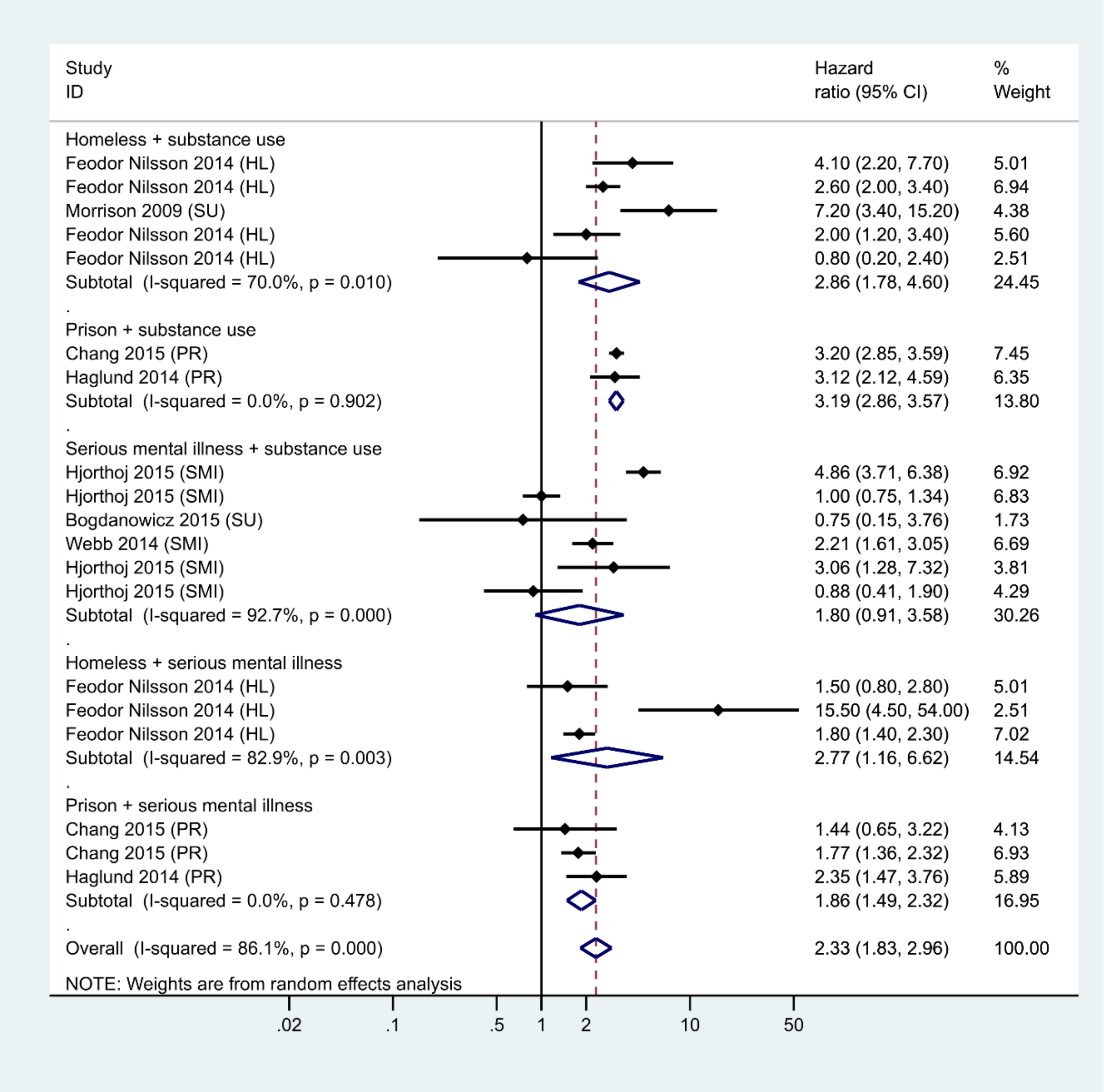
Note that effect direction and forest plots omit combinations for which no data points were identified.

Figure 7. Summary effect direction plot for external mortality (ICD-10 chapters 19 & 20), by exposure combination



Note that effect direction and forest plots omit combinations for which no data points were identified.

Figure 8. Forest plot for meta-analysis of data points reporting external cause mortality using hazard ratios, by exposure combination



HL – homelessness and housing insecurity; SU – substance use; PR – prison; SW – sex work; SMI – severe mental illness (Information in brackets indicates comparator group).

Note that effect direction and forest plots omit combinations for which no data points were identified

5.7 Discussion

Our systematic review demonstrates that existing evidence on the association between multiple exclusion and health is dominated by cross-sectional studies examining a limited number of exposure combinations and outcomes. In particular, we found there is a predominance of studies on infectious disease, mental illness, and external causes of morbidity and mortality. Few studies have examined combinations involving sex work, or more than two of these experiences. Results of our narrative and quantitative synthesis suggested that multiple exclusion is associated with increased all-cause and external cause mortality, as well as higher prevalence of BBV. For non-communicable diseases, few data points were available and associations varied by NCD type, exposure combination, and outcome measure.

The skew of previous research towards specific exposure combinations and outcomes means that available evidence may not reflect the population overlap between these experiences or conditions causing the greatest burden of ill-health. For instance, multiple exclusion appears to be associated with a higher risk of some NCDs, which may translate into a substantial population burden, yet these conditions were relatively under-studied. These populations may therefore be further disadvantaged by evidence gaps on potentially important health needs.

Nonetheless, the available data demonstrate stark health inequalities. An estimated 57% greater hazard of mortality associated with multiple exclusion, beyond the 8 to 12-fold differential seen between people with any one such experience and the rest of the population (Aldridge et al., 2018), suggests extreme health disadvantage among these populations. The findings of excess risk of infections, and of co-morbidities such as respiratory disease, are especially noteworthy in the context of the current COVID-19 pandemic.

The mechanisms by which intersecting forms of social exclusion may influence health are likely to be complex. Multiple exclusion may worsen health through multiplicative or additive risks, or even improve it by enabling access to services with beneficial effects. Alternatively, the combination of these experiences may pose no additional risk (particularly where background risk is already high) or merely represent a marker for other forms of cumulative adversity with effects on health, such as extreme poverty.

The strengths of this review include its comprehensive scope, systematic and transparent approach, and use of best practice guidelines for narrative synthesis (Campbell et al., 2020). To our knowledge no other review to date has attempted to synthesise the evidence of health outcomes associated with multiple forms of social exclusion in this way.

However, a number of limitations to our review should be noted. Given the large number of studies identified, we were unable to explore diversity within exposure categories in detail: for instance, homelessness encompasses a spectrum of housing exclusion from rough sleeping to ‘sofa surfing’. The nature of these experiences – and their relationship with health – is also likely to vary across contexts with different welfare regimes, healthcare systems, and legislative approaches: this may further contribute to heterogeneity and merits more detailed investigation.

Another potential limitation is the risk of publication bias. Inspection of funnel plots suggested potential for small-study effects (Supplementary material accompanying Chapter 5), though this may be explained by true heterogeneity or methodological weaknesses of smaller studies.

Our findings cannot be used to draw conclusions about the causal effects of multiple exclusionary experiences, since few of the original studies used designs appropriate to causal inference and to enhance comparability, our data extraction focused on minimally adjusted measures. Further work is required to establish the extent and nature of potential causal mechanisms.

Nonetheless, descriptive epidemiology can provide insights into ways to mitigate observed health inequalities. For instance, the high rates of external cause mortality identified here suggest an important role for overdose, suicide, and accident prevention interventions in justice settings, temporary accommodation, and mental healthcare. Existing services and policies tend to be narrowly focused on single experiences: a phenomenon particularly well-documented in mental healthcare, where people with substance use problems are often excluded from services (Public Health England, 2017). Our results suggest a more integrated approach may be warranted. Descriptive epidemiology can also provide baseline data for evaluating policy and service changes with the potential to impact health (Culhane, 2016, Kinner and Young, 2018).

Future research in this area would benefit from being informed by conceptual and empirical understandings of multiple exclusion: for instance, by prioritising combinations which are most common or associated with poorest outcomes. There is also a need for more longitudinal research examining more than two overlapping experiences and for a greater focus on the potential burden of non-communicable diseases.

However, there are also important opportunities for action on the available evidence. While people affected by multiple exclusion represent a relatively small group within society, the extreme health inequalities identified here means that their experiences and needs should be an important consideration within health care systems, public health, and public policy more broadly. This is especially pertinent during the global COVID-19 pandemic, in which these populations face a ‘perfect storm’ of clinical and social vulnerability (Perri et al., 2020, Kinner et al., 2020, Marsden et al., 2020).

Conclusion

Evidence to date suggests that people affected by multiple exclusionary processes experience profound health inequalities, though there are also important gaps in the research landscape. In particular, there is a need for studies examining a broader range of exposure combinations and outcomes, especially non-communicable diseases, and exploring possible causal mechanisms. In the meantime, addressing the health needs of these populations is likely to require co-ordinated action across multiple sectors, such as healthcare, criminal justice, drug treatment, housing, and social security.

Declarations:

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on request.

Competing interests

AH is a trustee of the Pathway Homeless Health Charity. AS is the clinical lead and manager for the UCLH Find & Treat service. The remaining authors have no competing interests to declare.

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Authors’ contributions

EJT proposed the hypothesis for the review, and EJT, RWA, AH, AS, SWH, and SVK drafted the study protocol. EJT carried out the literature searches. EJT, AK, SVK, DL, CS, PS, and RT undertook screening of titles and abstracts and full text screening. Following data extraction by EJT, data were checked and independent risk of bias scoring was undertaken by AK, SVK, DL, AKP, CS, PS, and RT. EJT undertook narrative synthesis and meta-analysis, and wrote the first draft of the manuscript. All authors reviewed and interpreted the results and edited the manuscript.

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Chapter 6 Co-occurring homelessness, justice involvement, opioid dependence, and psychosis: a proof-of-principle study using cross-sectoral administrative data linkage

6.1 Foreword

This section aims to provide additional background on methodological issues relevant to the paper which follows, in particular the challenges of realising the record linkage.

As outlined in Section 2.6, administrative data linkage may be a useful approach in addressing the lack of population-based studies describing the intersection between the experiences of interest to this thesis. Given that the occurrence and co-occurrence of these experiences is likely to be highly context-dependent, robust evidence from UK settings is required to inform services and policy.

Moreover, the systematic review described in Chapter 5 identified several key gaps in our knowledge of health outcomes associated with their overlap. There were many under-studied exposure combinations and outcomes, and a lack of longitudinal studies from the UK. Non-communicable diseases were especially poorly understood, even though morbidity and mortality from these conditions appeared to be similar or higher among people with multiple exposures compared to fewer (see Supplementary material accompanying Chapter 5).

In light of these gaps, I designed and undertook a retrospective cohort study using cross-sectoral administrative data linkage to investigate the intersection between these experiences and associated health outcomes.

To my knowledge, this project represents the first occasion on which the relevant datasets have been linked. Although the homelessness, prisons, opioid substitution therapy dispensing, and psychosis data had each been linked to healthcare and mortality datasets (Table 1), they had not previously been combined together. The use for research of the criminal justice social work reports dataset appears to be especially limited, and it does not appear to have been linked to other datasets at an individual level. The study described in the following section therefore extends existing precedents for the use of administrative data to identify people affected by the experiences of interest by creating a novel population-based cohort focused on their intersections.

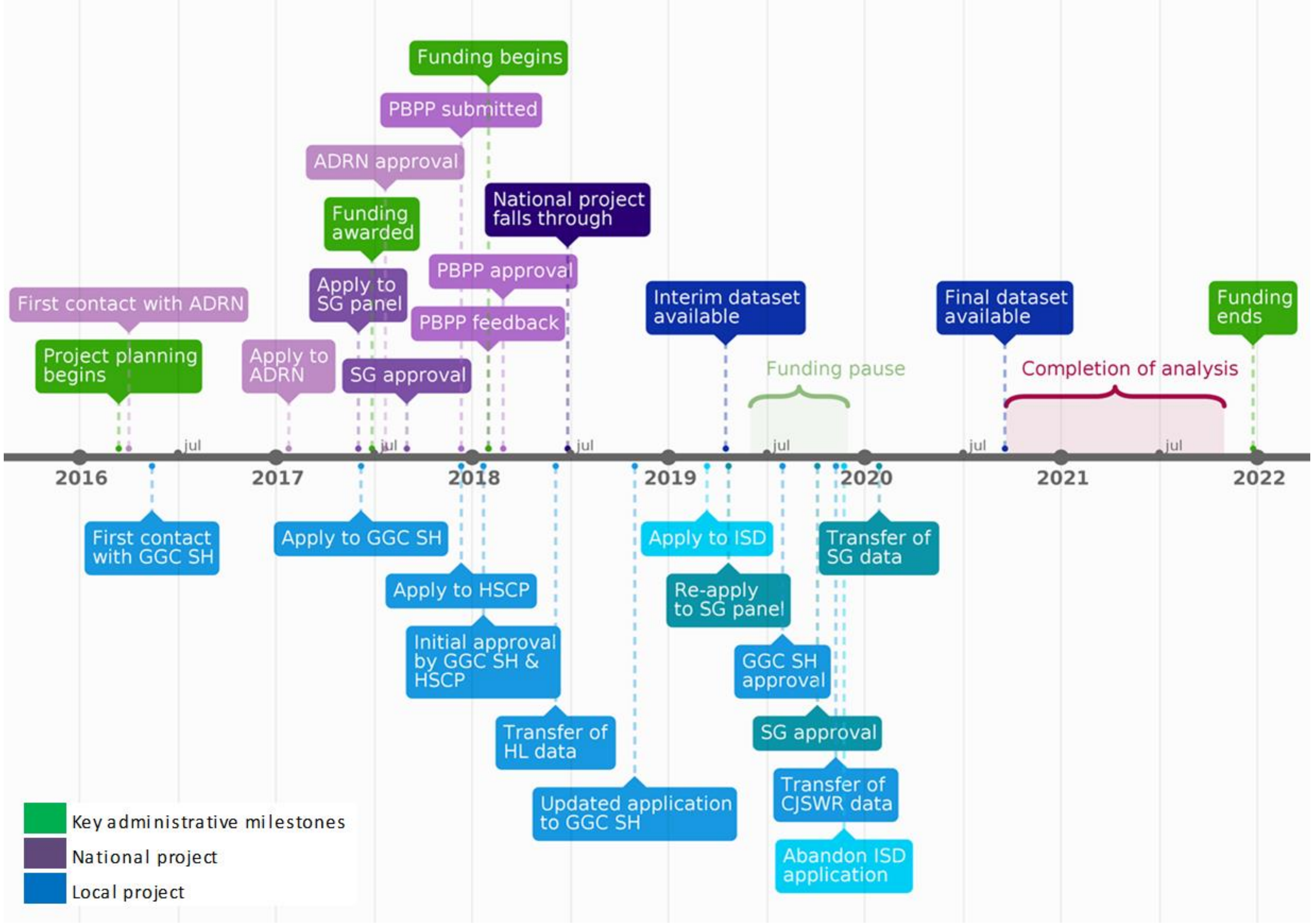
Inevitably, the use of administrative data created several constraints and challenges: above all, significant delays in approvals and access to datasets. Figure 9 provides a summary timeline for the project. It includes events relating to both the national project as originally planned, which later had to be abandoned, and the local project which had been intended as pilot work but subsequently was used for the primary analyses.

Prior to starting the PhD, I anticipated that the proposed project would entail significant governance challenges and therefore began the necessary groundwork more than 18 months in advance. However, at a late stage in the process of securing access to an existing national homelessness dataset, I was informed that the advice I had originally been given on data controllership for that dataset was incorrect and that additional permissions would be required. These comprised information sharing agreements between each of Scotland’s 32 local authorities and National Records of Scotland, as well as information sharing agreements between each local authority and the University of Glasgow. Even once agreements had been reached and data had been provided by participating local authorities to the Trusted Third Party for linkage (in this case the Administrative Data Research Network for Scotland), there would be a minimum five-month delay in indexing and linkage before the study dataset would be ready for analysis.

Table 1. Summary of key studies which have previously undertaken record linkage between health outcomes and the exposure datasets featured in Chapters 6 and 7

Citation	Dataset	Experience of interest	Outcome dataset used in linkage	Key findings
Morrison (2008), Morrison (2009)	HL1	Homelessness	Hospitalisation records (SMR01) Death registrations	Homelessness associated with substantial excess mortality after accounting for socioeconomic deprivation, including from non-communicable diseases such as circulatory and respiratory disorders
Waugh et al. (2018)	HL1	Homelessness	Death registrations	Elevated number of deaths among homeless people compared to their housed peers – however, used a relatively simple approach that did not include accounting for person-time at risk or multivariate analysis
Gao et al. (2016), Gao et al. (2019)	Prescribing Information System (PIS)	Opioid dependence	Death registrations	High rates of physical co-morbidities such as cardiovascular and respiratory disease among those dying from drug-related deaths
Scottish Drugs Forum (2017)	Prescribing Information System (PIS)	Opioid dependence	Hospitalisation records (SMR01 and SMR04)	People with older problem drug use experience high rates of a number of long-term conditions (including chronic respiratory disease and cardiovascular disease) as well as substantial projected future increases in hospital usage.
Graham et al. (2015)	PR2	Imprisonment	Death registrations	People released from prison in Scotland between 1996 and 2007 experienced extremely high mortality rates compared to community controls, even after accounting for socioeconomic deprivation, including high rates of death from cardiovascular and respiratory causes
Martin et al. (2014c)	PsyCIS	Psychosis	Death registrations	Linkage between psychosis clinical registry and death registrations, showing that excess mortality among people with psychotic disorder was observed across the socioeconomic spectrum but most pronounced among people living in the most deprived areas.

Figure 9. Timeline summarising process of cohort creation and analysis



Having spent some time exploring the situation with ADRN and discussing with my supervisory team, I concluded that pursuing the national data – or even a subset of local authorities – as the basis for the PhD carried too many risks to timely completion. Given these concerns, I decided to restrict the scope of the cohort study to Glasgow City, where I had already obtained approvals for pilot work with the HL1 homelessness dataset and other health datasets via the NHS Greater Glasgow and Clyde Safe Haven.

The decision to abandon the national study reflected the cumulative impact of multiple difficulties and delays, and the anticipation that these were likely to continue even with an amended national project. These included:

- The steps required to secure approval for data access and to negotiate data extraction were often unclear, and it often took some time to identify individuals who knew for certain what the requirements were, and who had the authority to make the necessary decisions. This was the case at both national and local level.

- It was often hard to get timely responses from data controllers or those working in the linkage infrastructure: since the process often required sequential input from each of these, this meant that bottlenecks were often compounded.

- The cross-sectoral nature of the linkage proposed meant that – under the system as it stands – the research underwent independent scrutiny by multiple different panels. There was on occasion confusion about the remit and relationship between these, for instance as to whether NHS and/or university ethics committee approval was required for linkage projects.

- No guarantees or accountability measures were available regarding timescales for different steps of the process and we found that projected timescales were frequently exceeded. This led to a cautious approach when assessing feasibility and risk, and was a major factor in deciding not to pursue the project at a national or multiple local authority scale.

Instead, I focused on supplementing the homelessness data with additional datasets on criminal justice, from Scottish Government (national prisons dataset; PR2) and Glasgow City Council (criminal justice social work reports; CJSWR). There were further delays in securing approvals; data extraction and transfer; and record linkage for these datasets, not least due to the Covid-19 pandemic, but a final dataset was obtained in autumn 2020, as illustrated in Figure 9. I additionally submitted an application to Information Services Division Scotland to access records from the Scottish Drugs Misuse Database but a satisfactory outcome could not be reached after 11 months of discussions, so the application was withdrawn.

As part of the thesis discussion in Chapter 9, I reflect on the implications of these experiences for the conduct of cross-sectoral linkage research and how they might be addressed in future.

Within Glasgow City Council and Health and Social Care Partnership (HSCP), there was already a great deal of interest in the topic area. This reflected multiple drivers, including an ongoing HIV outbreak in which injecting drug use, homelessness, and justice involvement were key risk factors; increasing numbers of drug-related deaths; well-documented failures in statutory homelessness provision; concerns about difficulties meeting the needs of 'high resource users' in frequent contact with services such as emergency departments; and negative public perceptions of public order and amenity associated with visible forms of street homelessness, begging, and drug use in public places. As a result, the project was fortunate to benefit from senior support within the council and HSCP, and opportunities to feed into local service planning, which mitigated somewhat the blow of having to restrict the geographical scope compared to my original plans.

Sex work was not included in plans for the national or local study, as no suitable datasets could be identified for inclusion in the linkage. Unlike prisons, criminal justice social work, and homelessness, there are no statutory entitlements or single national service for people involved in sex work in Scotland which might facilitate administrative data collection. Most attempts to estimate prevalence draw on data recorded in criminal justice or drug treatment settings, precluding a population-based assessment of co-occurrence (Scottish Government, 2017a). Changes in local service provision in Glasgow during the period of the interest resulted in a changing service user profile and therefore potential inconsistencies in the population captured by any data from this source (Scottish Government, 2017a). The implications of this lack of routine data on sex work are explored further in the thesis's discussion (Chapter 9).

The conduct of the cohort study described in this and the subsequent chapter was guided by an advisory group comprising stakeholders working in local government, NHS, Scottish Government, academia and the third sector, as well as two public representatives with lived experience of the issues at hand. Their input shaped both the design and interpretation of the analyses: for instance, Section 7.1 below describes their feedback on the choice of outcome measures in the longitudinal analysis, and the discussion in Chapter 9 draws on the group's discussions in identifying implications for policy, practice, and research.

6.2 Title, authorship, and publication details

This article has not yet been submitted for publication, pending further information from the West of Scotland Safe Haven about the characteristics of records in the PR2 dataset which could and could not be linked. It is hoped such data will be forthcoming early in 2022.

Tweed EJ, Leyland AH, Morrison DS, Katikireddi SV. Co-occurring homelessness, justice involvement, opioid dependence, and psychosis: a proof-of-principle study using cross-sectoral administrative data linkage.

6.3 Abstract

Background

Administrative data offer unique opportunities for researching experiences which pose barriers to participation in primary research and household surveys. Experiencing multiple social disadvantages is associated with very poor health outcomes, but little is known about how often this occurs and what combinations are most common. We linked administrative data across public services to create a novel population cohort containing information on experiences of homelessness, justice involvement, opioid dependence, and psychosis.

Methods

We securely linked administrative data from (1) a population register derived from general practitioner registrations; (2) local authority homelessness applications; (3) prison records; (4) criminal justice social work reports; (5) community dispensing for opioid substitution therapy; (6) a psychosis clinical register, for people aged ≥18 years resident in Glasgow, Scotland between 01/04/2010 and 31/03/2014. We estimated period prevalence and compared demographic characteristics for different combinations.

Results

Of 536,653 individuals in the cohort, 28,112 (5.2%) had at least one of the experiences of interest during the study period and 5,178 (1.0%) had more than one. Prevalence of individual experiences varied from 2.4% (homelessness) to 0.7% (psychosis). The proportion of people with multiple co-occurring experiences was highest for imprisonment (50%) and lowest for psychosis (14%). Most combinations showed a predominance of men living in the most deprived areas of Scotland.

Conclusions

Cross-sectoral record linkage to study multiple forms of social disadvantage showed that co-occurrence of these experiences was relatively common. Following this demonstration of feasibility, these methods offer opportunities for evaluating the health impacts of policy and service change.

6.4 Introduction

Administrative data generated by organisations as part of routine activities are increasingly used in research, thanks to potential time and cost savings; broad socio-demographic, geographical, and temporal coverage; and high external validity and policy relevance (Connelly et al., 2016, McGrail et al., 2018a). Enriching administrative datasets through linkage with data from other sources is especially valuable to public health research, given the diversity of factors which influence health at the individual, community, environmental, and societal level (Lyons et al., 2014, Academy of Medical Sciences, 2016, Ford et al., 2019). Such linkages offer the possibility of 'real-world' evidence able to inform policy making across multiple sectors to improve population health and reduce health inequalities, an endeavour often referred to as healthy public policy (Rutter et al., 2017, Academy of Medical Sciences, 2016).

These methodological developments are especially relevant to understanding the needs of population groups who experience marginalisation and disadvantage, who are often under-represented in primary research. For instance, they may find it difficult to participate in traditional cohort studies requiring active follow-up, leading to non-participation bias, differential attrition, and other threats to validity (Hwang et al., 2011, McKenzie et al., 1999, Kinner and Young, 2018, David et al., 2013). However, they often have high levels of need for, and utilisation of, public services and therefore may be well-represented in administrative datasets (Culhane, 2016). Administrative data also offer access to large population sizes which would not be feasible through direct recruitment, enabling analysis of relatively rare exposures and outcomes (Connelly et al., 2016).

We sought to understand the feasibility and value of linked administrative data in this context through a proof-of-principle study examining overlapping experiences of homelessness, criminal justice involvement, opioid dependence, and psychosis. These experiences were selected as 'sentinel' experiences of marginalisation and disadvantage which are of major policy interest in high-income countries (and in some cases increasing in prevalence); are associated with profound inequalities in morbidity and mortality; and appear to commonly co-occur (Foundation Abbé

Pierre/FEANTSA, 2021, Walmsley, 2018, European Monitoring Centre for Drugs and Drug Addiction, 2019, National Alliance to End Homelessness, 2020, Bramley and Fitzpatrick, 2015, Bramley et al., 2019b, Tweed et al., 2021, Aldridge et al., 2018).

Policy responses often consider these issues in isolation, resulting in fragmented services or conflicting goals (Bramley et al., 2019b, Page, 2011, Harland et al., 2021). As a result, understanding how these issues intersect is critical for effective design and delivery of relevant policy and services. Since the extent of this intersection is likely to depend on contextual factors such as healthcare provision, welfare regimes, and housing markets, informed public policy requires national and sub-national estimates (Benjaminsen and Andrade, 2015, Fitzpatrick and Stephens, 2014, Wildeman and Wang, 2017).

Although some studies have previously attempted to obtain such estimates, very few have used a population-based approach to estimate the overall prevalence and intersection of these experiences among an unselected sample (Bramley et al., 2020, Bramley et al., 2019b), and to our knowledge, none has done so using individual-level record linkage.

Here we describe the use of record linkage between multiple administrative datasets to create and characterise a population-based cohort including information on exposure to homelessness, justice involvement, opioid dependence, and/or psychosis, as a baseline for subsequent longitudinal studies.

6.5 Methods

Study design and setting

We undertook a retrospective cohort study using cross-sectoral record linkage between six administrative datasets. We chose Glasgow City local authority in the west of Scotland as our geographical setting, based on the feasibility of acquiring and linking relevant datasets and local policy interest in co-occurring disadvantage. Glasgow City is an urban area with a population of 595,070 in 2012 (the study period mid-point for the primary analyses reported here), representing 11% of the population of Scotland (National Records of Scotland, 2020). The study period for the primary analysis was chosen as 1st April 2010 to 31st March 2014 to maximise the availability and quality of study datasets: sensitivity analyses varying this period are described below under ‘Statistical analysis’.

Data sharing and access

We secured approval from the Local Privacy Advisory Committee of the West of Scotland Safe Haven (reference GSH/17/AM/003) to access data from the NHS Greater Glasgow and Clyde (NHSGGC) population register, prescribing records, and PsyCIS database (see next section for details of individual datasets) and for their support in managing data access, linkage and storage. Permissions for use of HL1 and CJSWR datasets were obtained from the Data Protection Officer and relevant Head of Service of Glasgow City Council and Health and Social Care Partnership. Permission for use of the PR2 dataset was obtained from the Scottish Government Statistics Public Benefit and Privacy Panel (reference 2019-0004) and from the Scottish Prison Service Research Access and Ethics Committee. The study was also approved by the research ethics committee of the University of Glasgow College of Medical, Veterinary, and Life Sciences.

Population

We obtained data on individuals resident in Glasgow City local authority area using the population register, selected on postcode of residence. This dataset is derived from general practitioner registrations and is widely used in record linkage studies as a proxy for total population (Information Services Division Scotland, 2021). It is updated with information on deaths or migration out of the NHSGGC health board area (within which Glasgow City lies; changes of residence within the health board, including between local authorities, are not recorded). Exclusion criteria comprised any of the following:

- Record of having died or moved out of NHSGGC prior to the end of the study period

- Aged below 18 years at the start of the study period, given statutory age limitations on some services represented in the datasets

- Turned 75 years of age during study period, given historical limitations in data availability for electronic death records for older individuals within the NHSGGC Safe Haven

Exposures

We obtained data on the experiences of interest from the sources listed in Table 2.

To identify individuals assessed as homeless or threatened with homelessness following an application to Glasgow City Council, as per their entitlements under Scottish law (see Supplementary material accompanying Chapter 6; Table S6.1.1), we used HL1, a statutory data collection mandated for all Scottish local authorities by Scottish Government, according to a nationally-agreed specification (Waugh et al., 2018, Morrison, 2009, Scottish Government, 2010c).

Data on justice involvement were obtained from two sources. Records of individuals received into prisons across Scotland for any duration, whether sentenced; awaiting trial; or awaiting sentencing, were obtained using the PR2 dataset, a record-keeping system used by all Scottish prisons (Graham et al., 2015). Criminal justice social work report (CJSWR) data were used to identify people for whom such a report was submitted to the courts by Glasgow City Council during the study period. This includes all individuals convicted of an offence who meet at least one of the statutory criteria for a social work report, as well as all those convicted who do not meet the statutory criteria but for whom the sheriff requests a report (for instance, due to potential extenuating circumstances). Statutory criteria for a criminal justice social work report are shown in the Supplementary material accompanying Chapter 6 (Table S6.1.2); in brief, they apply to people convicted of an offence who are currently under supervision or subject to an order, and to people for whom certain types of sentence are being considered (e.g. drug treatment and testing orders, community service orders, and first custodial sentences) (Scottish Government, 2010b). Since imprisonment is mutually exclusive with other exposures, and differs substantially in lived experience to community justice involvement, we classified justice involvement on a hierarchical basis using categories for any experience of prison custody, regardless of whether a court report was available (hereafter abbreviated to CUST) and community justice experience only (COMM; i.e., court report without imprisonment).

Data from the Prescribing Information System (PIS), which records dispensing events at community pharmacies across Scotland, were used to identify individuals who had received treatment in the community for opioid dependence (hereafter abbreviated as ODep) in the form of methadone, buprenorphine, or buprenorphine/naloxone during the study period (Alvarez-Madrazo et al., 2016).

Data on individuals with a diagnosis of primary psychotic disorder (excluding psychotic disorder secondary to substance use or the puerperal period; see Table S6.1.3. in Supplementary material accompanying Chapter 6 for list of ICD-10 codes) were identified from the Glasgow Psychosis Clinical Information System (PsyCIS). PsyCIS is a clinical registry of demographic, social, and treatment data collected from both administrative records and active follow-up (Park et al., 2008).

All of the study datasets have previously been used for health research, including through record linkage, with the exception of CJSWR (Martin et al., 2014a, Martin et al., 2014c, Srireddy et al., 2012, Pearsall et al., 2016, Pearsall et al., 2019, Alvarez-Madrazo et al., 2016, Graham et al., 2015, Morrison, 2009).

We defined exposure to each of the experiences of interest as at least one appearance in the relevant dataset during the study period: exposure combinations reported here therefore reflect exposures accumulated between the start and end of the study period. For clarity of reporting, we describe the prevalence of each exposure combination, but where describing demographic characteristics, use a two-category approach comprising each exposure in isolation or in combination (e.g., homelessness only vs homelessness + other exposures). To minimise risk of potential identification of individuals by deductive disclosure, on some occasions categories have been combined or results suppressed.

Table 2. Description of data sources used in cohort creation to ascertain exposures

Experience	Definition	Data source	Data collection	Selection process (if any)	Data provider
Homelessness or housing insecurity (HL)	Assessed by Glasgow City Council as homeless or threatened with homelessness (main applicant only)	HL1	Face-to-face interview between applicant and housing officer	Individual experiencing homelessness applies to local authority for support	Glasgow City Council
Justice involvement (CUST – any prison record; COMM – court report only)	Resident of Glasgow City having previously been received into a Scottish prison	PR2	Reception process when individual arrives into prison	None	Scottish Prison Service/Scottish Government
	Resident of Glasgow City having been the subject of a submitted criminal justice social work report	Criminal Justice Social Work Reports (CJSWR)	Face-to-face interview between applicant and social work officer	Individual convicted of offence meets statutory criteria for CJSWR or request otherwise made by sheriff	Glasgow City Council
Opioid dependence (ODep)	Resident of Glasgow City having received community-dispensed opioid substitution therapy (OST) anywhere in NHSGGC	Prescribing Information System (PIS)	Electronic record of dispensing, generated for reimbursement purposes	Individual with opioid dependence seeks treatment; is prescribed OST; and redeems prescription	NHSGGC
Psychosis (PSY)	Resident of Glasgow City with diagnosis of psychotic disorder	Glasgow Psychosis Clinical Information System (PsyCIS)	Review of clinical records by research nurse, +/- correspondence with clinical team	Individual experiencing psychosis is in contact with community mental health team	NHSGGC

Covariates

All analyses used demographic characteristics as recorded in the population register. The exception to this was ethnicity, which was only recorded in the HL1 (homelessness), PR2 (imprisonment), CJSWR (courts), and PsyCIS (psychosis) datasets and is therefore only reported for these source datasets (see Supplementary material accompanying Chapter 6). Age was calculated based on age at the end of the study period, given that this was the point at which cumulative exposure was measured. The Scottish Index of Multiple Deprivation (2012 release) was used to measure socioeconomic circumstances, based on postcode of residence (Scottish Government, 2012b).

Record linkage

Record linkage between all datasets was undertaken by the West of Scotland Safe Haven using the Community Health Index (CHI) number, a unique 10-digit numeric identifier used across the health service in Scotland (Information Services Division Scotland, 2021). Of the exposure data sources, PIS and PsyCIS already contained CHI numbers for all individuals; CJSWR contained CHI for some. CHI numbers were identified for individuals in HL1, PR2, and the remaining individuals in CJSWR by matching to the CHI spine using forename, surname, date of birth, and postcode (see Supplementary material accompanying Chapter 6 for details). Following linkage, de-identified data were accessed by the research team for analysis via the Safe Haven’s Secure Analytic Platform. At no point was any personal identifiable information available to the researchers. The linkage process is illustrated in Figure 10.

Statistical analysis

Data were cleaned and analysed in Stata 16 (StataCorp, TX), with visualisations created with R version 4.0.3 using *ggplot2* (Wickham, 2016).

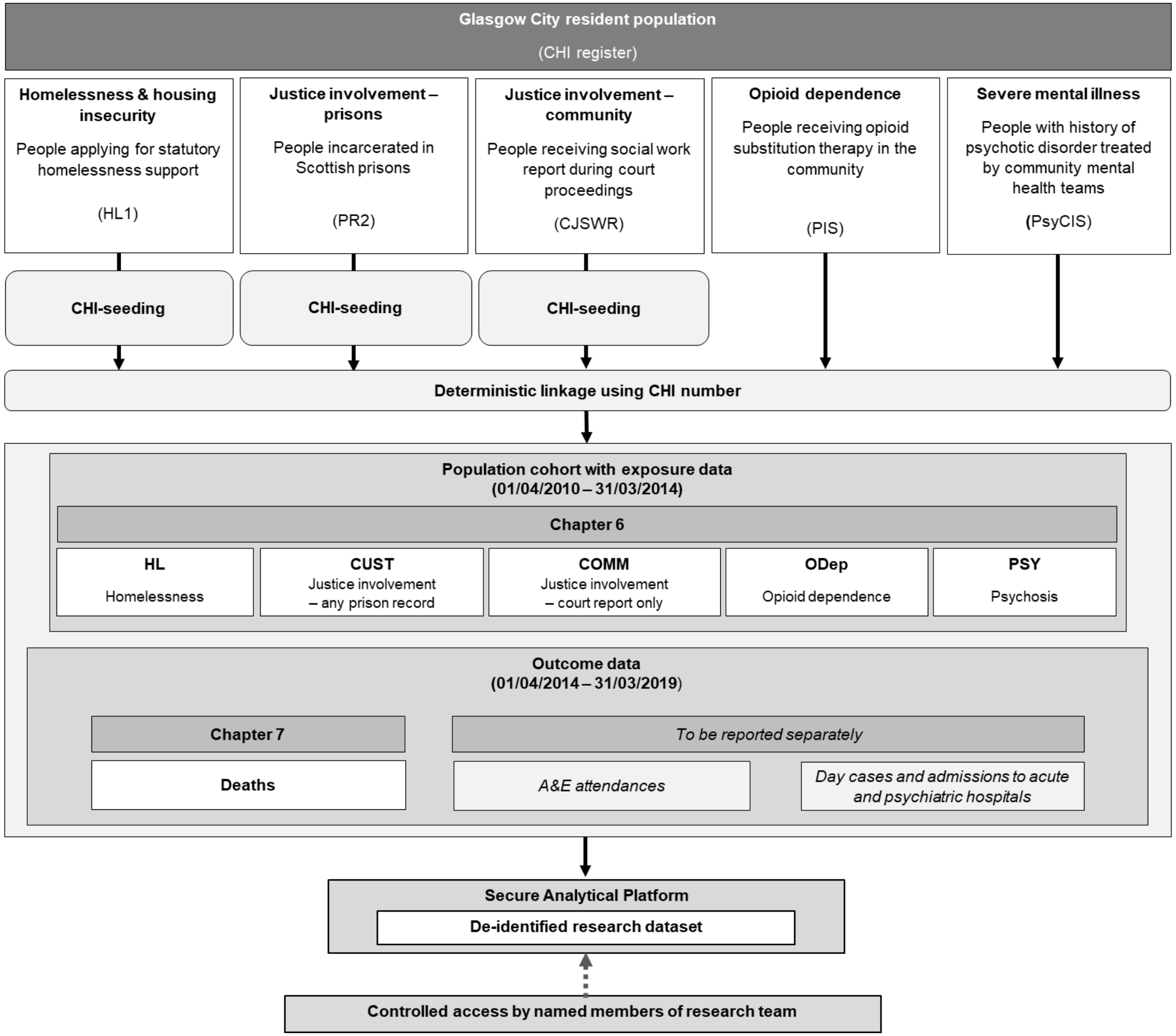
We used descriptive statistics to investigate the association between exposure combinations and demographic characteristics, and created UpSet plots – an alternative to Venn diagrams for more than 3 sets – in order to visualise the intersection between the experiences of interest (Lex and Gehlenborg, 2014). We estimated the period population prevalence of different exposure combinations among people alive at the end of the study period, based on the number of individuals with each combination of experiences divided by the total number of individuals from the population register not recorded as having died or transferred out.

We undertook sensitivity analyses of study period length on the prevalence and intersection of the exposures of interest, by limiting the exposure period to 01/04/2012 – 31/03/2014 and extending it to 01/04/2010 – 31/03/2016 (though imprisonment data were not available after 31/03/2014). We also undertook sensitivity analyses of our primary estimate of period prevalence using mid-year population estimates derived from the Census as the denominator, rather than the cohort identified from the CHI register.

Public and stakeholder involvement

The analyses and their interpretation were informed by several public and stakeholder engagement activities. These included two public engagement workshops with people with lived/living experience of homelessness, justice involvement, substance use, and/or psychosis (one prior to study initiation in February 2017 and another following preliminary results in July 2021) and a series of four advisory group meetings with stakeholders from academia, NHS, local government, Scottish Government, and the third sector, as well as two further public representatives.

Figure 10. Schematic diagram illustrating linkage process for creation of cohort



6.6 Results

For non-health datasets, details of the proportion of records which could be matched to the CHI register are provided in the Supplementary material accompanying Chapter 6. CHI was already known for a high proportion of records within the CJSWR dataset, so overall only 8% of records from this source could not be assigned a CHI number and there was little difference in age and gender profile for records for which a CHI number could and could not be identified. In contrast, for the homelessness (HL1) and prisons (PR2) datasets, 22% and 24% of records respectively could not be matched to a CHI number. For the HL1 dataset, the mean age was similar for records which could and could not be matched but the proportion of men among the former was slightly higher; comparable information on demographics for the PR2 dataset could not be provided by the Safe Haven in time for submission.

The cohort comprised 536,653 unique adults resident in Glasgow City Council area who were alive at the end of the study period on 31/03/2014 (Table 3).

Considering each exposure in isolation, between 01/04/2010 and 31/03/2014, a total of 13,075 (2.4%) people were assessed as homeless or threatened with homelessness at least once; 5,512 (1.0%) were received into prison at least once; 7,954 (1.5%) had at least one criminal justice social work report filed; 7,412 (1.4%) had at least one episode of OST dispensing; and 3,791 (0.7%) were identified in the PsyCIS psychosis case register. In total, 28,112 (5.2%) people had one or more of the experiences of interest. Of 7,954 individuals with a criminal justice social work report, 3,335 (41.9%) also experienced imprisonment (hereafter referred to as CUST), leaving 4,619 (58.1%) in contact with community justice without any imprisonment during the study period (COMM).

The most common combinations were those involving homelessness, opioid dependence, and justice involvement; combinations involving psychosis were much less common (Figure 11). Across the cohort, 5,178 people (1.0% of the cohort) had more than one exposure, though numbers of those with three or more were small (Table 3). Within each exposure, the proportion with or without additional exposures varied (Figure 11; Table S6.3.1): co-occurrence was highest among people with experience of custody (50%, n=2,757/5,512) and lowest among people with experience of psychosis (14%, n=536/3,791). Overlaps between exposure pairs are shown in Supplementary material accompanying Chapter 6 (Table S6.3.2).

People imprisoned during the study period – the only experience mutually exclusive with the others – spent a median total of 130 days (9% of the four-year study period) in prison, with 77% (n=1,266/5,512) incarcerated for less than one year in total (Supplementary material accompanying Chapter 6, Table S6.3.3). The distribution of total prison time was similar between people imprisoned who did and did not experience any of the other exposures (Supplementary material accompanying Chapter 6, Figure S6.3.1).

With regard to gender, justice involvement (especially custody) showed the greatest male predominance, with exposure combinations including justice involvement tending to follow this pattern (Figure 12; Table 4). The only category which did not show a male predominance was homelessness in isolation. People experiencing homelessness or justice involvement tended to be younger than people with opioid dependence or experiencing psychosis; this was also true for combinations involving these experiences (Figure 13, Table 4). There was no consistent association between age and single versus multiple exposures. People with any exposure were more likely to live in more deprived areas compared to the unexposed group, though this tendency was less pronounced for psychosis than for other exposures (Figure 14, Table 4). Within the homelessness, prisons, CJSWR, and psychosis data, recorded ethnicity data indicated that the large majority of individuals with these experiences were White (Supplementary material accompanying Chapter 6, Table S6.3.4).

For experiences consisting of clearly-defined episodes (homelessness, imprisonment, and court reports), people with multiple forms of disadvantage tended to have more episodes of a given experience during the study period than those with only one experience, but there was substantial overlap in the distributions (Supplementary material accompanying Chapter 6, Table S6.3.5 & Figure S6.3.2).

Table 4 shows the estimated period prevalence for the exposures of interest in Glasgow City among the study cohort over the four-year study period. Sensitivity analyses showed that varying the length of the exposure period had the greatest impact on the prevalence of combinations involving homelessness, followed by community justice involvement; there was little change in the estimated prevalence of combinations involving psychosis, imprisonment, or treatment for opioid dependence (Supplementary material accompanying Chapter 6, Tables S6.3.6-7 and Figure S6.3.3). Further sensitivity analyses showed that use of a population denominator derived from census estimates, rather than the CHI register, slightly increased the estimated prevalence of individual exposures and any exposure but did not affect conclusions about relative frequency of different combinations (Supplementary material accompanying Chapter 6, Table S6.3.8).

Table 3. Prevalence of exposure to experiences of disadvantage among adults living in Glasgow City, 01/04/2010 – 31/03/2014

Exposures of interest	Number of individuals	Percentage of total cohort i.e. period prevalence (%)	Percentage of exposed cohort (%)
Total population	536,653	100.00	-
No exposures of interest	508,541	94.8	-
Any exposure of interest	28,112	5.2	100.0
Summary of exposure combinations*:			
Any homelessness (HL)	**13,075**	**2.4**	**46.5**
HL only	9,463	1.8	33.7
HL + other exposures	3,612	0.7	12.9
Any opioid dependence (ODep)	**7,412**	**1.4**	**26.4**
ODep only	4,123	0.8	14.7
ODep + other exposures	3,289	0.6	11.7
Any justice involvement - custodial (CUST)	**5,512**	**1.0**	**19.6**
CUST only	2,755	0.5	9.8
CUST + other exposures	2,757	0.5	9.8
Any justice involvement – community (COMM)	**4,619**	**0.9**	**16.4**
COMM only	3,338	0.6	11.9
COMM + other exposures	1,281	0.2	4.6
Any psychosis (PSY)	**3,791**	**0.7**	**13.5**
PSY only	3,255	0.6	11.6
PSY + other exposures	536	0.1	1.9
Detailed exposure combinations: mutually exclusive categories**			
Homelessness (HL) only	9,463	1.8	33.7
Opioid dependence (ODep) only	4,123	0.8	14.7
Justice – community (COMM) only	3,338	0.6	11.9
Psychosis (PSY) only	3,255	0.6	11.6
Justice – custodial (CUST) only	2,755	0.5	9.8
HL + CUST	994	0.2	3.5
ODep + CUST	846	0.2	3.0
HL + ODep	820	0.2	2.9
HL + ODep + CUST	780	0.2	2.8
HL + COMM	574	0.1	2.0
ODep + COMM	433	0.1	1.5
HL + ODep + COMM	195	<0.1	0.7
HL + PSY	159	<0.1	0.6
ODep + PSY	135	<0.1	0.5
PSY + CUST	61	<0.1	0.2
PSY + COMM	56	<0.1	0.2
HL + PSY + CUST	35	<0.1	0.1
HL + PSY + ODep	26	<0.1	0.1
ODep + PSY + CUST	25	<0.1	0.1
HL + ODep + PSY + any justice involvement¤	19	<0.1	0.1
HL + PSY + COMM	10	<0.1	<0.1
ODep + PSY + COMM	10	<0.1	<0.1

* Ordered by frequency of ‘any’ category. ** Ordered by frequency of mutually exclusive categories.

¤ Results for HL + ODep + PSY + COMM and HL + ODep + PSY + CUST are grouped here due to small numbers, to avoid presenting potentially disclosive information.

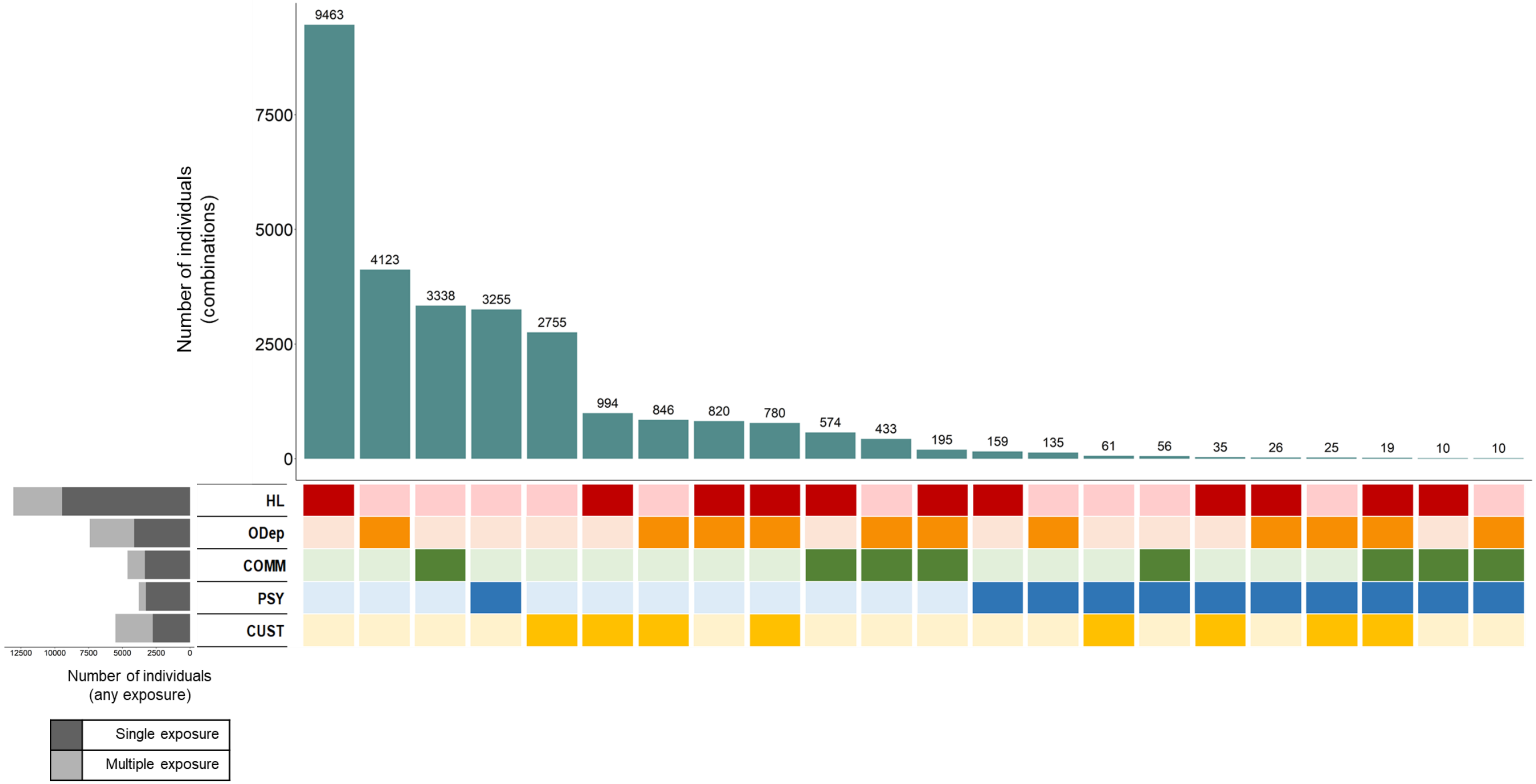
Table 4. Demographic characteristics of adults living in Glasgow City, stratified by exposure to single or multiple experiences of disadvantage, 01/04/2010 – 31/03/2014

Exposures of interest	Total (%)	% Male (95% CI)	Median age (IQR)	% most deprived SIMD quintile[§] (95% CI)
Total population	536,653	52.6 (52.4 – 52.7)	40.5 (29.5 – 53.8)	45.6 (45.5 – 45.7)
No exposures of interest	508,541	51.9 (51.7 – 52.0)	40.7 (29.5 – 54.2)	44.0 (43.9 – 44.1)
Any exposure of interest	28,112	64.8 (64.3 – 65.4)	39.0 (30.5 – 47.6)	75.2 (74.6 – 75.7)
Summary of exposure combinations*:				
Any homelessness (HL)	**13,075**	**54.6 (53.7 – 55.4)**	**35.7 (28.7 – 45.1)**	**77.8 (77.0 – 78.5)**
HL only	9,463	46.9 (45.9 – 48.0)	34.8 (28.1 – 45.6)	77.4 (76.5 – 78.2)
HL + other exposures	3,612	74.5 (73.0 – 75.9)	37.5 (30.8 – 44.3)	78.9 (77.5 – 80.2)
Any opioid dependence (ODep)	**7,412**	**68.8 (67.7 – 69.8)**	**41.7 (36.8 – 46.5)**	**80.3 (79.3 – 81.2)**
ODep only	4,123	65.3 (63.9 – 66.8)	42.9 (38.2 – 47.4)	80.5 (79.2 – 81.7)
ODep + other exposures	3,289	73.1 (71.5 – 74.6)	40.0 (35.1 – 45.1)	80.0 (78.5 – 81.4)
Any justice involvement - custodial (CUST)	**5,512**	**90.9 (90.1 – 91.6)**	**35.6 (28.9 – 44.0)**	**76.4 (75.1 – 77.5)**
CUST only	2,755	94.4 (93.4 – 95.2)	32.7 (27.0 – 43.0)	74.0 (72.2 – 75.8)
CUST + other exposures	2,757	87.4 (86.1 – 88.6)	37.9 (31.7 – 44.5)	78.6 (77.0 – 80.2)
Any justice involvement – community (COMM)	**4,619**	**78.3 (77.0 – 79.4)**	**36.4 (28.5 – 46.4)**	**73.5 (72.2 – 74.8)**
COMM only	3,338	81.7 (80.3 – 83.0)	35.2 (27.8 – 46.9)	70.6 (69.0 – 72.2)
COMM + other exposures	1,281	69.4 (66.8 – 71.9)	38.3 (31.4 – 45.2)	81.0 (78.7 – 83.2)
Any psychosis (PSY)	**3,791**	**57.7 (56.1 – 59.3)**	**48.6 (40.0 – 56.5)**	**63.4 (61.8 – 65.0)**
PSY only	3,255	55.7 (54.0 – 57.4)	50.0 (41.5 – 57.7)	61.2 (59.4 – 62.9)
PSY + other exposures	536	70.0 (65.9 – 73.8)	41.7 (34.9 – 48.4)	77.2 (73.3 – 80.7)

[§] Of those with SIMD data available. SIMD data was available for 96.8% (n=519,757/536,653) of the study cohort.

* Ordered by frequency of 'any' category.

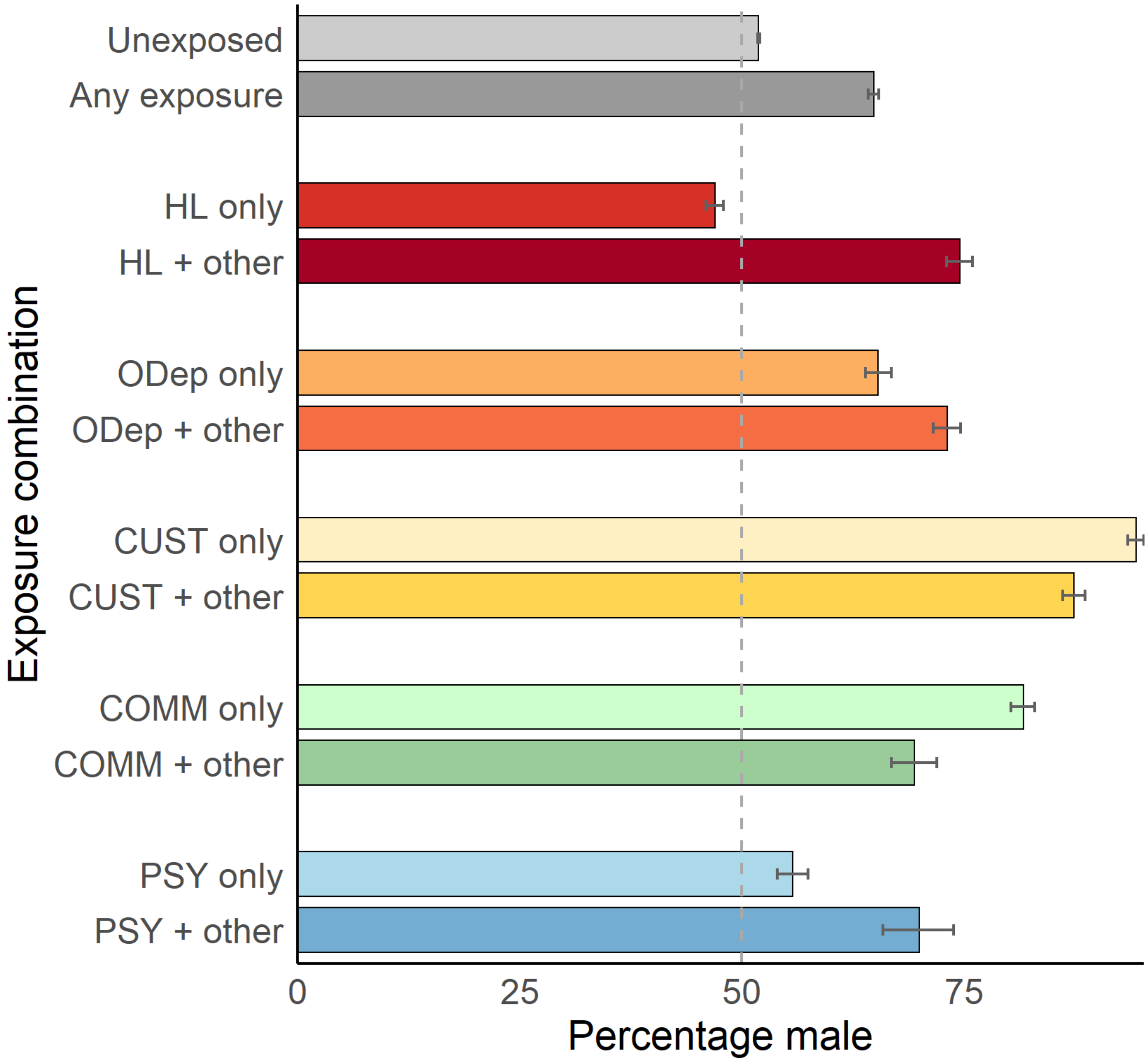
Figure 11. UpSet plot showing frequency of mutually exclusive exposure combinations (vertical bars) and any exposure (horizontal bars) among adults living in Glasgow City, 01/04/2010 to 31/03/2014



Note that exposure combinations are ordered by frequency of mutually exclusive categories.

HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; COMM – justice involvement in community without imprisonment; PSY – psychosis; CUST – imprisonment.

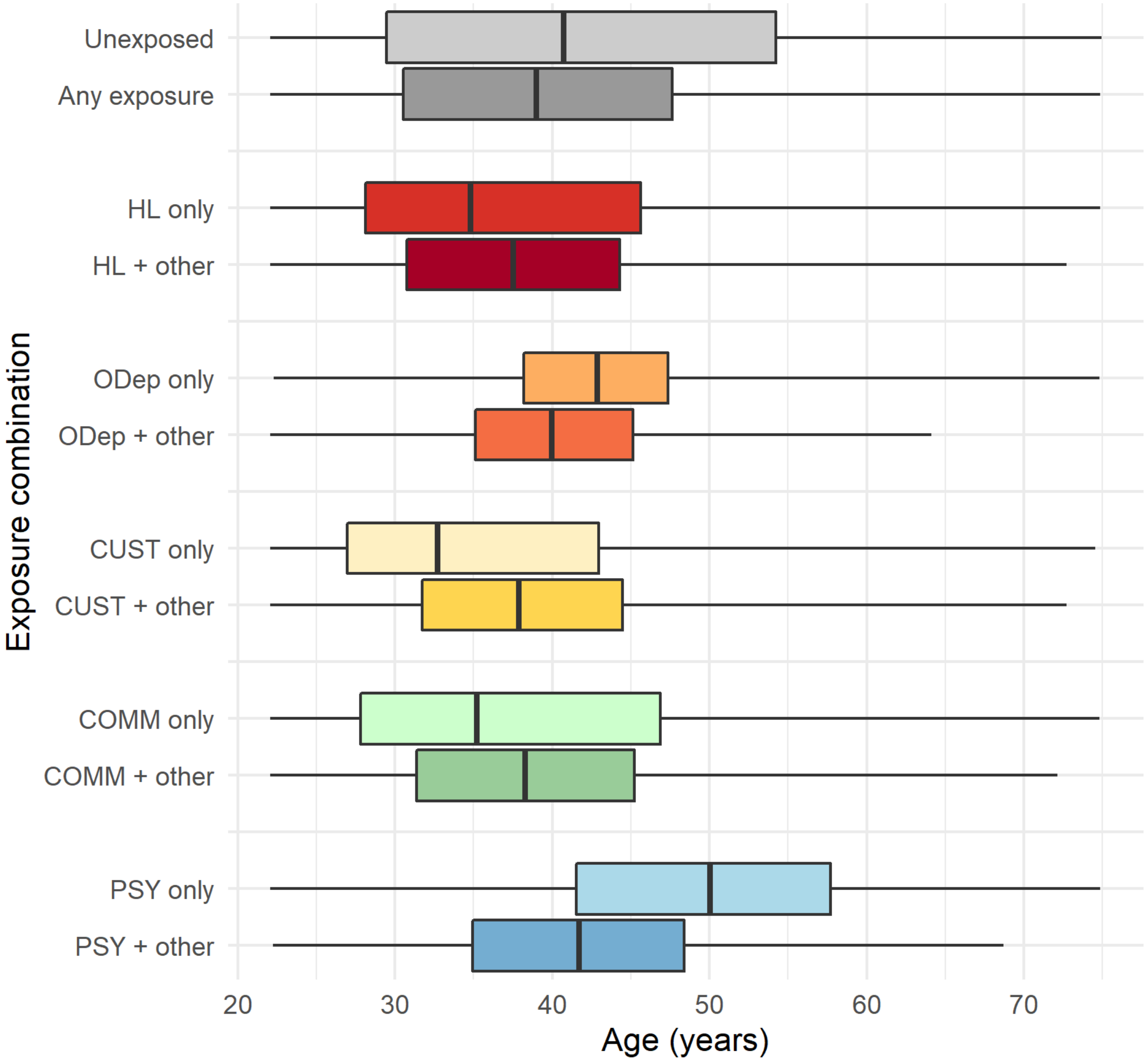
Figure 12. Percentage male (with 95% confidence intervals) among adults living in Glasgow City, stratified by exposure to experiences of disadvantage (01/04/2010 to 31/03/2014)



Note that exposure combinations are ordered by frequency of any flag for that exposure.

HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; CUST – imprisonment; COMM – justice involvement in community without imprisonment; PSY – psychosis.

Figure 13. Boxplot of age distribution among adults living in Glasgow City, stratified by exposure to experiences of disadvantage (01/04/2010 to 31/03/2014)

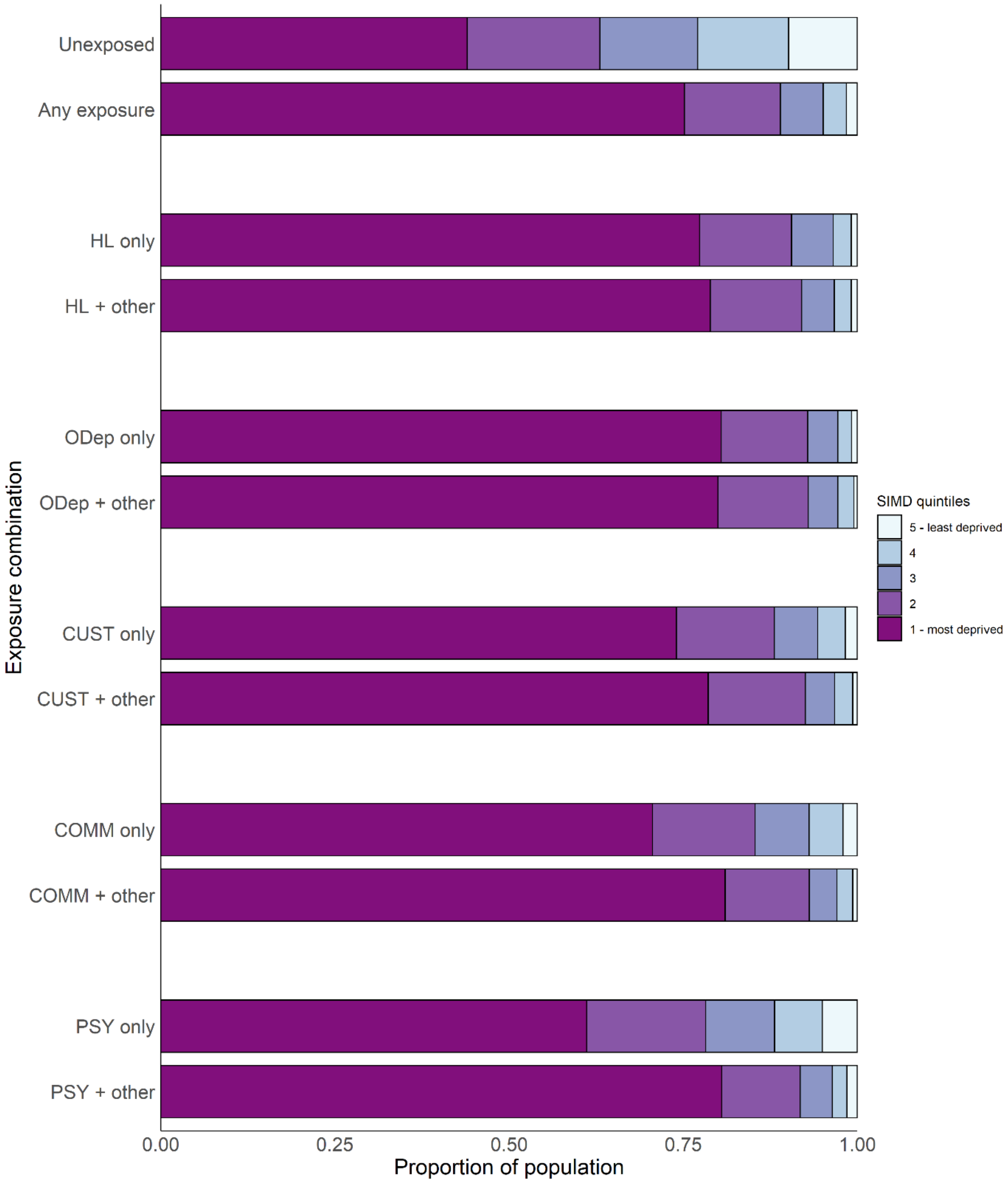


Central bar represents median; edges of box represent interquartile range; and lines represent range of values.

Note that exposure combinations are ordered by frequency of any flag for that exposure.

HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; CUST – imprisonment; COMM – justice involvement in community without imprisonment; PSY – psychosis.

Figure 14. Scottish Index of Multiple Deprivation quintile distribution among adults living in Glasgow City, by exposure to experiences of disadvantage (01/04/2010 to 31/03/2014)



Note that exposure combinations are ordered by frequency of any flag for that exposure

HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; CUST – imprisonment; COMM – justice involvement in community without imprisonment; PSY – psychosis.

6.7 Discussion

We have demonstrated the feasibility of a unique cross-sectoral record linkage combining datasets from local authority homelessness and criminal justice services, the prison system, and healthcare to create and characterise a cohort of people who, as a consequence of their social and health circumstances, may be less likely to participate in primary research or household surveys. We found that around 5% of the population experienced any of the five forms of disadvantage of interest during the study period, with 1% of the population affected by more than one. The majority of those experiencing multiple forms of disadvantage were White males aged between 30 and 50 years living in the most socioeconomically deprived areas, but profiles differed somewhat between different combinations of experiences, with those experiencing psychosis forming a relatively distinct population.

Although the co-occurrence of these experiences is associated with much higher rates of morbidity and mortality compared to one or none (Tweed et al., 2021), there are very few population-based estimates of the prevalence and patterning of this phenomenon. Almost all previous research draws on samples selected on the basis of at least one ‘index’ exposure and is limited in its reporting of exposure combinations (e.g., Krawczyk et al., 2020, Metraux and Culhane, 2006, Gisev et al., 2015). For instance, Somers et al. (2016b)’s record linkage study across provincial administrative databases in British Columbia to estimate the prevalence and geographic distribution of ‘complex co-occurring disorders’ (CCD; overlapping substance use, mental illness, homeless shelter use, and justice involvement) only included individuals with at least one criminal conviction and reported CCD as a single combined category. In contrast, our approach enables us to explore the prevalence of each exposure singly and in combination, across an unselected geographic population of adults.

In the UK, the ‘Hard Edges’ project has previously attempted to quantify the population overlap of homelessness, offending, and substance use, by combining weighted estimates from survey and routine data sources (Bramley et al., 2020, Bramley et al., 2019b). Our alternative approach, using individual-level linkage across administrative datasets, enabled us to minimise reporting and recall biases associated with self-report, as well as participation biases inherent to household and targeted surveys; it also permits longitudinal analyses of health and social outcomes, including mortality and service utilisation (reported separately; Chapter 7). While the definitions and data sources vary somewhat, we corroborate Bramley et al’s findings regarding demographic profile; homelessness as the most common experience overall; and justice involvement as the experience most likely to overlap with others (Bramley et al., 2019b).

This work demonstrates the potential for cross-sectoral administrative data linkage to respond to and inform policy priorities. For instance, our findings are particularly timely given ongoing initiatives in Scotland to expand Housing First services for people with homelessness and other co-occurring challenges; new models of joint working to address internationally high rates of drug-related deaths; and concerns about throughcare support for those entering and leaving prison (Homelessness and Rough Sleeping Action Group, 2018, Wilson, 2021, Scottish Drug Deaths Taskforce, 2021). This cohort – and others like it – also offer rich possibilities for the evaluation of the health impacts of social policies (such as welfare reform or homelessness prevention initiatives), through the use of natural experiment designs and policy decision modelling (Craig et al., 2017, Kim et al., 2017, Meier et al., 2016).

Among the strengths of this study are the novelty and breadth of the cross-sectoral data linkage achieved, creating a large population-based cohort. Ongoing longitudinal analyses – to be reported separately – seek to build on the proof-of-principle results reported here by investigating health outcomes among the cohort, including service utilisation, costs, and mortality.

By using administrative data, the cohort is likely to be more comprehensive and representative than would be feasible through primary research. For instance, most homelessness research to date has recruited participants from shelters, soup kitchens, or the streets: the use of administrative data can ensure the inclusion of those experiencing less visible forms of homelessness, such as ‘sofa-surfing’. Similarly, using community dispensing data on OST will include those treated in primary care as well as in specialist drug services; most previous research has focused on the latter. However, this comprehensive approach does potentially result in greater heterogeneity within each category and we classified experiences on a relatively simple cumulative basis that does not account for their dynamic nature over time.

We also recognise that ascertainment of these exposures is not complete – for instance, the HL1 data only included main applicants rather than other adults in the household, and criminal justice social work reports are not completed for every individual convicted in the courts. Relying on administrative data may not capture individuals not engaged with services, though our use of up to six years of data allowed us to test the sensitivity of our results to length of exposure period and maximised the likelihood of ascertaining individuals who may engage with services on a transient or infrequent basis. For instance, around 90% of people accessing injecting equipment provision in Scotland in 2017/18 reported having ever received OST, compared to 78% who had done so in the past year (Health Protection Scotland, 2019). In future, our methods may be also strengthened by triangulation between multiple administrative datasets relating to the same experience (e.g., from third sector as well as statutory services); cohorts recruited as part of primary research; and novel means of interrogating existing datasets (e.g., data phenotyping approaches) (53-55). Future work will also seek to extend the cohort nationally, to capture regional variation and maximise generalisability to other settings.

The CHI register is the best available source of population data in Scotland at present but may omit individuals not registered with primary care services or incorrectly include those who have not de-registered after migrating out of the area. As historical postcodes are not available from the CHI register, results may also be affected by potential misclassification of Glasgow City residence due to in- and out-migration since the study period.

A proportion of records from the non-health datasets could not be matched to a CHI number and were therefore not included in the cohort. As the CHI register is a live database updated on a regular basis, a failure to match may result from individuals having moved out of the NHSGGC area since being recorded in the exposure dataset or from incorrect identifiers having been recorded in one or multiple datasets. We are not able to distinguish between these possibilities, or to assess their potential impact on the risk of bias or representativeness of our results, though the broadly comparable age and gender profile for the matched and unmatched populations in the HL1 and CJSWR datasets is reassuring (Harron et al., 2017b).

Very few previous studies have reported measures of linkage success for comparison (Gisev et al., 2015, Metraux and Culhane, 2006, Graham et al., 2015, Krawczyk et al., 2020, Somers et al., 2016b, Gilbert et al., 2018). Waugh et al's national study using HL1 was able to match more than 90% of records, though had access to a national population spine and a more complex linkage algorithm (Waugh et al., 2018). Other studies using regional or local datasets from non-health sources report linkage success rates between 80-90%, more comparable to those observed here (Morrison, 2008, Rezansoff et al., 2013, Downs et al., 2019). Our study used relatively stringent matching criteria in comparison to methods reported elsewhere, which often rely more heavily on probabilistic approaches with score-based thresholds, and is therefore likely to have prioritised specificity at the expense of sensitivity. However, in the absence of a gold standard, we are unable to assess these metrics quantitatively. Future work using national datasets, prospective rather than retrospective linkages, and/or sensitivity analyses applying different linkage thresholds may offer opportunities to evaluate and improve linkage success (Harron et al., 2017b).

Despite these limitations, our results provide novel insights into a cohort of people in contact with services who may be reached through interventions to prevent or mitigate health and social inequalities. Realising the potential of cross-sectoral data linkage for informing healthy public policy depends on well-resourced and responsive infrastructure and governance processes. Close collaboration between researchers and other stakeholders is also critical in order to understand data availability and provenance, inform interpretation of findings, and identify priorities for further work.

Acknowledgements

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Authorship statement

The study was conceptualised and planned by EJT with input from other authors. EJT liaised with relevant agencies to gain access to the data and undertook all analyses, with input from other authors. EJT drafted the manuscript: all authors contributed to interpreting the results of analyses and critically revised the manuscript, and all have provided final approval of the version to be published.

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Chapter 7 Premature mortality among people affected by co-occurring homelessness, justice involvement, opioid dependence, and psychosis: a cohort study using linked administrative data

7.1 Foreword

This section provides some additional detail on the article which follows, and in particular some reflection on methodological choices associated with the challenges of cohort creation and analysis.

Following approval for and creation of the cohort described in Chapter 6, the datasets available under the terms of project approval offered the potential to investigate the following outcomes: A&E attendance; day cases and admissions to acute and psychiatric hospitals; and/or mortality.

However, time constraints created by the delays in this process required that I narrow the outcomes studied here. After discussion with the stakeholder advisory group, I chose to focus on the following outcomes;

(a) All-cause premature mortality (i.e., death before the age of 75)

(b) Mortality from causes considered avoidable (comprising treatable or preventable causes)

(c) Mortality from selected non-communicable diseases (cancer, cardiovascular disease, chronic respiratory disease, and diabetes mellitus)

(d) Years of potential life lost, from all causes

The rationale for the focus on mortality – rather than healthcare utilisation – was as follows, informed by the views of the advisory group and my own reading and reflections:

- Mortality is among the most severe health outcomes;

- Mortality is an outcome which is directly and comprehensively recorded as part of the vital registrations system, whereas hospitalisations and A&E are composite outcomes which depend on, and are imperfect proxies for, disease incidence and healthcare access/utilisation;

- Data on mortality can be important in interpreting results of the analysis of other health outcomes; for instance, due to differential survival. It can also be helpful in terms of hypothesis generation and identifying other priorities to look at, particularly within healthcare utilisation data;

- Interpretation of findings on healthcare utilisation (such as A&E attendance and hospital admission) can be more complex, as it is determined by both need and access;

- It was felt by stakeholders that evidence about mortality inequalities was likely to be more novel and impactful from a policy point of view, whereas the evidence base around, for instance, A&E attendance was considered more well-established and well-known in policy circles;

- Non-communicable diseases were also considered a priority focus, given that they are responsible for a substantial burden of disease across the population (ScotPHO, 2016); there exist well-documented inequalities by socioeconomic position, suggesting their burden may also be unequally distributed according to other forms of social disadvantage; there are effective means for their prevention and treatment; and they are potentially neglected at present in services for, and research with, the populations of interest (Section 2.4.7);

- Similarly, an analysis of metrics such as avoidable mortality and years of potential life lost was felt by stakeholders and the project team to have the greatest potential to contribute to the existing evidence base. As discussed in Chapter 2, there is scanty evidence on these outcomes for most of the experiences of interest examined in isolation (with the exception of psychosis). The systematic review described in Chapter 5 went on to identify only one previous study applying either of these metrics in populations with more than one experience of interest (Lumme et al., 2016, who estimated mortality amenable to healthcare among people with co-occurring severe mental illness and substance use in Finland).

However, A&E attendance and hospitalisations were still felt to merit attention: I plan to undertake subsequent work on these outcomes using this cohort.

In the remainder of this section, I provide a brief overview of the metrics of avoidable mortality; non-communicable disease (NCD) mortality; and years of potential life lost (YPLL), as a background to the article that follows.

Avoidable mortality

The metric of avoidable mortality is widely used as an indicator of health system quality and reflects the notion that deaths from certain causes should not occur or be extremely infrequent where people have timely access to effective healthcare (Nolte and McKee, 2004). Definitions have varied over time with regard to the conditions included, their justification, and any other criteria imposed (such as age), partly reflecting the availability of effective interventions (Nolte and McKee, 2004). The metric originally comprised only causes considered amenable to healthcare activities such as diagnosis and treatment (also referred to as treatable causes); more recent iterations have also included causes of death potentially preventable through the efforts of public health and healthy public policy (Castelli and Nizalova, 2011). Some causes are considered both treatable and preventable, and are assigned a corresponding weight for each component (OECD/Eurostat, 2019).

Avoidable mortality has been used extensively to investigate variations in healthcare system performance and quality of care, according to geographical areas, periods of time, or social groups (OECD/Eurostat, 2019, Castelli and Nizalova, 2011, Barber et al., 2017).

The concept of avoidable mortality does have a number of limitations worth highlighting here (Castelli and Nizalova, 2011, Nolte and McKee, 2004). First is the problem of attribution; any binary classification of a given death as avoidable or otherwise is inevitably a simplification, given the multiple factors typically involved. This is especially problematic where a condition may have both preventable and treatable components. A similar problem of classification and attribution occurs in relation to the age threshold which, whilst informed by life expectancy estimates and intermittently updated, is to some extent inherently arbitrary and value-laden. Third, avoidable mortality is influenced by both the incidence and case-fatality of the conditions of interest. This composite nature may confound comparisons across different times, places, or social groups; ideally, analyses of avoidable mortality should be accompanied by detailed data on incidence of relevant conditions. Fourth, such comparisons may also be confounded by variation in death certificate completion and classification, particularly in ageing populations where multiple conditions are typically listed as contributing factors. Finally, all analyses of mortality are vulnerable to the criticism that deaths alone are a crude indicator of health system performance and may not reflect the priorities of patients and the public.

Avoidable mortality is therefore best understood as an indicator or sentinel measure which can be used to identify areas of concern meriting more detailed analyses of potential shortcomings in public health and healthcare system performance (Nolte and McKee, 2004).

Another potential challenge for the field is the existence of multiple definitions of this measure. In this analysis, I use the harmonised mortality definition published by the Organisation for Economic Co-operation and Development (OECD) and Eurostat in 2019, on the basis of (a) it having been revised relatively recently, and (b) consistency with official statistics in Scotland and the rest of the UK, and with other international sources (OECD/Eurostat, 2019, Office for National Statistics, 2020a).

Non-communicable diseases

The concept of non-communicable diseases (NCDs) has gained prominence within the last few decades, reflecting the relative decline in disease burden from infectious causes and increasing concern about the burden of long-term conditions associated with ageing populations. Definitions vary in their scope, from broader definitions – such as that used by the Global Burden of Disease project – encompassing a wide range of causes of ill-health not directly caused by infectious agents, to narrower ones focusing on a small selection of chronic conditions with similar risk factors, and accounting for the majority of overall burden (Tan et al., 2021).

In this work, I apply a narrow definition of NCDs (known as NCD4) based on the WHO Global Action Plan, comprising cancer, cardiovascular disease, chronic respiratory disease, and diabetes mellitus (World Health Organisation, 2014b): details of the relevant ICD-10 codes are included in Supplementary material accompanying Chapter 7.

. As detailed in Section 2.4.7, the rationale for this choice reflects these four condition’s commonalities in terms of proximal risk factors; their requirements for ongoing monitoring and treatment; and their predominance within the total burden of NCDs.

Years of Potential Life Lost

Years of Potential Life Lost (YPLL), sometimes referred to as Years of Life Lost, is a measure of premature mortality incorporating both the number of deaths and the age at which they occur, based on a threshold for expected life expectancy.

YPLL can be used to describe the mortality burden associated with specific exposures (Hjorthøj et al., 2017, Degenhardt et al., 2014b, Onyeka et al., 2015) or with specific causes of death (ScotPHO, 2016, Hanlon et al., 2021).

There are two main approaches to the calculation of YPLL, which differ in how the threshold for expected life expectancy is determined. One approach is to use standard life tables to obtain the predicted remaining life expectancy for each individual at their age of death. This is the approach used in the Global Burden of Disease study, and its Scottish counterpart (Vos et al., 2020, ScotPHO, 2016). The other approach is to use a fixed age threshold below which a death is considered ‘premature’, and to calculate the difference between this age and the age at death for each decedent. This method has been used by the OECD and some public health observatories internationally (OECD, 2021, Association of Public Health Epidemiologists in Ontario, 2021). Both approaches have previously been used by other researchers attempting to estimate YPLL associated with the experiences of interest to this thesis (Onyeka et al., 2015, Morden et al., 2012, Degenhardt et al., 2014b).

This analysis used the latter approach of a fixed age threshold of 75 years of age, rather than life tables. I made this choice in the interests of conceptual and methodological consistency with the broader focus of the paper on premature mortality (as defined as death before 75 years of age). This method also has the advantage of greater simplicity in interpretation – particularly when communicating with non-academic audiences – compared to the life table approach, and avoids potential value judgements associated with the selection of reference population for the lifetables (such as geographical area and whether or not to account for socioeconomic deprivation). However, it does result in estimates which are less nuanced and empirically-founded with regard to expectations of remaining length of life.

7.2 Title, authorship, and publication details

This article has not yet been submitted for publication, pending further information from the West of Scotland Safe Haven about the characteristics of records in the PR2 dataset which could and could not be linked. It is hoped such data will be forthcoming early in 2022.

Tweed EJ, Leyland AH, Morrison DS, Katikireddi SV. Premature mortality among people affected by co-occurring homelessness, justice involvement, opioid dependence, and psychosis: a cohort study using linked administrative data.

7.3 Abstract

Background

Homelessness, opioid dependence, justice involvement, and psychosis are each associated with profound health inequalities, but commonly co-occur. To address limitations in existing evidence on mortality associated with this co-occurrence, we undertook a retrospective cohort study using linked administrative data.

Methods

We linked a population register of adults resident in Glasgow, Scotland, to administrative datasets from homelessness and criminal justice services; community pharmacies; and a clinical psychosis registry during 01/04/2010-31/03/2014. Linkage to death registrations during 01/04/2014-31/03/2019 provided follow-up data on premature (<75 years) all-cause, avoidable, and non-communicable disease (NCD) mortality. We estimated hazard ratios (HR) using Poisson regression, adjusting for age, gender, socioeconomic deprivation, and calendar time.

Findings

Of 536,653 cohort members, 11,484 (2.1%) died during follow-up. All-cause premature mortality was substantially elevated among people with multiple versus single exposures, and any exposure versus none (e.g., homelessness plus other exposures – HR 8.7, 95% CI 7.6-9.9; homelessness alone – HR 2.3, 95% CI 2.0-2.6; unexposed group – reference). Avoidable mortality was highest among those with multiple exposures (e.g. imprisonment plus other exposures – HR 11.2, 95% CI 9.6-13.1; imprisonment alone – HR 4.0, 95% CI 3.1-5.0). NCD mortality was higher among those with any exposures versus none, despite accounting for a lower proportion of deaths, though in some cases there was little difference between estimates for single versus multiple exposures.

Interpretation

Avoidable causes of death – including NCDs – account for much of the excess mortality associated with these co-occurring forms of disadvantage. Tackling these inequalities demands wide-ranging efforts across healthcare provision, public health, and social policy.

7.4 Introduction

People affected by homelessness, justice involvement, opioid dependence, or psychosis experience profound health inequalities, with each of these experiences individually associated with higher rates of ill-health and premature death compared to unaffected peers (Aldridge et al., 2018). Evidence suggests these experiences frequently occur together, though the extent of this overlap varies by context (Somers et al., 2016b; Chapter 6, Bramley et al., 2019b, Bramley et al., 2020).

A recent systematic review suggested that the co-occurrence of these experiences is associated with especially poor outcomes but identified very limited evidence for conditions other than infections or external causes of morbidity and mortality, with particular gaps around the burden of non-communicable diseases and those avoidable through healthcare or public health interventions (Tweed et al., 2021). There was also a lack of longitudinal studies from countries outside North America, Scandinavia, and Australia and some exposure combinations, especially those other than imprisonment/substance use and severe mental illness/substance use.

An accurate understanding of the burden of ill-health among people with these experiences is essential to inform the development and implementation of services and policies that meet their needs and tackle inequalities in health. For instance, in the UK, the National Institute of Health and Care Excellence has highlighted a lack of evidence on the physical health needs of people with co-existing substance misuse and severe mental illness, and the mental health of adults in contact with the justice system (National Institute for Health and Care Excellence, 2017, National Institute for Health and Care Excellence, 2016). Descriptive epidemiology can also provide a baseline picture against which efforts to address these forms of adversity – and their health consequences – can be evaluated.

One approach to this challenge is the use of administrative data, produced by services as a by-product of their day-to-day operation (Jutte et al., 2011, Connelly et al., 2016). Administrative data typically provide extensive, or even complete, population coverage; are of low cost to obtain; and have high external validity and policy relevance (Connelly et al., 2016, Hand, 2018). Record linkage between such datasets across different sectors can be uniquely powerful in helping understand the social and structural determinants of health and identify opportunities for intervention on cross-cutting policy issues (Lyons et al., 2014). This is especially valuable in understanding the experiences and needs of marginalised populations who may be poorly represented in primary research, for instance due to ascertainment difficulties or participation burdens that affect recruitment and retention, but who often have high levels of need for, and use of, public services.

We have previously described the creation and characterisation of a novel population-based cohort of people affected by homelessness, justice involvement, opioid dependence, and/or psychosis, using cross-sectoral linkage of administrative data (Chapter 6). Here we extend this work by investigating premature mortality among this cohort according to exposure combination, with a particular focus on mortality from potentially avoidable causes; mortality from non-communicable diseases; and years of potential life lost (YPLL).

7.5 Methods

Study design and setting

We used cross-sectoral record linkage of administrative datasets from local authorities, healthcare services, and death registrations to undertake a retrospective cohort study encompassing the Glasgow City local authority area between 1st April 2010 and 31st March 2019. Glasgow City is an urban area with a population of 595,070 in 2012 (the mid-point of the exposure period for our primary analyses), representing 11% of the population of Scotland (National Records of Scotland, 2020). The definition of exposure and follow-up periods described below were determined by the availability and quality of the datasets of interest, which varied over time.

Data sources: population and exposures

Creation of the study cohort has already been described elsewhere (Chapter 6) and is illustrated in Figure 10. In brief, we identified a cohort of people resident in the Glasgow City local authority area using postcode of residence as recorded within the Community Health Index population register held by the West of Scotland Safe Haven. This dataset is derived from general practitioner registrations and is widely used in record linkage studies as a proxy for total population (Information Services Division Scotland, 2021). We then used the administrative datasets detailed in Table 2 to identify individuals within this cohort with the exposures of interest between 1st April 2010 and 31st March 2014 (hereafter referred to as the exposure period), defining exposure as the presence of at least one episode in the relevant dataset during this four-year period. Exposure combinations reported here therefore reflect exposures accumulated during this period. For justice involvement, we assigned individuals to one of two exposure categories using the combination of prison and court records: custodial (i.e., any record of imprisonment during study period, regardless of whether a court report was made) and community (i.e., court report but no record of imprisonment).

To ensure sufficient size in each exposure group, and in light of our interest in premature mortality associated with multiple co-occurring exposures, the primary exposure categories used in mortality analyses classified exposed individuals into those with a given exposure in isolation (for instance, homelessness alone) versus those with that exposure in combination with others (for instance, homelessness plus opioid dependence), on the basis of their cumulative history during the exposure period.

We excluded individuals recorded as having died or transferred out during the exposure period and aged below 18 years at the start of the exposure period (given statutory age limitations on some of the services represented in the datasets). Given historical limitations on data availability for electronic death records for older individuals within the Safe Haven, and the low prevalence of these experiences in older age groups, we restricted analyses of mortality from all causes, avoidable causes, and non-communicable diseases to a cohort of individuals aged under 75 years of age at the start of follow-up and censored follow-up if participants turned 75 years of age during the study period. Details of the linkage process and success rates are provided in Supplementary material accompanying Chapter 6.

Data sources: outcomes

Data on deaths among the cohort were obtained from death registrations collected by National Records of Scotland and provided to the West of Scotland Safe Haven. The follow-up period for mortality outcomes was defined as 1st April 2014 to 31st March 2019, with follow-up ceasing on the date of the earliest of the following four events:

- death,
- migration out of NHS Greater Glasgow and Clyde (the geography for which migration and mortality data were available),
- turning 75 years of age,
- or end of follow-up on 31st March 2019.

To account for the possibility of death on the first day of follow-up, 0.5 days of survival-time was added for everyone in the cohort, except for those who did not die, migrate out, or turn 75 during the study period and therefore completed the full 1,825 days of follow-up.

Defining outcomes of interest

All-cause premature mortality was defined as death during follow-up from any cause prior to the age of 75, as per the definition applied by National Records of Scotland (Scottish Government, 2021c).

Cause-specific mortality definitions were based on ICD-10 codes from the underlying cause of death field. We focused on deaths from avoidable causes and from non-communicable diseases. For avoidable mortality, we used the internationally harmonised OECD-Eurostat 2019 definition; using definitions from the same source, it was further subdivided into mortality from preventable causes (those which can be mainly avoided by effective public health and primary prevention activity) and treatable causes (those which can be mainly avoided through timely access to high quality healthcare) (OECD/Eurostat, 2019). For non-communicable disease mortality, we used the NCD4 definition employed by the World Health Organisation Noncommunicable Diseases Global Monitoring

Framework and UN Sustainable Development Goals, comprising cancer; cardiovascular disease; diabetes; and chronic respiratory disease; restricted to deaths prior to the age of 75 for consistency with other analyses reported here (World Health Organisation, 2014b, United Nations, 2021). ICD-10 code lists for cause-specific mortality definitions used in the paper are listed in Supplementary material accompanying Chapter 7, Sections S7.1 and S7.2. Finally, we defined Years of Potential Life Lost as the difference between age at death and an age threshold of 75 years, in keeping with the definition of premature mortality used elsewhere in this analysis; the constraints of our data with regard to historical death records for older age groups; and the definition of this indicator used in OECD health statistics (OECD, 2021).

Record linkage

All record linkage was undertaken by the West of Scotland Safe Haven, with no personal identifiable information available to the research team at any stage. Those datasets originating outwith the NHS which did not already contain Community Health Index numbers (CHI; a unique 10-digit personal identifier used across the health service in Scotland) were CHI-seeded using probabilistic matching to the population spine using forename, surname, date of birth, and postcode. All datasets were then linked deterministically using the CHI number, with a de-identified dataset being made available to the research team for analysis via a secure analytic environment within the Safe Haven. Details of the linkage process are provided in Supplementary material accompanying Chapter 6 (Section S6.2).

Statistical analysis

All data cleaning and analysis was undertaken in Stata 15.0 (StataCorp, College Station, TX), with visualisations created in R version 4.0.3 using ggplot2 (Wickham, 2016). We used UpSet plots – an alternative to Venn diagrams for more than 3 sets - to visualise the intersection between the experiences of interest alongside relative hazard for premature mortality (Lex and Gehlenborg, 2014).

We calculated crude and age-stratified absolute mortality rates for each of the outcomes of interest. We undertook Poisson regression to obtain hazard ratios for each mortality outcome adjusted for age, gender, socioeconomic position (using quintiles of the area-based Scottish Index of Multiple Deprivation measure, SIMD), and year of follow-up. Due to the presence of an interaction between exposure and year of follow-up, these primary results should be interpreted as the weighted average of the hazard ratios over the five-year follow-up. We also undertook secondary analyses where hazard ratios were estimated separately for each exposure category and year of follow-up, accounting for this interaction. We estimated mean years of potential life lost (YPLL) per 100,000 people by exposure combination, based on all-cause mortality prior to 75 years of age.

Data sharing and ethical approvals

Permission to access and link the relevant datasets was provided by the following organisations: the Local Privacy Advisory Committee of the West of Scotland Safe Haven (NHS Greater Glasgow and Clyde population register, prescribing records, PsyCIS register, and death records); the Data Protection Officer and relevant Head of Service of Glasgow City Health and Social Care Partnership (HL1 and CJSWR datasets); the Scottish Government Statistics Public Benefit and Privacy Panel and the Scottish Prison Service Research Access and Ethics Committee (PR2 dataset). Following approval from these organisations, a letter of comfort was issued by the research ethics committee of the University of Glasgow College of Medical, Veterinary, and Life Sciences. To minimise risk of potential identification of individuals by deductive disclosure, on some occasions categories have been combined or results suppressed.

7.6 Results

The cohort for primary analyses consisted of 536,653 unique adults identified as residents of Glasgow City Council area who were alive and aged <75 at the start of follow-up on 1st April 2014. Details of the success rates for linkage are provided in the Supplementary material accompanying Chapter 6.

Table 4 (Chapter 6) shows the characteristics of the study cohort. Of these individuals, a total of 13,075 people (2.4%) made at least one statutory homelessness application during the preceding exposure period; 7,412 people (1.4%) had at least one episode of OST dispensing; 5,512 people (1.0%) were received into prison on at least one occasion; 4,619 people (0.9%) had at least one court report in the absence of imprisonment; and 3,791 people (0.7%) were identified in the PsyCIS psychosis case register. In total, 28,112 people (5.2%) had any of the experiences of interest; 5,178 (1.0%) had more than one).

There were a total of 2,502,096 person-years of follow-up, with a mean of 4.7 person-years per individual (SD 1.0). A total of 11,484 individuals died during follow-up (2.1% of cohort), with a further 37,302 individuals leaving the cohort due to migration out of the study area (7.0%) or turning 75 years of age (n=21,576, 4.0%).

All-cause premature mortality rates were substantially higher among people with at least one of the exposures of interest compared to those with none, across all age strata (Table 5). The additional premature mortality risk conferred by multiple exposures varied by the index exposure: for instance, adjusted hazard ratios were 2.3 (95% CI 2.0-2.6) vs 8.7 (95% CI 7.6-9.9) for homelessness alone versus in combination with other exposures, compared to 6.9 (95% CI 6.2-7.7) vs 11.0 (95% CI 9.7-12.4) for opioid dependence alone versus in combination (Figure 15). Figure 16 illustrates the frequency of each exposure combination in the cohort alongside its associated hazard ratio for premature mortality. Secondary analyses incorporating an interaction between exposure and calendar year yielded broadly similar results, though the effect estimate for multiple exposures tended to vary somewhat over the period of follow-up (see Supplementary material accompanying Chapter 7; Table S7.3.1 and Figures S7.3.1-S7.3.6). A secondary analysis to explore potential differential survival during the exposure period (01/04/2010 – 31/03/2014) suggested that the overall pattern of mortality by exposure combination was similar to that observed during the outcome period, although effect estimates were higher during the latter (see Supplementary material accompanying Chapter 7; Table S7.3.2 and Figure S7.3.7).

Testing for potential multiplicative effects suggested that for most experiences of interest, the effect of multiple exposures was additive rather than multiplicative: the exception to this was opioid dependence, where additional exposures were associated with a multiplicative effect of 1.6 (95% CI for hazard ratio 1.3 – 1.9, p<0.001; Table S7.3.3).

The proportion, absolute rate, and hazard ratio of death from causes deemed avoidable was consistently higher among people with any versus no exposures of interest, and for almost all age groups, among people with multiple rather than single exposures (Figure 17a; Tables S7.3.4 and S7.3.5 in Supplementary material accompanying Chapter 7). The majority of deaths from avoidable causes among exposed individuals were accounted for by preventable deaths, with treatable deaths making up a smaller fraction; this was more pronounced among those with multiple exposures.

The proportion of deaths attributed to non-communicable diseases (cancer, cardiovascular disease, diabetes, and chronic respiratory disease) was lower among people with the exposures of interest compared to those unexposed, and among people with multiple versus single exposures (Table S7.3.6 in Supplementary material accompanying Chapter 7). However, absolute rates and hazard ratios for NCD deaths were higher among those with any exposure, and for most instances of multiple versus single exposures (Figure 17b; Table S7.3.7 in Supplementary material accompanying Chapter 7).

The overlap between the avoidable and NCD category was lower among those with any exposures of interest; that is, deaths among the exposed population were more likely to result from avoidable causes that were not NCDs than among the unexposed population.

The mean YPLL per decedent was higher for all exposure combinations compared to the unexposed group, ranging from 14.1 (PSY only) to 33.9 (HL + ODep + COMM; Figure 18a; Table S7.3.8 in Supplementary material accompanying Chapter 7). Mean YPLL per 100,000 people at risk – which provides an indication of population burden – was also substantially higher for all exposure combinations compared to the unexposed group, with the highest burden associated with combinations involving opioid dependence (Figure 18b and Table S7.3.8 in Supplementary material accompanying Chapter 7).

Table 5. All-cause mortality among the cohort, by exposure status – age-stratified rate, crude hazard ratio, and adjusted hazard ratio

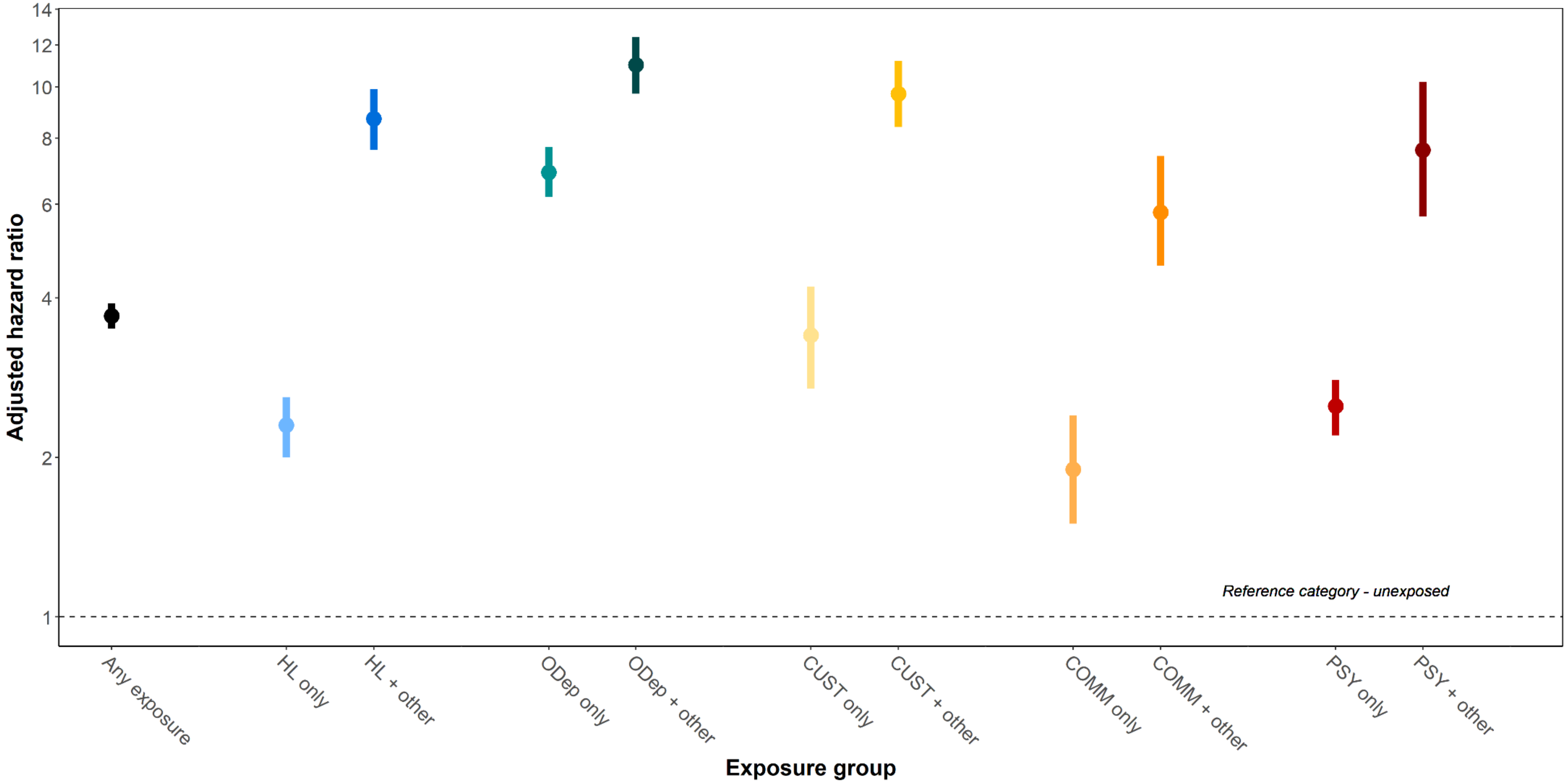
	Total number of deaths (person-years at risk)	Age-stratified all-cause mortality rate per 100,000 person-years (95% confidence interval)				Crude HR* (95% CI)	Adjusted HR** (95% CI)
		18-29 yrs	30-44 yrs	45-59 yrs	60-74 yrs		
Exposure status							
Unexposed	10,103 (2,367,741.8)	12.6 (10.2 – 15.7)	79.4 (73.3 – 86.0)	468.8 (452.4 - 485.9)	1,933.0 (1,886.2 – 1,981.0)	1.0 (reference)	1.0 (reference)
Any exposure	1,381 (134,354.0)	184.1 (142.6 – 237.6)	801.8 (733.2 – 876.7)	1,752.1 (16,20.9 – 1,893.9)	3,381.3 (2,950.7 – 3,874.8)	2.4 (2.2 – 2.5)	3.7 (3.5 – 3.9)
Homelessness							
HL only	241 (45,335.5)	45.4 (21.6 – 95.2)	332.5 (258.7 – 427.3)	1,206.9 (1,007.7 – 1,445.6)	3,088.1 (2,370.9 – 4,022.2)	1.2 (1.1 – 1.4)	2.3 (2.0 – 2.6)
HL + others	270 (170,041.3)	488.9 (311.9 – 766.5)	1,529.3 (1,298.9 – 1,800.7)	2,809.6 (2,307.3 – 3,421.3)	3,706.9 (1,853.8 – 7,412.3)	3.7 (3.3 – 4.2)	8.7 (7.6 – 9.9)
Opioid dependence							
ODep only	347 (19,631.2)	615.5 (198.5 – 1,908.4)	1,233.4 (1,049.3 – 1,449.8)	2,598.2 (2,246.0 – 3,005.7)	6,170.4 (3,780.2 – 10,071.9)	4.1 (3.7 – 4.6)	6.9 (6.2 – 7.7)
ODep + others	310 (15,431.7)	1,106.3 (612.7 – 1,997.7)	1,636.7 (1,410.7 – 1,898.8)	3,284.4 (2,754.3 – 3,916.5)	3,276.8 (461.6 – 23,262.3)	4.7 (4.2 – 5.3)	11.0 (9.7 – 12.4)
Justice – custodial							
CUST only	88 (13,137.2)	264.5 (156.7 – 446.7)	493.3 (333.3 – 730.1)	1,481.5 (1,068.6 – 2,053.8)	3,744.1 (2,174.0 – 6,448.1)	1.6 (1.3 – 1.9)	3.4 (2.7 – 4.2)
CUST + others	219 (12,948.2)	791.6 (510.7 – 1,226.9)	1,501.8 (1,248.9 – 1,805.9)	2,971.4 (2,396.2 – 3,684.6)	2,888.0 (931.4 – 8,954.4)	4.0 (3.5 – 4.5)	9.7 (8.4 – 11.2)
Justice - community							
COMM only	77 (16,302.2)	164.1 (85.4 – 315.3)	327.1 (211.0 – 507.0)	791.2 (559.5 – 1,118.9)	2,432.4 (1,490.2 – 3,970.4)	1.1 (0.9 – 1.4)	1.9 (1.5 – 2.4)
COMM + others	72 (6,154.0)	296.9 (111.4 – 791.2)	1,069.7 (768.0 – 1,489.8)	1,877.4 (1,287.5 – 2,737.6)	6,207.9 (2,788.9 – 13,818.0)	2.7 (2.2 – 3.5)	5.8 (4.6 – 7.4)
Psychosis							
PSY only	227 (15,491.5)	94.1 (13.3 – 667.9)	551.6 (369.7 – 822.9)	1,449.2 (1,196.9 – 1,754.7)	3,425.2 (2,807.1 – 4,179.4)	3.4 (3.0 – 3.9)	2.5 (2.2 – 2.8)
PSY + others	49 (2,533.4)	921.6 (297.2 – 2,857.5)	1,579.6 (1,019.1 – 2,448.4)	2,698.5 (1,808.7 – 4,026.0)	3,818.6 (955.0 – 15,268.5)	4.5 (3.4 – 6.0)	7.6 (5.7 – 10.2)

Exposure combinations are ordered by frequency of any flag for that exposure.

*Unexposed population as reference group.

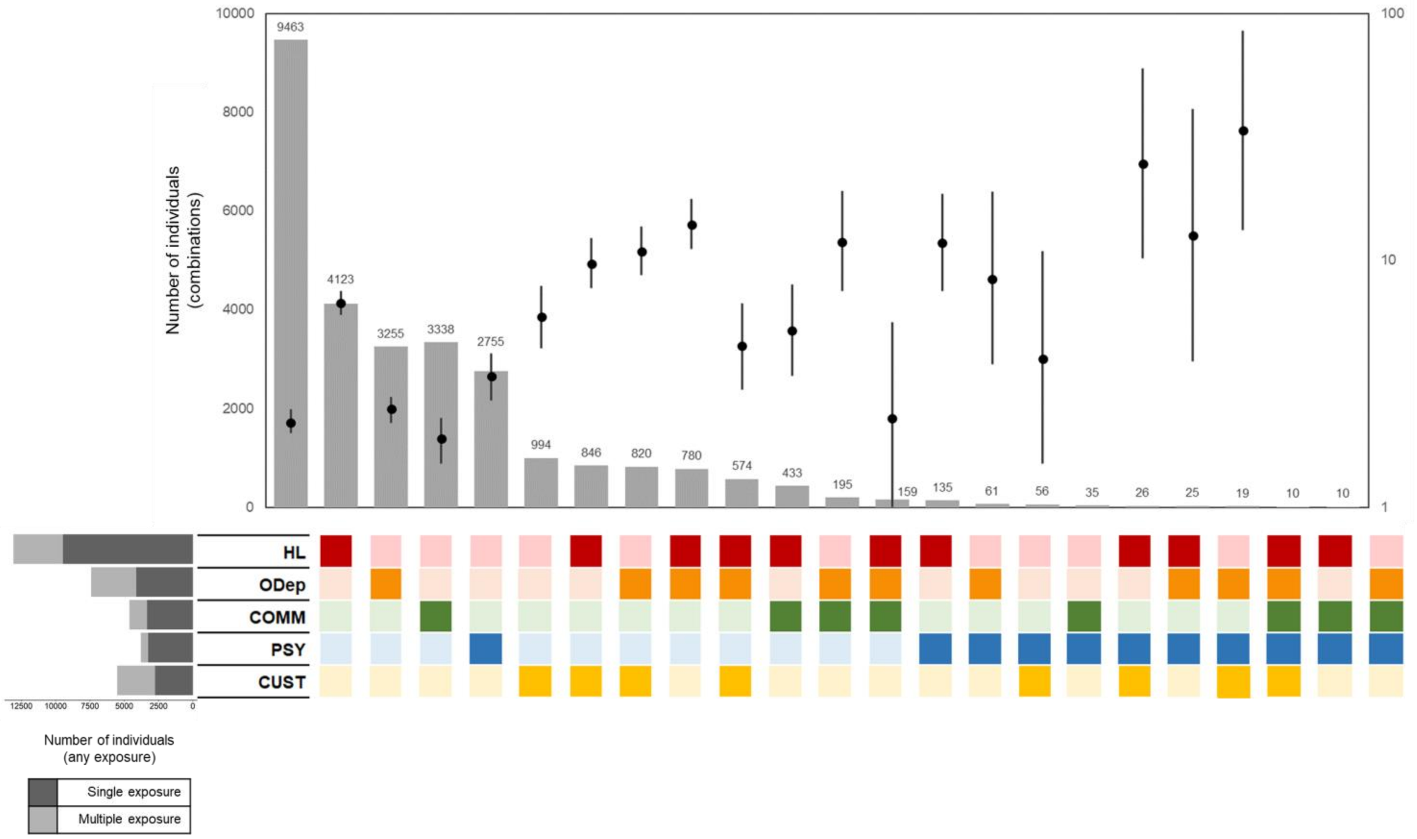
** Unexposed population as referenc group. Adjusted for age, gender, SIMD quintile, and calendar time. All models except those for psychosis include an interaction term between exposure and calendar time.

Figure 15. Adjusted hazard ratio for all-cause premature mortality, comparing each exposure combination to unexposed population



Note that exposure combinations are ordered by frequency of any flag for that exposure.

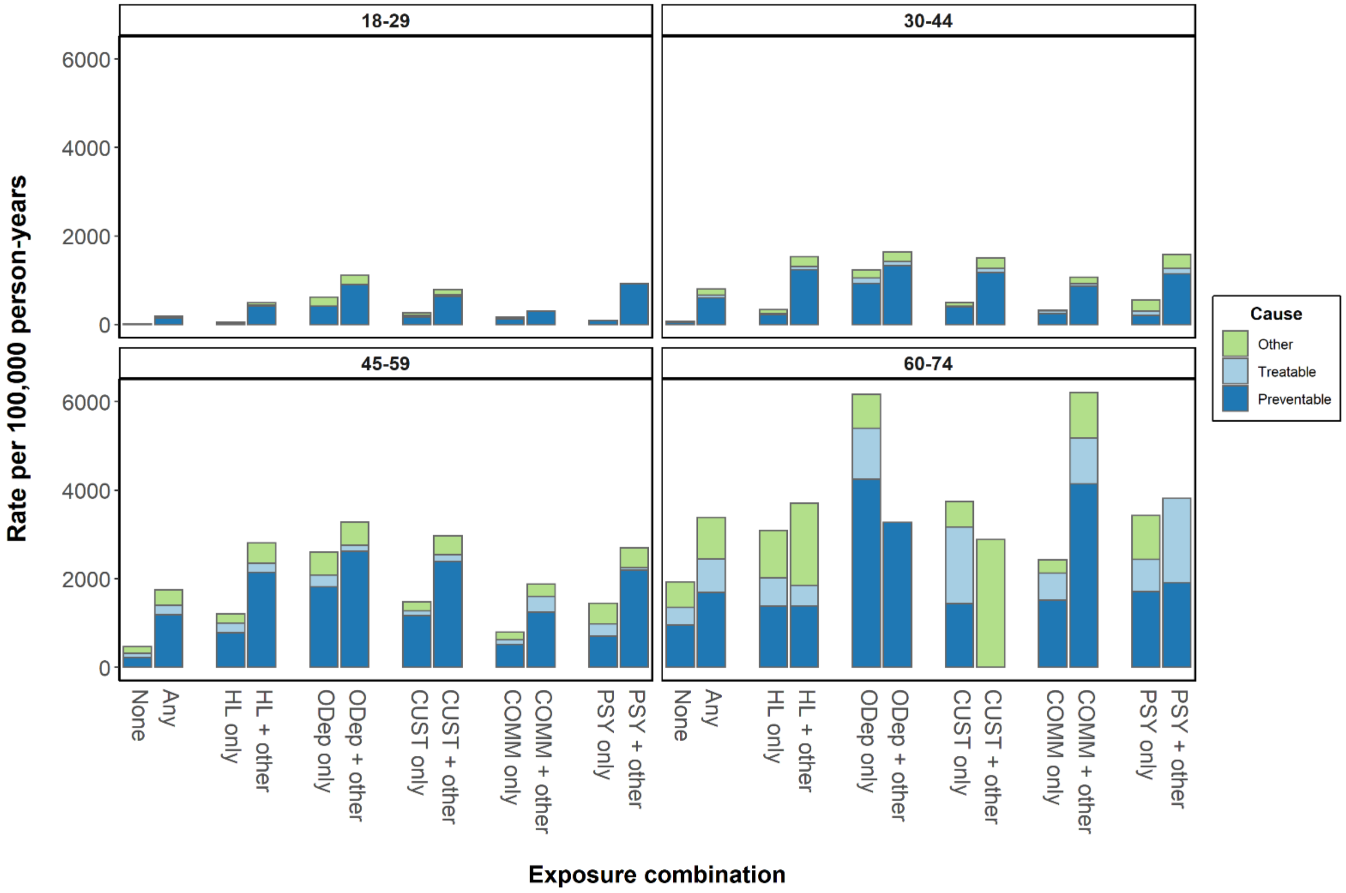
Figure 16. UpSet plot showing frequency of mutually exclusive exposure combinations (vertical bars; first y axis); adjusted hazard ratios with 95% confidence intervals for all-cause premature mortality (circles & lines; second y axis); and frequency of any exposure (horizontal bars)



HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; CUST – imprisonment; COMM – justice involvement in community without imprisonment; PSY – psychosis. Note that exposure combinations are ordered by frequency of mutually exclusive categories. Hazard ratios are omitted for exposure combinations in which <3 deaths occurred during follow-up; HL + PSY + COMM; ODep + PSY + COMM; HL + PSY + CUST.

Figure 17. Age-stratified mortality rates per 100,000 person-years, by exposure combination and cause

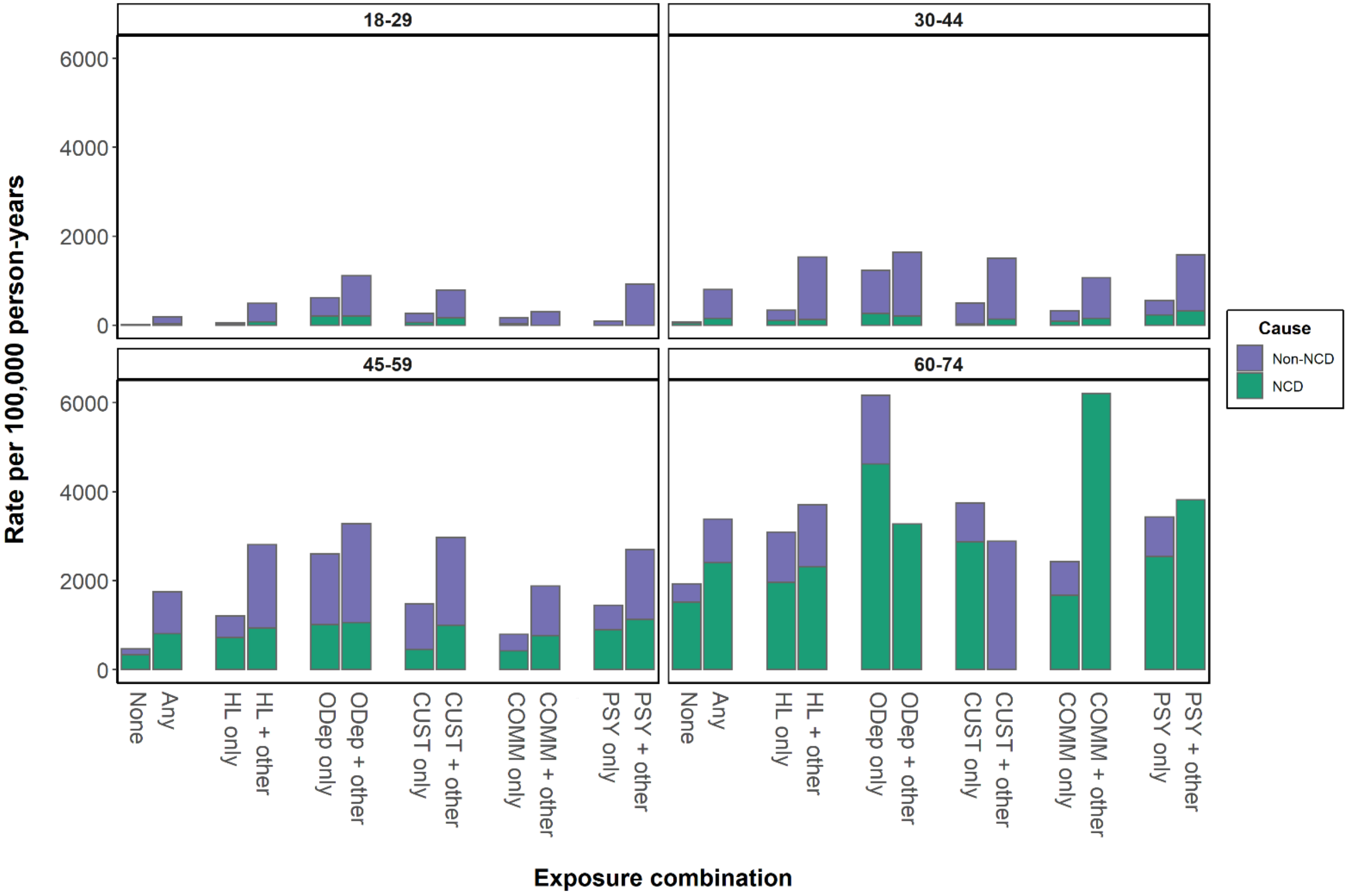
(a) Avoidable causes (comprising preventable and treatable causes)



Note that exposure combinations are ordered by frequency of any flag for that exposure.

HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; CUST – imprisonment; COMM – justice involvement in community without imprisonment; PSY – psychosis.

(b) Non-communicable diseases (comprising cancer, cardiovascular disease, chronic respiratory disease, and diabetes)

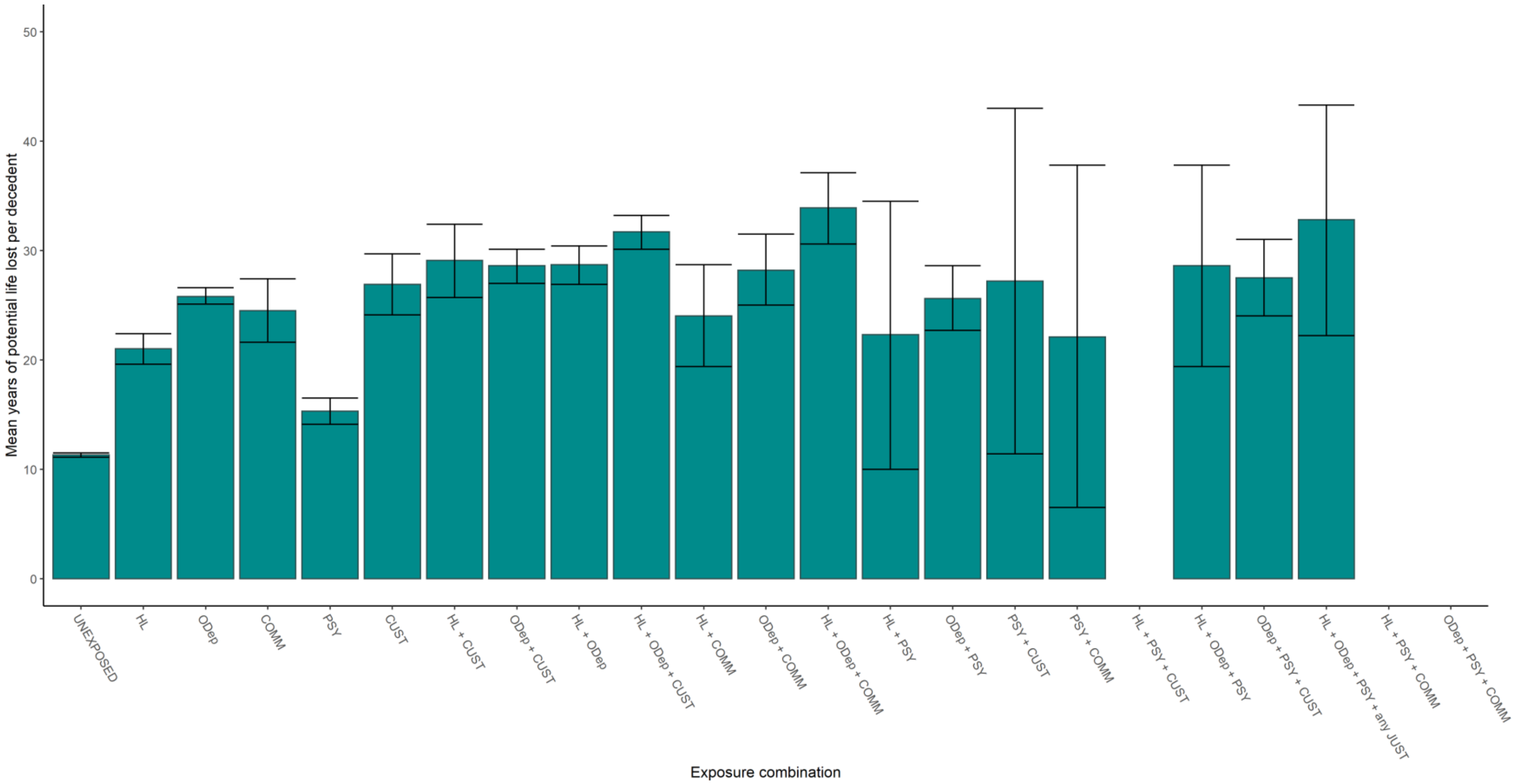


Note that exposure combinations are ordered by frequency of any flag for that exposure.

HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; CUST – imprisonment; COMM – justice involvement in community without imprisonment; PSY – psychosis.

Figure 18. Years of potential life lost, by exposure combination

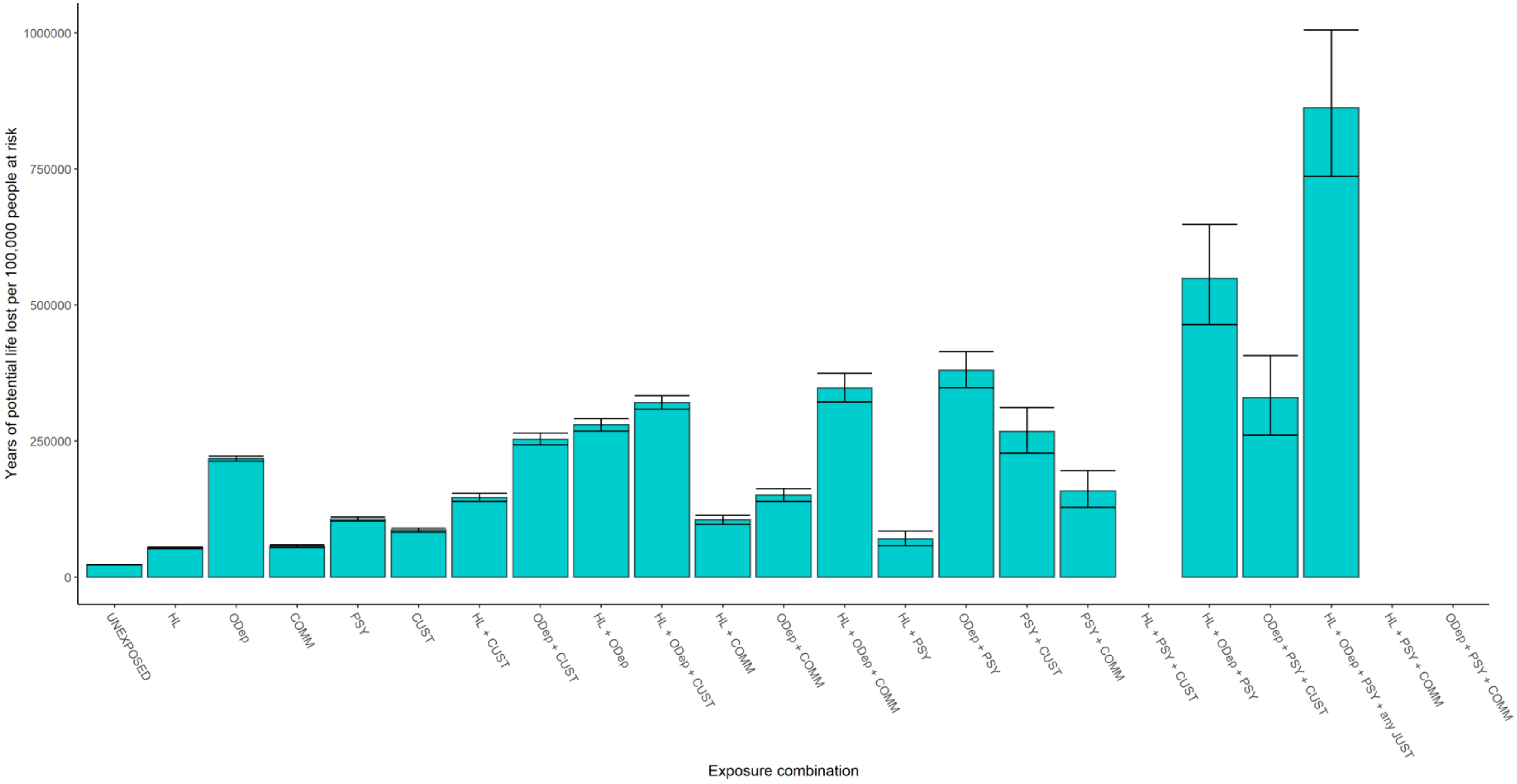
(a) Mean years of potential life lost per decedent and 95% confidence intervals



HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; CUST – imprisonment; COMM – justice involvement in community without imprisonment; PSY – psychosis.

Note that exposure combinations are ordered by frequency of mutually exclusive categories. Results omit exposure combinations in which <3 deaths occurred during follow-up.

(b) Mean years of potential life lost per 100,000 people at risk and 95% confidence intervals



HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; CUST – imprisonment; COMM – justice involvement in community without imprisonment; PSY – psychosis.

Note that exposure combinations are ordered by frequency of mutually exclusive categories. Results omit exposure combinations in which <3 deaths occurred during follow-up.

7.7 Discussion

Using cross-sectoral administrative data linkage from local authority, healthcare, and vital registration systems, we found that people with co-occurring experiences of homelessness, justice involvement, opioid dependence, and psychosis experienced high rates of premature mortality compared to individuals with one or none of these experiences. The impact of multiple disadvantage varied, however: for instance, people with opioid dependence experienced high levels of premature mortality regardless of whether they had co-occurring experiences. The rate and proportion of deaths from avoidable causes among people with multiple disadvantages was higher than among people with only one for almost all age groups, which was in turn higher than among those with none; the majority of these avoidable deaths were accounted for by conditions preventable through public health and primary prevention. Although NCDs accounted for a lower proportion of deaths among people with one or multiple disadvantages compared to people with none, absolute rates and relative hazards of NCD mortality were higher for any versus no exposures of interest, and for most combinations of multiple versus single exposures.

Our finding that multiple disadvantage was generally associated with higher mortality, but that this association varies by the individual exposures involved, is consistent with existing literature (Aldridge et al., 2018, Tweed et al., 2021), and may facilitate the identification and support of subgroups at particularly high risk of poor outcomes. However, it is notable that mortality was substantially increased even among those only exposed to one form of disadvantage. For instance, individuals with homelessness alone accounted for almost 2% of the Glasgow population yet experienced a 2.4-fold greater hazard of premature death compared to their peers. Similarly, among people with a history of imprisonment, hazard ratios for premature mortality were 3.4 times greater than the unaffected population even in the absence of other well-established risk factors such as opioid dependence or homelessness (Tweed et al., 2021, Chang et al., 2015, Kinner et al., 2013). These findings suggest the need for wide-ranging policy and service efforts across the population to prevent these experiences and mitigate associated poor health outcomes.

The high burden of avoidable mortality associated with the intersection between these experiences is notable as, to our knowledge, only one previous study has investigated this question (Lumme et al., 2016, which only examined the combination of severe mental illness and substance use). Our results extend previous research demonstrating that each of these experiences in isolation is associated with a substantial increase in the risk of death from potentially treatable or preventable causes (Amaddeo et al., 2007, Hoang et al., 2012, Degenhardt et al., 2014b, Onyeka et al., 2015, Aldridge et al., 2019, Charvin-Fabre et al., 2020). Together, these findings suggest that current public health and healthcare provision is failing to benefit many of those with the experiences of interest, creating unjust inequalities in risk of death.

Our findings also contribute to a relatively under-developed evidence base on the burden of non-communicable diseases among people affected by single and multiple forms of disadvantage (Aldridge et al., 2018, Tweed et al., 2021). Other studies have found that access to prevention and treatment for common physical health conditions among people experiencing social marginalisation and exclusion is often poor (Bradbury and Lewer, 2021, Fraser, 2021, Liu and Hwang, 2021, Mitchell et al., 2009, Mitchell et al., 2018, Liu et al., 2017). Current priorities for service delivery and research activity with these populations tend to be dominated by the prevention and management of infections and external causes: our findings suggest that this does not adequately reflect their true burden of ill-health, to which NCDs make a substantial and likely increasing contribution, and that greater attention must be paid to the prevention and treatment of common long-term conditions.

Strengths of this study include its population-based approach, which enables us to assess the associations between diverse exposure combinations and mortality in comparison to an unexposed population, rather than assessing risk factors for mortality among people selected on the basis of an index exposure. The use of linked administrative and registry data maximises our coverage and ascertainment, and reduces the risk of threats to validity from participation and attrition biases, which are common in traditional cohort studies with people experiencing social disadvantage and difficult life circumstances. While there may be under-ascertainment of people not accessing services for some exposures of interest (such as drug treatment or statutory homelessness provision), the use of four years of exposure data maximises the chances of inclusion even where engagement with services is sporadic or short-lived: a previous analysis indicated that changes in the length of the study period had a limited effect on prevalence estimates for most exposures (Chapter 6).

The use of avoidable mortality to understand mortality inequalities among people with these experiences is novel and offers new insights into opportunities for services to intervene: nonetheless, we note the assumptions and limitations of this metric (Nolte and McKee, 2004, Castelli and Nizalova, 2011). In particular, our findings would be enhanced by further work to disentangle the relative contribution of incidence and case-fatality to the overall burden of avoidable mortality among people with the experiences of interest. In considering ‘avoidability’, it is also important to note that many instances of these experiences can be averted or limited in duration through wider social policy measures in the realms of welfare, employment, housing, and justice (Moore 1995, Goldblatt and Lewis 1998, Advisory Council on the Misuse of Drugs 2015, Advisory Council on the Misuse of Drugs 2018, Centre for Homelessness Impact & Campbell Collaboration 2021).

Limitations in data available meant that we classified exposure using a cumulative approach across a four-year period, and treated exposure and follow-up periods separately. Improvements to data access in future should enable exposures to be assessed and modelled on a time-varying basis, and the impact of event timing explored. Similar constraints meant we were unable to account for periods of incarceration during follow-up, during which mortality risk may differ (e.g., Graham et al., 2015). However, modelling by Kinner et al. (2013) suggests the overall impact of this omission is likely to be small and in our study, the median in-prison time during the exposure period among those imprisoned was only 9% Chapter 6). We did not have data on heterogeneity within our exposure categories – for instance, polysubstance use or periods in and out of treatment among people with opioid dependence – that may have affected mortality risk.

As documented in Chapter 6, the extent to which records from non-health sources could be assigned a CHI number – and therefore included in the linked cohort – varied between datasets. The failure to match to the CHI register may be explained by potential migration out of the NHSGGC area following exposure (as the CHI register is a live database, in contrast to the retrospective exposure datasets) or incorrect identifiers in one or multiple datasets, though also reflects the use of a relatively stringent matching algorithm likely to prioritise specificity over sensitivity. The exclusion of those records for whom a CHI could not be assigned is therefore an important limitation which could be addressed in future work using national (rather than regional) population registers, prospective rather than retrospective linkages, and threshold-based approaches to probabilistic linkage permitting sensitivity analyses.

Nonetheless, our findings demonstrate the value of administrative data linkage in understanding the health experiences of people for whom participation in primary research can be challenging. At present, such cross-sectoral linkage is often resource-intensive and time-consuming, hindering efforts to monitor trends and evaluate interventions at the population level, and to support joined-up care provision and multi-agency working at the individual level. Investment in routine and responsive linkage across multiple sectors may therefore facilitate service and policy responses that are not only better informed by evidence but more holistic in their approach.

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Authorship statement

The study was conceptualised and planned by EJT with input from other authors. EJT liaised with relevant agencies to gain access to the data and undertook all analyses, with input from other authors. EJT drafted the manuscript: all authors contributed to interpreting the results of analyses and critically revised the manuscript, and all have provided final approval of the version to be published.

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Chapter 8 Evaluation of a national smoke-free prisons policy using medication dispensing: an interrupted time-series analysis

8.1 Foreword

In this section I introduce the context for the final empirical paper of the PhD, a time-series analysis using routine dispensing data to evaluate the health impacts of a national smoke-free prisons policy. I provide background detail on the policy intervention; how the analysis fits within the broader TIPs project as a whole; the rationale for different methodological choices; and some personal reflections on this part of the thesis. The published paper then follows, from Section 8.2 onwards. Both this overview and the published paper draw on the TIDieR-PHP reporting guidance on population health and policy interventions (Campbell et al., 2018).

Natural experiments and the Tobacco in Prisons study (TIPs)

Natural experiments can be defined in the broadest sense as an event affecting the distribution of a particular exposure within a population which is not under the control of the researcher, but which allows them to assess the effect of that exposure on the outcome(s) of interest (Craig et al., 2017).

The value of natural experiments in public health is two-fold. First, they allow for the evaluation of specific ‘real-world’ interventions not usually amenable to experimental study – for instance, social policies such as changes in educational practice or welfare entitlements – on population health and health inequalities (Ogilvie et al., 2020). Second, they can be used to draw more broadly applicable conclusions about the causal effects of a particular exposure on the outcome of interest, where the study design and context permit (Dunning, 2012).

The Tobacco In Prisons study (TIPs) was a four year mixed-methods project that evaluated progress towards, and impacts of, the implementation of smoke-free prisons in Scotland – taking advantage of the natural experiment created by this policy change (Hunt, 2021). TIPs began in 2016, at a time when a comprehensive smoke-free policy was still under consideration by the Scottish Prison Service (SPS). The study drew on repeated cross-sectional surveys of people in prison custody (PiC) and prison staff; focus groups and semi-structured interviews with PiC, prison staff, and other professional stakeholders; measurements of second-hand smoke levels; and routinely collected data from NHS and SPS sources. More information on TIPs can be found in the final project report (Hunt, 2021).

Within the TIPs project, I was responsible for leading on the use of administrative data to assess health impacts of the smoke-free policy. I authored the protocol for this strand of the project (included in Supplementary material accompanying Chapter 8), with input from colleagues, and led the analysis of pharmacy data described here.

Study intervention

The intervention of interest had two components. First, the announcement on 17th July 2017 by SPS of their intention to introduce a comprehensive smoke-free policy across the Scottish prison estate, and second, the implementation of this policy on 30th November 2018. Prior to implementation, PiC were permitted to smoke in their own cells and during outdoor recreation, whilst staff, visitors, and contractors were not permitted to smoke anywhere on SPS property. Following implementation, no person was permitted to smoke anywhere in any Scottish prison or grounds, including outdoors, and there was a prohibition on tobacco and other smoking-related paraphernalia (such as lighters, matches, and rolling papers) on all prison property.

There were multiple motivating factors for the policy's introduction, including the Scottish Government's aspiration to achieve smoke-free prisons as part of a broader strategy of "creating a smoke-free Scotland" and concerns within SPS about the impact of smoking on both staff and PiC (Hunt, 2021). These concerns were heightened by the publication of preliminary results from TIPs finding very high levels of second-hand smoke across prisons in Scotland, comparable to those found in a typical smoking home (Semple et al., 2017). These findings precipitated the July 2017 announcement, mentioned above, in which the Scottish Prison Service committed to a November 2018 implementation date. Other factors informing the decision included the ongoing roll-out of smoke-free prisons in

England and Wales from 2016 onwards, as well as a number of high-profile legal challenges across the UK brought by non-smoking people in custody (Bowcott, 2017, Sweeting and Hunt, 2015).

The rationale for including both policy announcement and implementation as dates of interest was based on results from other strands of TIPs and informal feedback from stakeholders suggesting that announcement had resulted in increased enforcement of existing rules on tobacco use (such as limiting smoking to people's own cells or outdoors) and a commensurate reduction in second-hand smoke exposure (Hunt, 2021). This approach has also been used in other policy evaluations using natural experiment methods, including the soft drinks industry levy in the UK (Pell et al., 2020). I also included a sensitivity analysis which modelled a one-month delay to full implementation, based on qualitative results from TIPs suggesting that some stockpiled tobacco may have been in circulation immediately post-implementation.

Interrupted time series analysis

Interrupted time series (ITS) analysis is a method for assessing the impact of an intervention on an outcome which has been measured repeatedly over a period of time (Wagner et al., 2002, López-Bernal et al., 2017). By establishing a pre-existing trend in the outcome measure, changes in response to an intervention at a specific point in time can be detected and compared to a counterfactual scenario predicting how the trend would have continued in the absence of the intervention.

The power of ITS methods – and in particular those using autoregressive integrated moving average (ARIMA) modelling – lies in their ability to take into account secular trends, seasonal fluctuations, and autocorrelation (that is, the tendency of measures close together in time to be alike), which might otherwise bias or obscure the relationship between the intervention and outcome and lead to a mis-estimation of standard errors (Pickup, 2015). The potential for causal inference from ITS analyses can be strengthened by the use of control populations (which differ in exposure status) or control outcomes (not expected to change following the intervention; also known as falsification outcomes), which help address potential confounding from other changes coinciding with the intervention of interest (Craig et al., 2017, López-Bernal et al., 2017). Another approach is to use temporal falsification, in which true implementation dates are substituted for false ones, to test whether an observed effect is specific to the date of intervention. Section 8.6 describes the use of falsification tests in this analysis, including a falsification outcome (anti-epileptic medications) and analytical approach enabling temporal falsification (indicator saturation), as well as the absence of a suitable control area.

ITS methods have been used to evaluate a wide variety of policies relevant to public health (Turner et al., 2020), including alcohol sales restrictions (Robinson et al., 2018), a multi-component teenage pregnancy strategy (Baxter et al., 2021), legal restrictions on novel psychoactive substances (Yeung et al., 2017), and the prohibition of smoking in indoor public spaces (Mackay et al., 2010a, Mackay et al., 2011).

In designing the study, I drew on published work describing best practice in undertaking and reporting ITS analyses (Ramsay et al., 2003, López-Bernal, 2018, Lopez Bernal et al., 2018b, Turner et al., 2020), including those specific to medication utilisation research (Jandoc et al., 2015). A protocol describing the study hypotheses and proposed methods was published prior to the start of analysis (Tweed et al., 2020) and is included in Supplementary material accompanying Chapter 8.

Outcomes of interest

Medication dispensing via prison pharmacy services was chosen as the outcome measure for the ITS analysis, for the following reasons:

- The data were routinely collected in a manner consistent across all prisons in Scotland, as part of the administration of the pharmacy services contract between NHS National Services Scotland and the pharmacy contractor. This enabled comprehensive coverage across a national prison system, maximising representativeness and statistical power.

- Data collection had also been consistent over time across the period of study, reducing the risk of erroneous conclusions resulting from changes in the way the outcome of interest is measured or ascertained (instrumentation bias) (Lopez Bernal et al., 2018a). Although there may have been changes in dispensing practice over time (for instance, in the preferred medication for treating a particular condition), our use of broad outcome categories comprising all medications for a particular indication (Section 8.6) minimises the potential impact of this within a given outcome measure.

- The data were easily available on request from NHS National Services Scotland without the potential risk of lengthy delays in governance or linkage processes.

- Medication dispensing offers an objective indicator of health impacts that is more sensitive to changes in health status than indicators of more severe illness such as hospitalisations.

Recent years have seen a proliferation of interrupted time series analyses of medication utilisation (Jandoc et al., 2015). Several authors have argued for the value of medication data in monitoring population health and evaluating policy changes, particularly for subtle health impacts not serious enough to warrant hospital admission which nonetheless may cause a substantial human and economic cost at population scale.

Medication dispensing has been widely used as a proxy for symptomatology in studies of ambient air quality, which may provide insights relevant to changes in exposure to first- and second-hand smoke (Caamano-Isorna et al., 2011, Elliott et al., 2013, Finnbjornsdottir et al., 2013, Johnson et al., 2019, Menichini and Mudu, 2010). For instance, Johnson et al. (2019) found that mine fires were associated with increased medication dispensing for physical and mental health conditions, especially respiratory medications; similarly, Elliott et al. (2013) found that wildfire-related increases in particulate matter were associated with increased dispensing of inhaled salbutamol for chronic respiratory disease. Fewer studies have investigated the impact on medications for non-respiratory conditions, though both Finnbjornsdottir et al. (2013) and Johnson et al. (2019) found that air pollution events were associated with subtle but clinically meaningful increases in cardiovascular dispensing.

However, at the time of writing, the use of medication data as a proxy for health impacts in policy evaluation remains uncommon: this is discussed further as part of the thesis's contributions in Section 9.1.

I had originally intended to examine hospitalisations as an outcome as well as medication dispensing, as described in the study protocol (Tweed et al., 2020; Supplementary material accompanying Chapter 8). Given the lack of time and financial resource available to undertake an individual-level linkage, we developed an approach to identify people in custody from Scottish Morbidity Records (SMR) data on hospital episodes, in discussion with the team responsible for SMR data at Information Services Division Scotland. This approach used the following criteria: a postcode of residence corresponding to one of Scotland's 15 prisons; registered with the single GP practice code used for all prisons in Scotland; or a record in the 'Admission/transfer from' field of "Legal establishment". Primary analyses were to use the postcode-only method as the most specific approach, with secondary analyses using any one of the three criteria above.

However, further discussions with the SMR team identified a data quality issue which posed a significant problem for our analysis; as a result, the intention to use hospitalisations as an outcome had to be abandoned. Prior to July 2018, new episodes in SMR resulted in the postcode of all previous episodes corresponding to that individual (identified using the CHI number) being over-written with the postcode associated with the new admission, resulting in potential misclassification error if an individual had hospital admissions from both prison and community settings during the study period. Alternative approaches – such as only including data on the most recent admission up to July 2018 where the postcode was a prison – were ruled out, for two reasons. First, the analyses were already drawing on small numbers of admissions and therefore at risk of inadequate statistical power, even for all-cause admissions. Second, this alternative approach would have required individual-level rather than aggregate data, necessitating additional layers of information governance and potential delays in accessing data. In future, more timely and accessible mechanisms for individual-level record linkage between administrative data from prison and hospital settings may avoid such issues and enable more reliable and responsive evaluations of policy impact on healthcare utilisation among people in custody.

Reflections

On a personal note, I found this the most satisfying element of the overall project. The project benefited enormously from being able to draw on the findings of the wider TIPs study, both the qualitative strands which documented the process of introducing the smoke-free policy and the extensive stakeholder engagement undertaken alongside the research. For instance, these findings informed the inclusion in our analysis of both policy announcement and implementation as dates of interest, and of the sensitivity analysis which modelled a one-month lag in full implementation. The wider TIPs study findings also informed the inclusion of anti-depressant medications as an outcome category, reflecting widespread concern about potential impacts on the mental health of PiC.

Another strength of the project was the ease and speed with which the medications data were made available, largely due to the fact they were healthcare data originating from a single source and not requiring record linkage. This was an important determinant of the feasibility of undertaking this policy evaluation and a stark contrast to the experience of cohort creation and analysis described in Chapter 6. This has important implications for undertaking timely and impactful policy evaluation, a point I pick up in the final discussion in Chapter 9.

Finally, this chapter has been able to build on the other elements of the thesis by using administrative data in a way that moved beyond purely descriptive epidemiology (as per the cohort analyses in Chapter 6 and Chapter 7) into policy evaluation using methods able to support robust causal inference. It has provided policy-relevant evidence about an intervention with potential to tackle the burden of non-communicable diseases among people experiencing imprisonment, a key priority identified by other parts of the project.

8.2 Title, authorship, and publication details

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Tweed EJ, Mackay DF, Boyd KA, Brown A, Byrne T, Conaglen P, Craig P, Demou E, Graham L, Leyland AH, McMeekin N, Pell JP, Sweeting H, Hunt K (2021). Evaluating of a national smoke-free prisons policy using medication dispensing: an interrupted time series analysis. *Lancet Public Health.* doi: https://doi.org/10.1016/S2468-2667(21)00163-8

8.3 Abstract

Background

Internationally, smoking prevalence among people in prison custody (i.e., people on remand awaiting trial, awaiting sentencing, or serving a custodial sentence) is high. In Scotland, all prisons implemented a comprehensive smoke-free policy in 2018 after a 16-month anticipatory period. In this study, we aimed to use data on medication dispensing to assess the impact of this policy on cessation support, health outcomes, and potential unintended consequences among people in prison custody.

Methods

We did an interrupted time-series analysis using dispensing data for 44,660 individuals incarcerated in 14 closed prisons in Scotland between March 30, 2014, and Nov 30, 2019. We estimated changes in dispensing rates associated with the policy announcement (July 17, 2017) and full implementation (Nov 30, 2018) using seasonal autoregressive integrated moving average models. Medication categories of primary interest were treatments for nicotine dependence (as an indicator of smoking cessation or abstinence attempts), acute smoking-associated illnesses, and mental health (antidepressants). We included antiepileptic medications as a negative control.

Findings

A 44% step increase in dispensing of treatments for nicotine dependence was observed at implementation (2,250 items per 1,000 people in custody per fortnight, 95% CI 1,875 to 2,624) due primarily to a 42% increase in dispensing of nicotine replacement therapy (2,109 items per 1,000 people in custody per fortnight, 1,701 to 2,516). A 9% step decrease in dispensing for smoking-related illnesses was observed at implementation, largely accounted for by respiratory medications (−646 items per 1,000 people in custody per fortnight, −1,111 to −181). No changes associated with announcement or implementation were observed for mental health dispensing or antiepileptic medications (control).

Interpretation

Smoke-free prison policies might improve respiratory health among people in custody and encourage smoking abstinence or cessation without apparent short-term adverse effects on mental health dispensing.

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8.4 Research in context

Evidence before this study

Previous studies indicate that smoke-free policies in public places are associated with reductions in acute coronary syndromes, respiratory disease, and sensory symptoms. However, evidence of the health impacts of smoke-free policies in prisons and other institutional settings is scarce. We searched MEDLINE and Embase from database inception to Jan 5, 2021, for published studies on the impact of smoke-free policies in prisons, using synonyms for smoking restrictions ([“smok*” OR “tobacco”] AND [“ban” OR “prohib*”]) combined with those for custodial settings (“prison*” OR “incarcer*”)); and separately for studies on medication usage in relation to smoke-free policies in any context using synonyms for smoking restrictions combined with either terms for medication use (“prescrib*” OR “dispens*”) or for the specific conditions and medications of interest in this study.

Our search yielded 2,608 studies. Studies in community settings have found significant associations between ambient air quality and medication dispensing for respiratory conditions, suggesting that medication dispensing might be a valid and sensitive indicator of acute health impacts. Previous research suggests potential reductions in mortality and acute myocardial infarction, and improvements in self-reported health, but might be biased by secular trends, seasonality, or changes in exposure or outcome measurement. Previous systematic reviews have identified a need for high-quality studies assessing the health impact of smoking bans in institutional settings such as prisons. To our knowledge, no previous studies have investigated objective indicators of health impacts among people in custody (including potential unintended harms) using robust designs able to account for underlying trends.

Added value of this study

Using routine medication dispensing data for 44,660 people in custody in Scottish prisons (regardless of custodial status) during a 5.7-year period, we found that the implementation of a comprehensive smoke-free policy was associated with a substantial increase in indicators of smoking cessation or abstinence attempts and improvements in indicators of respiratory health, with no evidence of changes in dispensing for mental health. In contrast to previous work in this area, our analyses accounted for underlying trends, seasonal effects, and autocorrelation, with our main findings evident in both modelling strategies used (seasonal autoregressive integrated moving average with prespecified breakpoints and indicator saturation with model-identified breakpoints). We found no change in dispensing rates for antiepileptic medications (control) in response to policy announcement or implementation, which strengthens our confidence in the potentially causal relationship between policy implementation and dispensing rates. This analysis is part of the first study internationally to assess the implementation of a comprehensive smoke-free policy across an entire prison system and, to our knowledge, represents the first use of medication dispensing to assess the impact of smoke-free policies in institutional settings on smoking-related health conditions and mental health.

Implications of all the available evidence

This study corroborates existing evidence from community settings that smoke-free policies can result in rapid and sustained improvements in respiratory health and extends this finding to institutional settings largely exempt from the UK smoke-free policy introduced in 2006–07 in public places. Findings are pertinent for other jurisdictions considering smoke-free prison policies. We found that a smoke-free policy had no apparent effect on antidepressant dispensing, which is reassuring with regard to potential unintended consequences for mental health, but does not exclude the possibility of potential negative impacts for some people who are in custody, especially among those most at risk of poor mental health. Medication dispensing seems to be a sensitive and widely available outcome indicator for monitoring population health impacts of tobacco control policies and air quality changes, especially for relatively mild symptoms that might not otherwise result in healthcare utilisation, but which collectively could represent a substantial population burden.

8.5 Introduction

In most countries worldwide, the prevalence of tobacco smoking among people in custody is high, in contrast to the decrease observed in the general population (Spaulding et al., 2018). For example, in Scotland in 2017, 68% of people in prison custody (refers to people on remand awaiting trial, awaiting sentencing, or serving a custodial sentence hereafter) were smokers compared with 18% of adults at liberty (Carnie et al., 2017, Bardsley et al., 2017), and levels of second-hand smoke in prisons were comparable to those within a typical smoking home (Semple et al., 2017).

Smoke-free policies in public places have resulted in substantial reductions in diseases associated with smoking and respiratory, irritant, and sensory symptoms (Frazer et al., 2016a). However, national smoking bans vary in whether they encompass custodial settings. In the UK, prisons were partially exempt from the 2006–07 legislation on smoke-free enclosed public places; in Scotland people in custody were permitted to smoke in their cells and during outdoor recreation (Scottish Prison Service, 2016a).

Although several jurisdictions worldwide have introduced smoke-free prison policies (Sweeting and Hunt, 2015), little evidence is available on the health impacts of such policies, particularly with regard to objective measures of health and healthcare utilisation. A 2016 Cochrane review identified a need for more robust studies assessing the health impacts of smoking bans in institutional settings such as prisons, including both pre-ban and post-ban data and follow-up for longer than 6 months (Frazer et al., 2016b).

In July, 2017, the Scottish Prison Service announced plans to implement a comprehensive smoke-free policy in the 15 prisons in their estate (Semple et al., 2017, Scottish Prison Service, 2017) This policy, which was implemented on Nov 30, 2018, prohibited smoking in all indoor and outdoor areas and was accompanied by high compliance and immediate, substantial improvements in indoor air quality (Semple et al., 2020).

The Tobacco in Prisons study (TIPs) is a multi-method study with a natural experimental design, which has investigated the process and impacts of this policy, using objective air quality measurement; routinely collected data; surveys, interviews, and focus groups with staff and people in custody; and health economic analyses (Hunt, 2021). In this study, as part of TIPs, we assessed the impacts of this smoke-free policy on treatment for nicotine dependence (as a proxy for smoking cessation or abstinence attempts); specific smoking-associated illnesses; and mental health among people in custody, using routinely collected pharmacy data on medication dispensing in Scottish prisons.

8.6 Methods

Study design

We used an interrupted time-series analysis to quantify changes in medication dispensing in Scottish prisons after the announcement of a smoke-free prisons policy and subsequent implementation of the policy. The population of interest comprised people in custody in Scottish prisons during the analysis period (March 30, 2014, to Nov 30, 2019). Primary analyses included all 14 closed prisons; secondary analyses also included Scotland's one open prison. Details of the Scottish prison estate and population are available online[2].

We obtained anonymised individual-level dispensing data for people in custody from the single pharmacy provider, which manages procurement and reimbursement of medications for Scottish prisons, via National Health Service (NHS) National Services Scotland. These data were based on individual patient medication records and stock (bulk) supply to prisons, and comprise all medications dispensed in Scottish prisons during the study period with the exception of nicotine replacement therapy in one prison, which is managed by an in-reach service provided by the local health board. This prison was therefore excluded from analyses of nicotine replacement therapy but included in all other analyses.

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[2] For more on the Scottish prison estate and population see https://www.sps.gov.uk/Corporate/Corporate.aspx

Prison population data and contracted capacity for the study period were obtained from the Scottish Prison Service, based on the twice-weekly prison census. Prison population data were averaged to obtain a fortnightly mean population.

Mean dispensing rates per person for each medication category were calculated by dividing the sum of dispensed items by the mean prison population for each fortnightly unit. Data cleaning techniques are described in detail in Supplementary material accompanying Chapter 8.

Table 6. Medications of interest included in the smoke-free prisons evaluation and their grouping for analytical purposes

			Included medications		
Level 1 grouping	Level 2 grouping		Medications	British National Formulary[1] (BNF) chapters or codes	
Indicators of smoking cessation/abstinence attempts	Treatment for nicotine dependence	Nicotine replacement therapy	Nicotine	BNF section 4.10.2	0410020B0 0410020D0
		Other medications for treatment of nicotine dependence	Bupropion Varenicline		0410020A0 0410020C0
Indicators of smoking-related illnesses or symptoms	Respiratory: short-term relief of chronic lower respiratory disease (e.g., asthma and COPD) and treatment of lower respiratory tract infections		Short-acting bronchodilators	Selected medications from section 3.1	
			Antibacterial drugs	BNF section 5.1	
	Cardiovascular: treatment and prophylaxis of acute angina		Glyceryl trinitrate: sublingual formulations	0206010F0	
	Gastrointestinal: gastro-oesophageal reflux disease		Proton pump inhibitors; antacids; H2 receptor antagonists	BNF section 1.1 BNF section 1.3.1 BNF section 1.3.5	
	Sensory: conjunctivitis and eye irritation		Anti-infective eye preparations: chloramphenicol	1103010C0	
Indicators of potential unintended consequences for mental health	Anxiety and depression		All anti-depressants	BNF section 4.3	
			Selective serotonin re-uptake inhibitors only	BNF section 4.3.3	
Controls	Medications for the control of epilepsy, excluding gabapentin and pregabalin			BNF 4.8.1 (excluding 0408010G0 and 0408010AE)	

1. The British National Formulary is the pharmaceutical reference book used in the UK National Health Service.

The TIPs study protocol was approved by the Scottish Prison Service Research Access and Ethics committee and University of Glasgow ethics committee[3]. The analysis reported here used only de-identified dispensing records and aggregate prison population data, collected as part of routine healthcare and prison service provision; thus the requirement for written informed consent was waived.

Outcomes

Selection of medication categories as outcomes was based on an *a priori* set of criteria informed by the clinical and operational expertise of the co-investigators (see Supplementary material accompanying Chapter 8). The key outcomes of interest were dispensing rates of medications for treatment of nicotine dependence (as a proxy for smoking cessation or abstinence attempts); for acute smoking-related conditions of the respiratory, cardiovascular, gastrointestinal and sensory systems; and antidepressants. The smoking-associated illnesses category included two categories strongly associated with tobacco smoking and second-hand smoke exposure (respiratory and cardiovascular) and two categories with a weaker association (gastrointestinal and sensory). Since data were not available on the conditions drugs were dispensed for, and a range of antibacterial drugs are used to treat lower respiratory tract infections, we chose to include all antibacterial drugs within the respiratory category. Since antidepressant medications might be used for indications other than mental health (e.g., some tricyclic antidepressants are used for neuropathic pain), and in the absence of data on indication, we included a subgroup analysis for selective serotonin reuptake inhibitors (SSRIs) only, because this antidepressant class is most specific to mental health problems. Our original analysis plan did not include hypnotic and anxiolytic drugs in the mental health category due to the widespread use of benzodiazepines for alcohol detoxification in the prison setting; thus we did a post-hoc analysis of this category (Supplementary material accompanying Chapter 8).

We also did an analysis of a control group of medications, expected to be unaffected by the intervention, to address the potential for time-varying confounding by changes in dispensing practice or coding, changes in composition of the population being studied, or co-occurring interventions (Table 6). We chose

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[3] For the TIPs study protocol see https://fundingawards.nihr.ac.uk/award/15/55/44

medications for managing epilepsy as the control, because neither smoking status nor second-hand smoke exposure are known to affect epilepsy onset or severity or the pharmacokinetics of these medications, and dispensing rates were likely to be high enough to provide sufficient statistical power. Gabapentin and pregabalin were excluded from the control group due to their reclassification as class C controlled substances under the Misuse of Drugs Act 1971 during the study period, in October 2018, and their potential for misuse (which might have resulted in displacement use following the withdrawal of tobacco).

We considered and rejected the possibility of using medication dispensing among the non-prison population of Scotland as a control series, due to differences in population characteristics and co-occurring interventions that were likely to undermine the strength of the counterfactual, and pragmatic challenges in obtaining national community dispensing data.

Table 7. (S)ARIMA modelling of changes in fortnightly dispensing rates per 1000 people in custody at smoke-free policy announcement and policy implementation for closed prisons in Scotland

	Announcement				**Implementation**			
	Step		**Slope**		**Step**		**Slope**	
	Coefficient (95% CI)	P value	Coefficient (95% CI)	P value	Coefficient (95% CI)	P value	Coefficient (95% CI)	P value
Smoking cessation/abstinence attempts: treatment for nicotine dependence								
All[1]	-204.8 (-1,564.7 – 1,155.2)	0.768	12.6 (-28.1 – 53.4)	0.544	2,249.6 (1,874.9 – 2,624.4)	<0.001	-2.6 (-44.4 – 39.1)	0.901
Nicotine replacement therapy[1]	-256.8 (-1244.6 – 731.0)	0.610	16.0 (-13.2 – 45.1)	0.283	2,108.6 (1,701.3 – 2,515.9)	<0.001	1.1 (-26.1 – 28.3)	0.936
Other (varenicline/bupropion)[2]	-4.9 (-46.3 – 36.5)	0.817	0.1 (-2.1 – 2.3)	0.953	48.2 (20.0 – 76.5)	0.001	-9.1 (-14.4 – -3.8)	0.001
Smoking-related illness								
All	-76.4 (-458.9 – 306.1)	0.695	-23.9 (-41.4 – -6.4)	0.007	-646.2 (-1,110.9 – -181.4)	0.006	16.5 (-13.6 – 46.7)	0.282
Respiratory	65.7 (-130.4 – 261.9)	0.511	-4.3 (-13.0 – 4.4)	0.330	-485.9 (-746.7 – -225.1)	<0.001	-11.0 (-24.7 – 2.7)	0.114
Cardiovascular	-105.6 (-191.4 – -19.8)	0.016	1.3 (-1.9 – 4.5)	0.418	-49.6 (-170.8 – 71.6)	0.422	-2.2 (-9.4 – 5.1)	0.561
Gastrointestinal	-73.9 (-303.7 – 156.0)	0.529	-21.0 (-32.3 – -9.7)	<0.001	-137.3 (-507.6 – 233.1)	0.468	30.2 (8.6 – 51.7)	0.006
Sensory	1.4 (0.1 – 2.6)	0.032	-0.1 (-0.2 – 0.0)	0.002	-0.8 (-3.5 – 1.8)	0.541	0.2 (0.0 – 0.3)	0.017
Mental health								
All anti-depressants[2]	-119.7 (-270.2 – 30.7)	0.119	-2.9 (-11.5 – 5.6)	0.502	151.7 (-114.2 – 417.5)	0.263	0.5 (-12.6 – 13.6)	0.940
SSRI anti-depressants[2]	-121.3 (-171.9 – -70.7)	<0.001	-3.1 (-5.7 – -0.5)	0.020	18.2 (-52.0 – 88.4)	0.611	3.2 (-0.1 – 6.4)	0.054
Control series								
Anti-epileptics[2]	-19.0 (-94.8 – 56.8)	0.623	2.1 (-1.3 – 5.5)	0.230	-70.9 (-184.8 – 43.1)	0.223	-0.7 (-6.6 – 5.2)	0.820

Analyses of nicotine replacement therapy (NRT) and the NRT component of the combined nicotine dependence category exclude one closed prison for which nicotine replacement therapy was dispensed via an in-reach service provided by the local health board, rather than the national pharmacy contract, and for which detailed data on NRT dispensing was therefore not available. This prison is included in all other analyses.

Seasonal ARIMA (SARIMA) models provided the best model fit for these outcomes given seasonality in dispensing associated with the Christmas period.

Statistical analysis

To distinguish the effects of policy announcement and implementation, we divided the analysis period (March 30, 2014, to Nov 30, 2019) into three phases: pre-announcement (March 30, 2014, to July 17, 2017); anticipatory (July 18, 2017, to Nov 29, 2018); and post-implementation (Nov 30, 2018, to Nov 30, 2019). The design and analysis were prespecified in a published protocol (Tweed et al., 2020; reproduced in Appendices). Changes to the protocol are described in Supplementary material accompanying Chapter 8.

We analysed the data using auto-regressive integrated moving average (ARIMA) models, including seasonal ARIMA (SARIMA) models where appropriate, to account for underlying secular trends, seasonality, and autocorrelation. We modelled the coefficients for step and slope changes in dispensing rates at the transition points between the pre-announcement, anticipatory, and post-implementation phases, using indicator variables reflecting the dates of policy announcement and implementation. Since overcrowding is acknowledged as an important determinant of health in the prison setting, a crowding indicator for use as a covariate in sensitivity analyses was calculated on the basis of the ratio of the observed fortnightly mean population to the contracted capacity (i.e., the number of people in custody that the prison is contracted by the Scottish Prison Service to hold) of the prison estate recorded for that period. The choice of model was based on the Box-Jenkins three-step approach of identification of auto-regressive and moving average components, using autocorrelation and partial autocorrelation functions; model estimation; and diagnostic checking, using the Portmanteau Q statistic for white noise residuals, kernel density plots to assess normality of residuals, and the Akaike Information Criterion and Bayesian Information Criterion for each model (Pickup, 2015).

We first modelled the whole time series before modelling and testing the effect of policy announcement and implementation (see Supplementary material accompanying Chapter 8).

The impact of the smoke-free policy was hypothesised to differ in important ways in open versus closed establishments, because people in custody in Scotland's open prison might smoke on periods of home leave, or while working outside of the prison. Primary analyses therefore comprised fortnightly dispensing rates for the 14 closed prisons in Scotland. For primary analyses, we additionally calculated relative effect estimates for step and slope changes by applying the absolute coefficients for the change obtained from ARIMA or SARIMA modelling to mean dispensing rates immediately preceding announcement and implementation.

We did prespecified secondary analyses comprising: all 15 prisons in Scotland (open and closed); indicator saturation to identify step or slope changes not specified *a priori* (Pretis et al., 2018); weekly time series; and adjustment for the crowding indicator. Since qualitative analyses of TIPs suggested some stockpiled tobacco might have been in circulation immediately after implementation of the smoke-free policy, we did a post-protocol analysis to test whether specifying a later implementation date (Dec 30, 2018) provided a better model fit. Full results of secondary and post-protocol analyses are provided in Supplementary material accompanying Chapter 8.

Data cleaning and ARIMA or SARIMA modelling were done using Stata software (version 16); indicator saturation analyses were done using R software (version 3.6.3) using the *gets* package.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

8.7 Results

The mean daily prison population during the study period was 7,517 (SD 235.4, range 6,984–8,143) for the closed estate (primary analyses) and 7,730 (235.4, 7,185–8,335) for all prisons (secondary analyses). 44,660 unique individuals were estimated to have spent time incarcerated in the closed estate in Scotland during the study period (primary analyses); and 44,775 individuals for all prisons (secondary analyses). A total of 148 fortnights (86 pre-announcement, 35 in the anticipatory period, and 27 post-implementation) and 31·3 million eligible dispensed items (3,324,178 items for nicotine dependence, 16,850,875 items for smoking-associated illnesses, 9,214,162 items for mental health, 1,885,990 for the control condition) were included in the analyses. Total dispensed quantities and mean rates for each medication category during the overall study period and each phase are shown in the Supplementary material accompanying Chapter 8.

Within the overall category of medications for nicotine dependence, a 44% increase in dispensing was observed (Figure 19a, Table 7; supplementary material), primarily driven by nicotine replacement therapy, which accounts for the majority of dispensing in this category. For nicotine replacement therapy, a 42% increase in dispensing associated with policy implementation was observed (2,109 items per 1000 people in custody per fortnight, 95% CI 1,701–2,516; Figure 19b, Table 7; supplementary material).

An initial step increase in dispensing rates of other medications for nicotine dependence was observed (48 items per 1000 people in custody per fortnight, 95% CI 20 to 77) with a negative slope change (−9 items, 95% CI −14 to −4) at the point of policy implementation (Figure 19c, Table 7). Sensitivity analysis demonstrated that a delayed implementation date (Dec 30, 2018) provided a better fit to the data on dispensing of other medications for nicotine dependence, indicating that an initial peak immediately after implementation was followed by a sustained step decrease in dispensing (−80 items per 1000 people in custody per fortnight, 95% CI −106 to −53; supplementary material) and a negative slope trend (−5 items, 95% CI −2 to −8).

For medications for smoking-related illnesses, primary analysis of the combined category suggested a negative slope change at the point of policy announcement (−24 items, 95% CI −41 to −6; 0·3% relative decrease) followed by a step decrease on implementation (−646 items per 1000 people in custody per fortnight, 95% CI −1111 to −181; 9% relative decrease; Figure 20a, Table 7; supplementary material).

For respiratory disease, a substantial step decrease was observed at the point of policy implementation (−486 items per 1000 people in custody per fortnight, 95% CI −747 to −225; 11% relative decrease), which largely accounted for the observed decrease in overall smoking-related illness dispensing (Figure 20b, Table 7).

For cardiovascular conditions, a substantial step decrease was observed at the point of policy announcement (Figure 20c, Table 7), although the 95% CIs were wide (−106 items per 1000 people in custody per fortnight, 95% CI −191 to −20; 44% relative decrease). No other significant changes in dispensing for cardiovascular conditions were observed.

For gastrointestinal diseases, there was a pre-existing upward trend in dispensing rates, which plateaued at the point of policy announcement and subsequently resumed at the point of implementation (Figure 20d, Table 7). For the sensory disease category, dispensing rates were low overall (Figure 20e). Modelling suggested a similar pattern to gastrointestinal diseases, with a small step increase observed at announcement, but the absolute changes were small (around 1 or fewer items per 1000 people in custody per fortnight; 0·1–0·2% relative change) and most confidence intervals included zero (Table 7).

No significant changes in dispensing rates of antidepressant medications were observed in association with policy announcement or implementation in either primary (Figure 21a, Table 7) or sensitivity analyses (supplementary material). For the subgroup of SSRI antidepressants, policy announcement was associated with a negative step change (−121 items per 1000 people in custody per fortnight, 95% CI −172 to −71; 12% relative decrease) and small negative slope change (−3 items, 95% CI −6 to 0; 0·1% relative decrease), followed by a positive slope change of similar magnitude at the point of policy implementation (3 items, 95% CI 0 to 6; Figure 21b, Table 7).

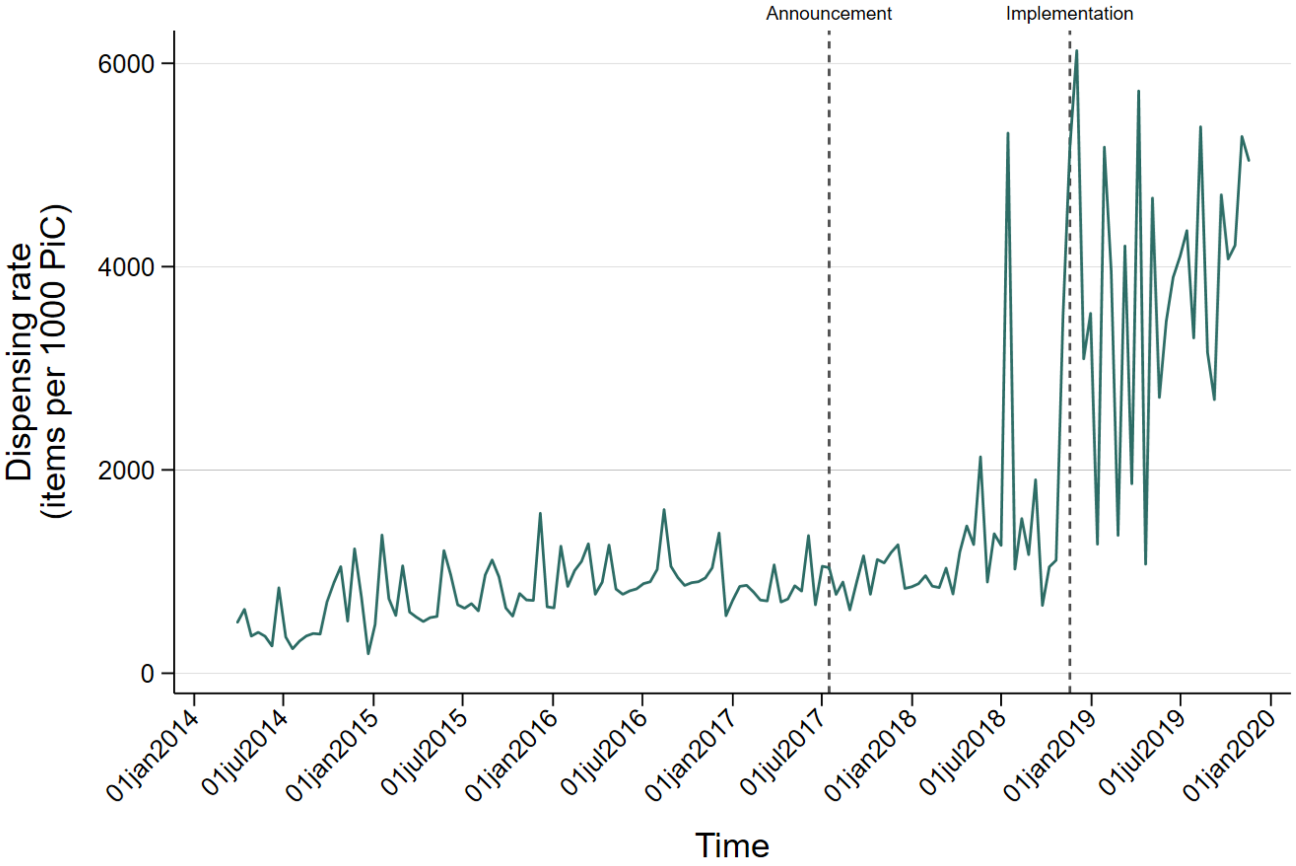
No significant changes in the dispensing rates of antiepileptic medications (control) were observed at announcement or implementation (Figure 22, Table 7).

Indicator saturation results for nicotine replacement therapy, other medications for nicotine dependence, and respiratory medications confirmed substantial changes following policy implementation, with dates in December 2018 (2–4 weeks after official implementation), identified as the key breakpoint for step changes (supplementary material). For other outcomes, no significant changes associated with policy announcement or implementation were identified. The modest step and slope changes in dispensing rates for non-respiratory smoking-associated illnesses observed in primary analyses were not confirmed by indicator saturation.

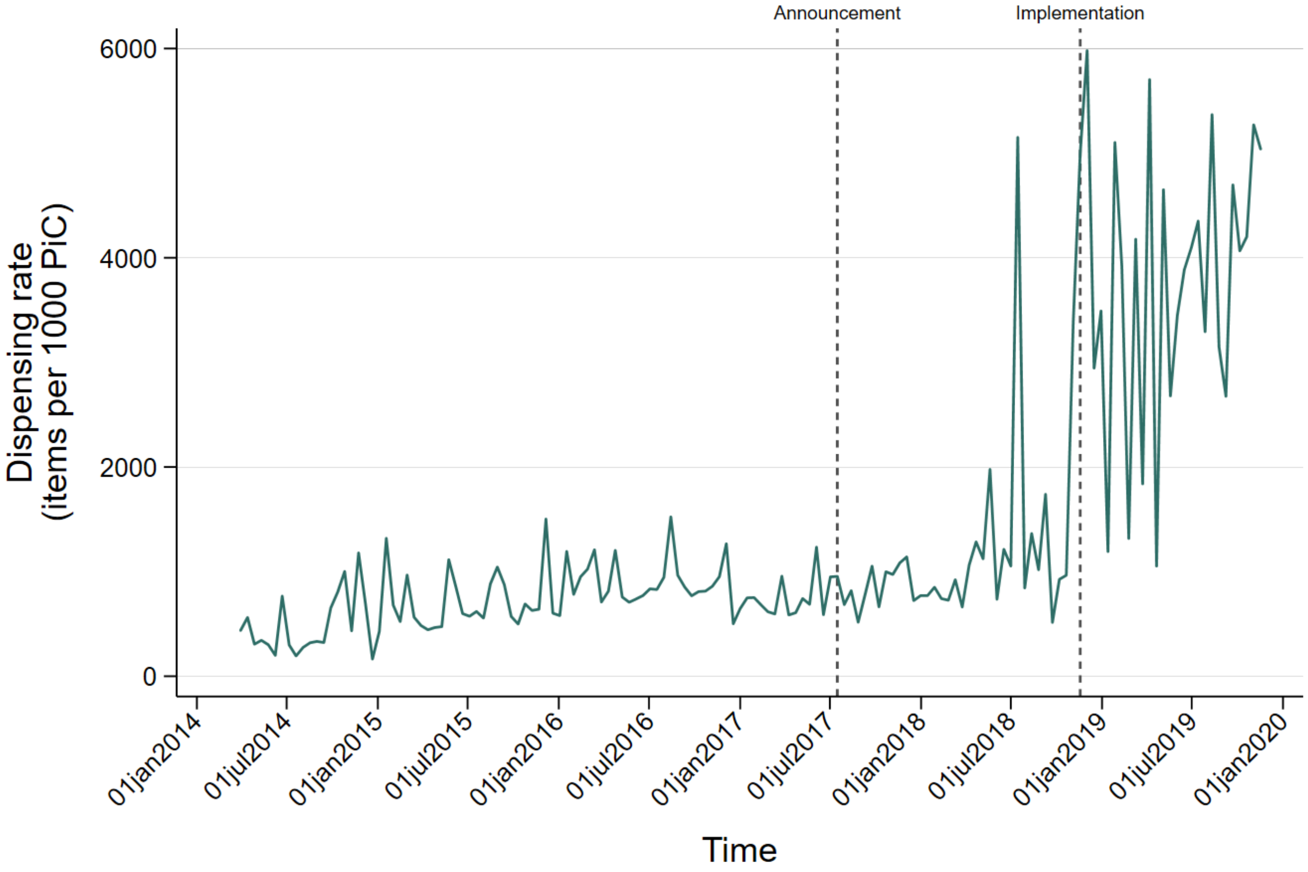
Results of sensitivity analyses were otherwise consistent with the primary results, including those encompassing the open prison (supplementary material). A post-hoc analysis of dispensing of hypnotic or anxiolytic medications did not identify any changes associated with policy announcement or implementation (supplementary material).

Figure 19. Time series of dispensing rate (items per 1000 persons in custody per fortnight, PiC) for medications for nicotine dependence, as indicators of smoking cessation/abstinence attempts, in Scottish prisons during the study period, showing dates of policy announcement and implementation. (Note that scales of Y axis differ).

(a) All medications for nicotine dependence



(b) Nicotine replacement therapy



(c) Other medications for nicotine dependence (varenicline or bupropion)

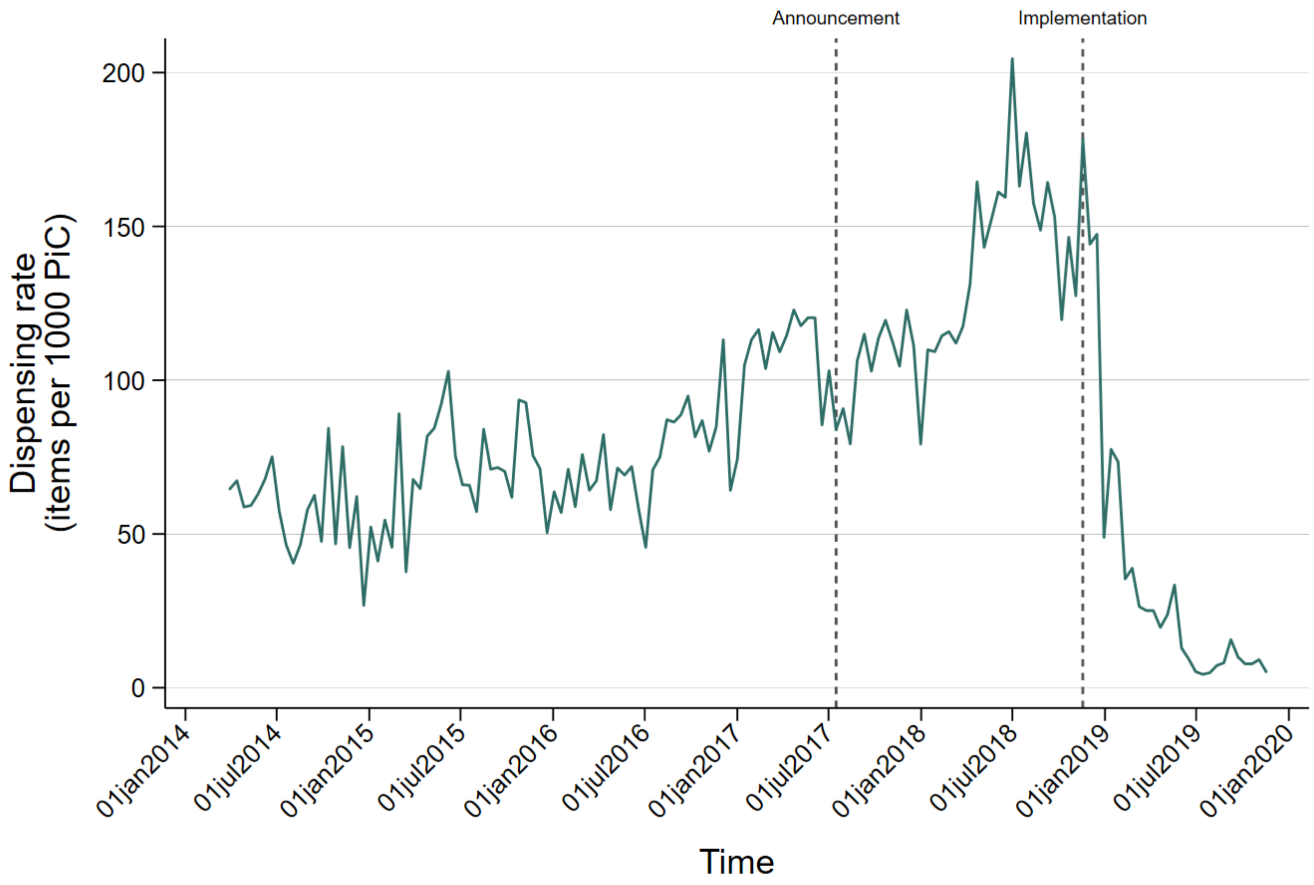
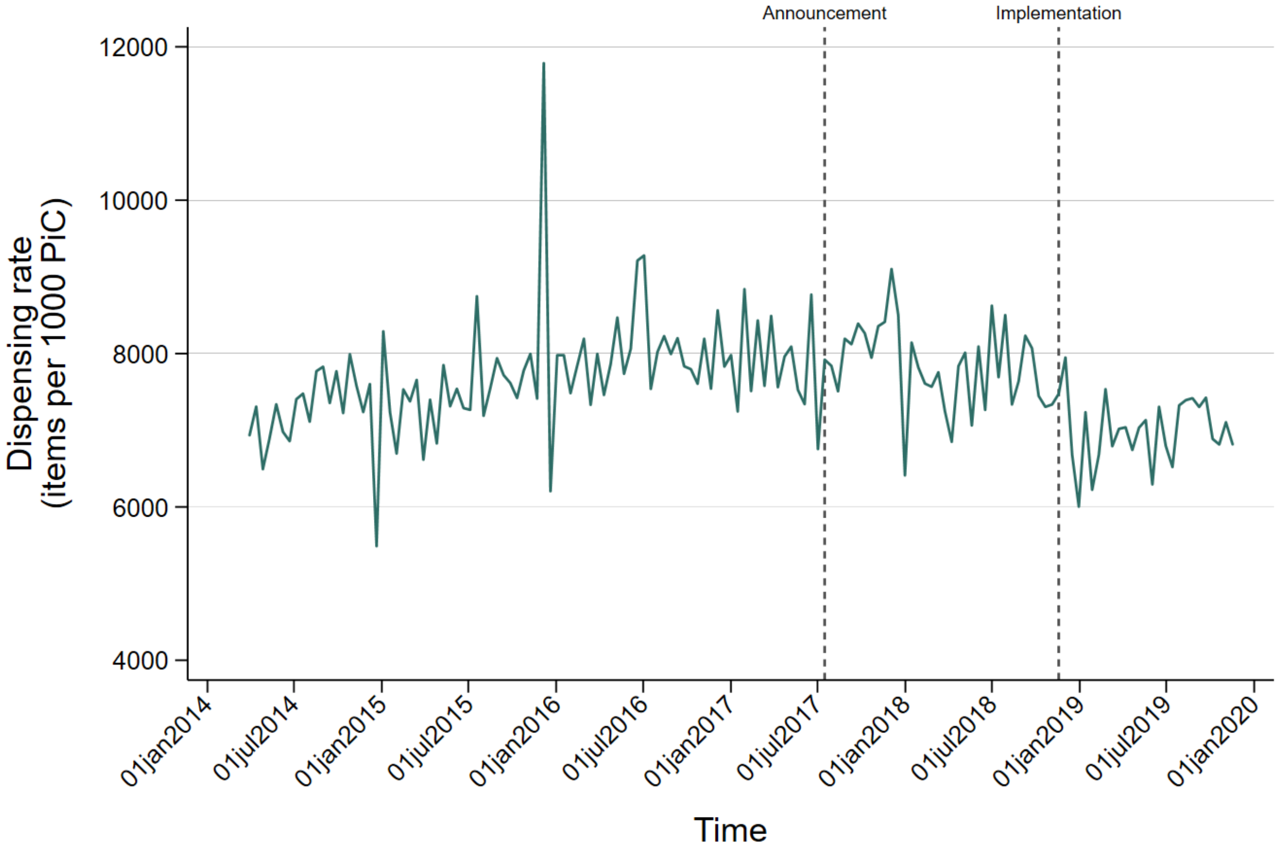
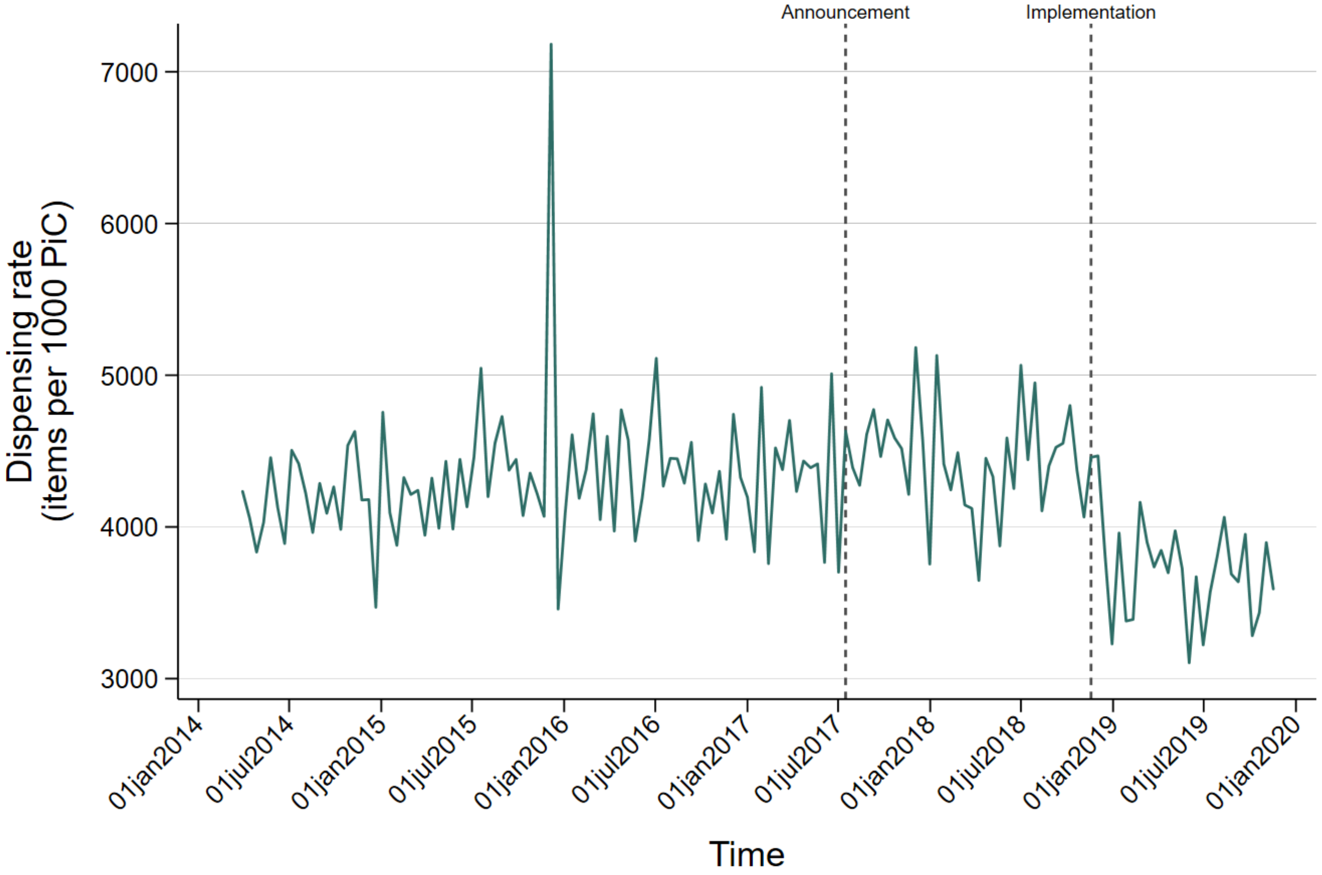


Figure 20. Time series of dispensing rate (items per 1000 persons in custody per fortnight, PiC) for medications for smoking-related illnesses in Scottish prisons during the study period, showing dates of policy announcement and implementation. (Note that scales of Y axis differ).

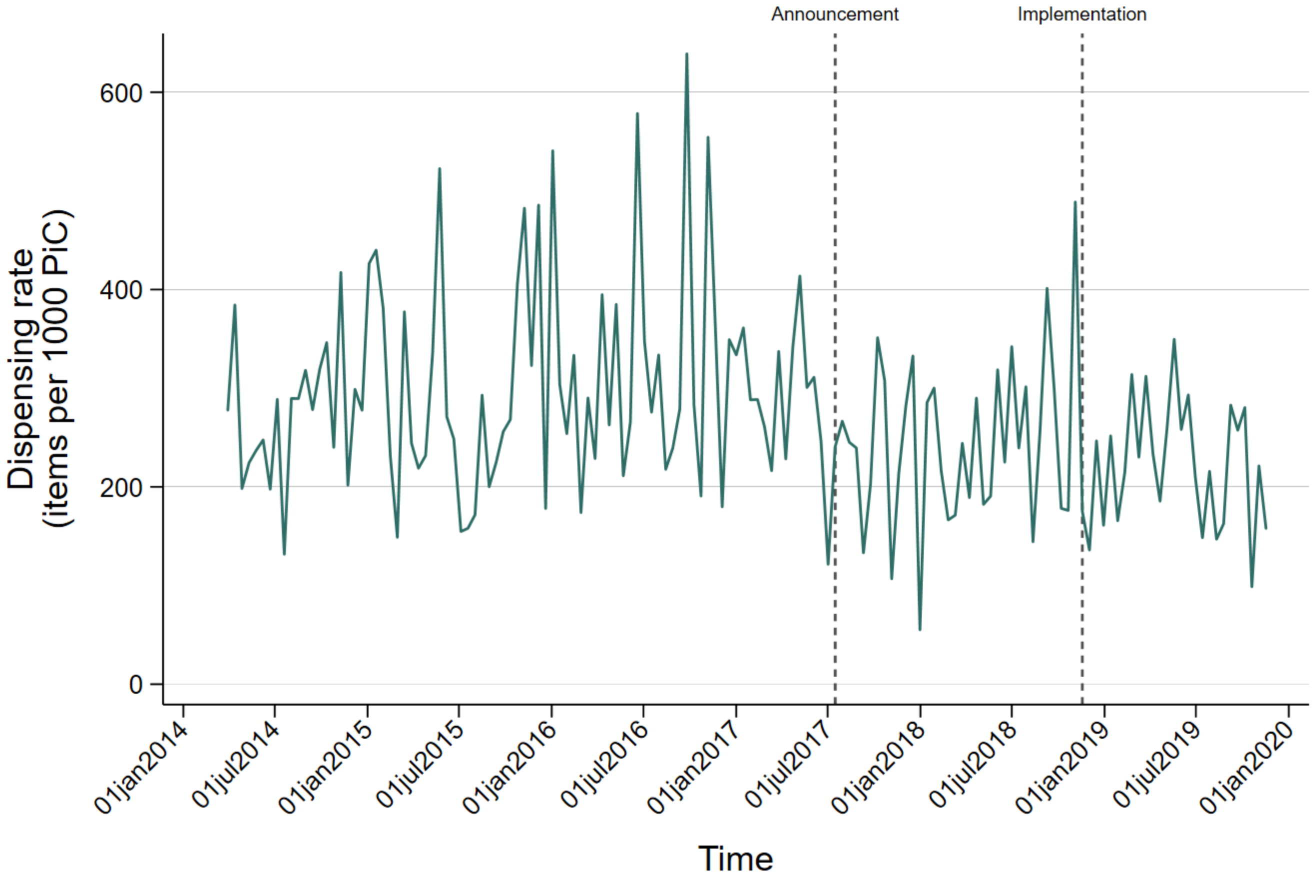
(a) All medications for smoking-related illnesses



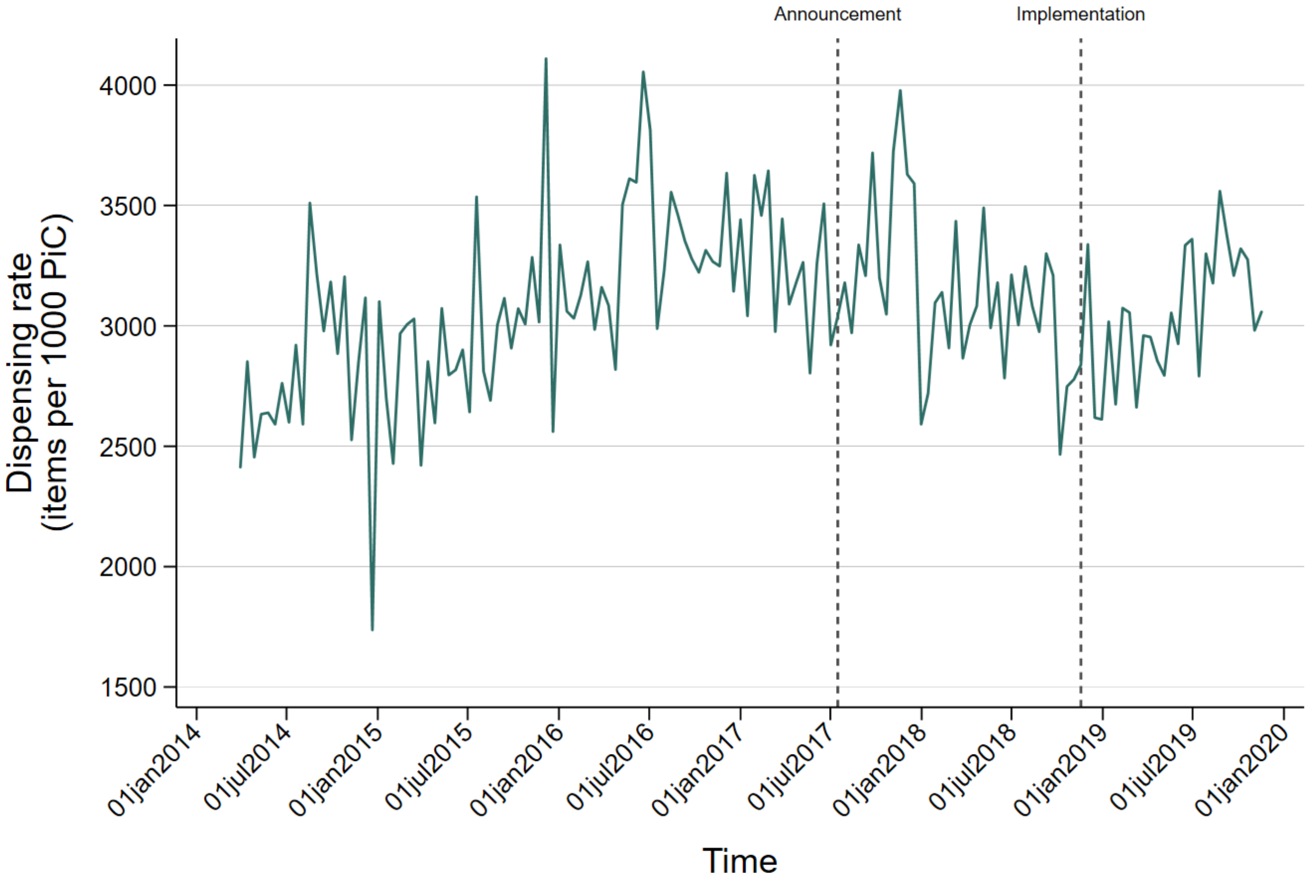
(b) Medications for respiratory illnesses



(c) Medications for cardiovascular illnesses



(d) Medications for gastrointestinal illnesses



(e) Medications for sensory illnesses

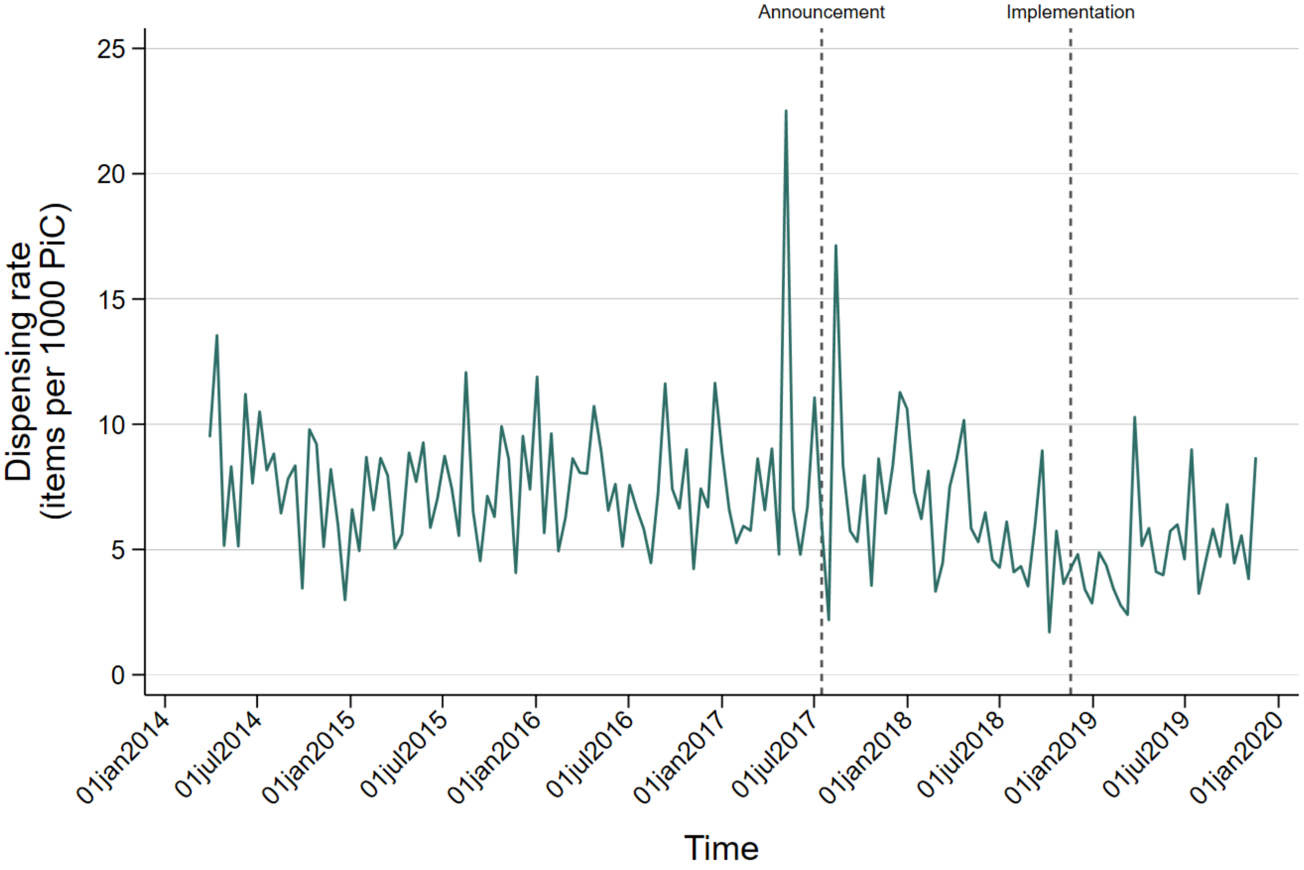
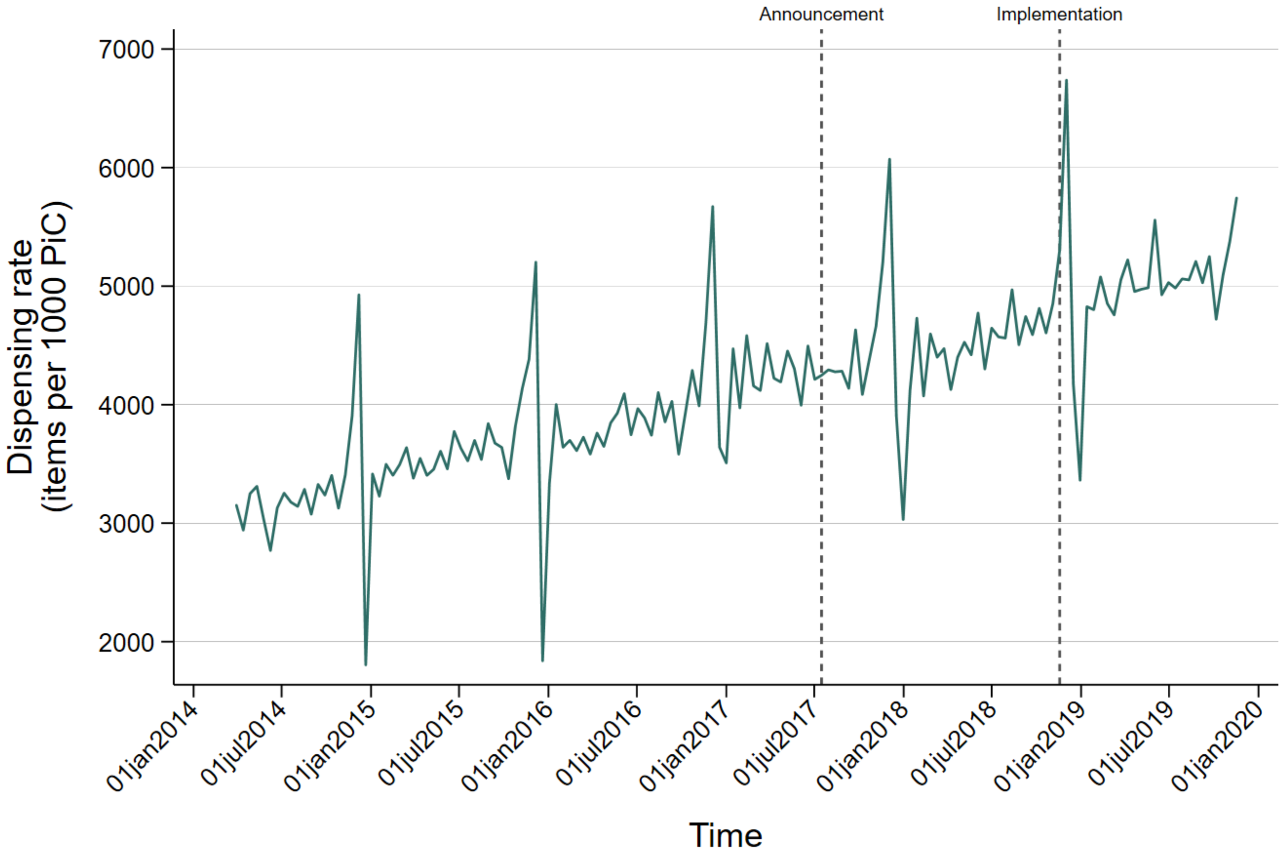


Figure 21. Time series of dispensing rate (items per 1000 persons in custody per fortnight, PiC) for antidepressant medications in Scottish prisons during the study period, showing dates of policy announcement and implementation. (Note that scales of Y axis differ).

(a) All antidepressant medications



(b) Selective serotonin reuptake inhibitors

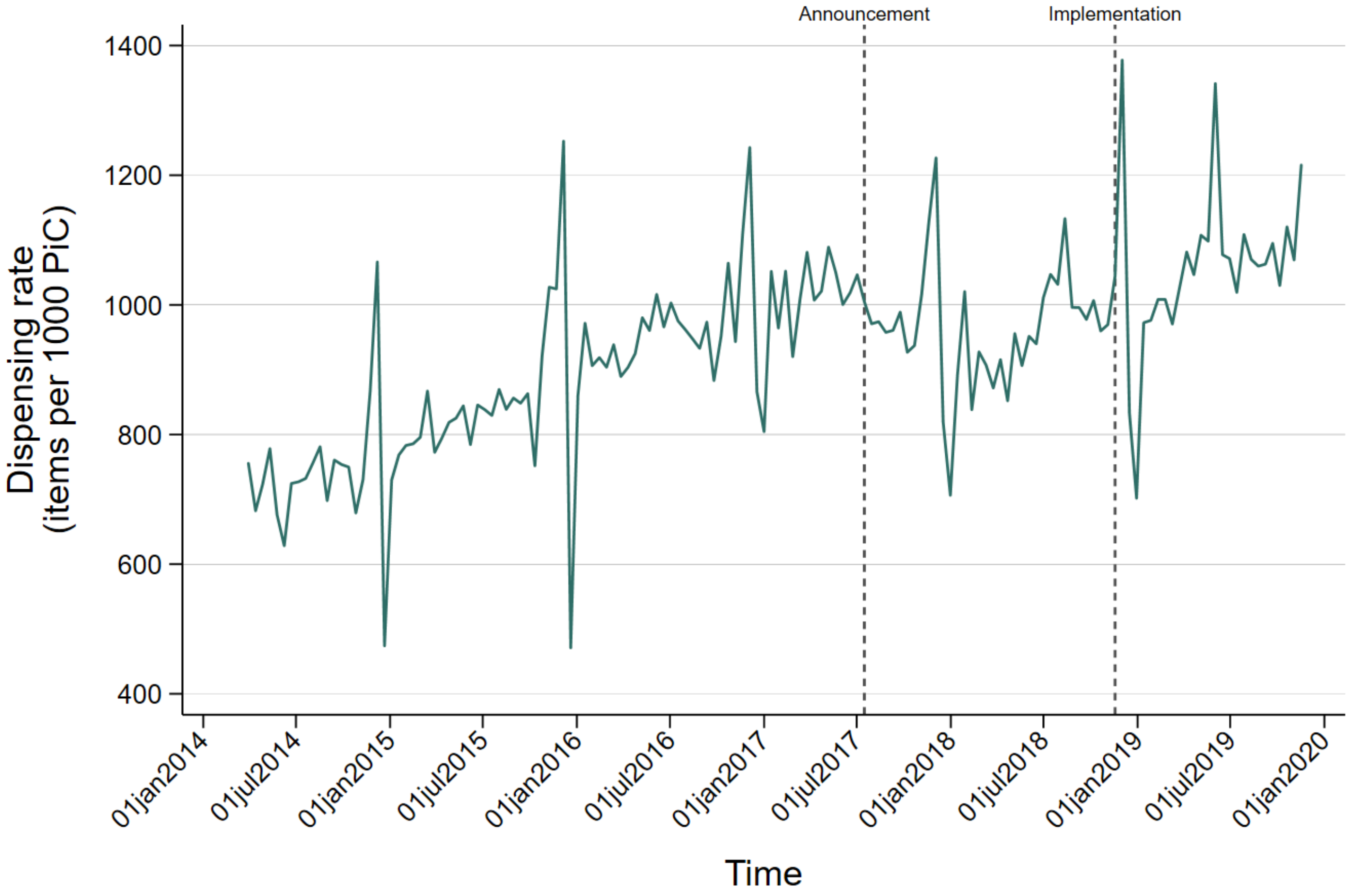
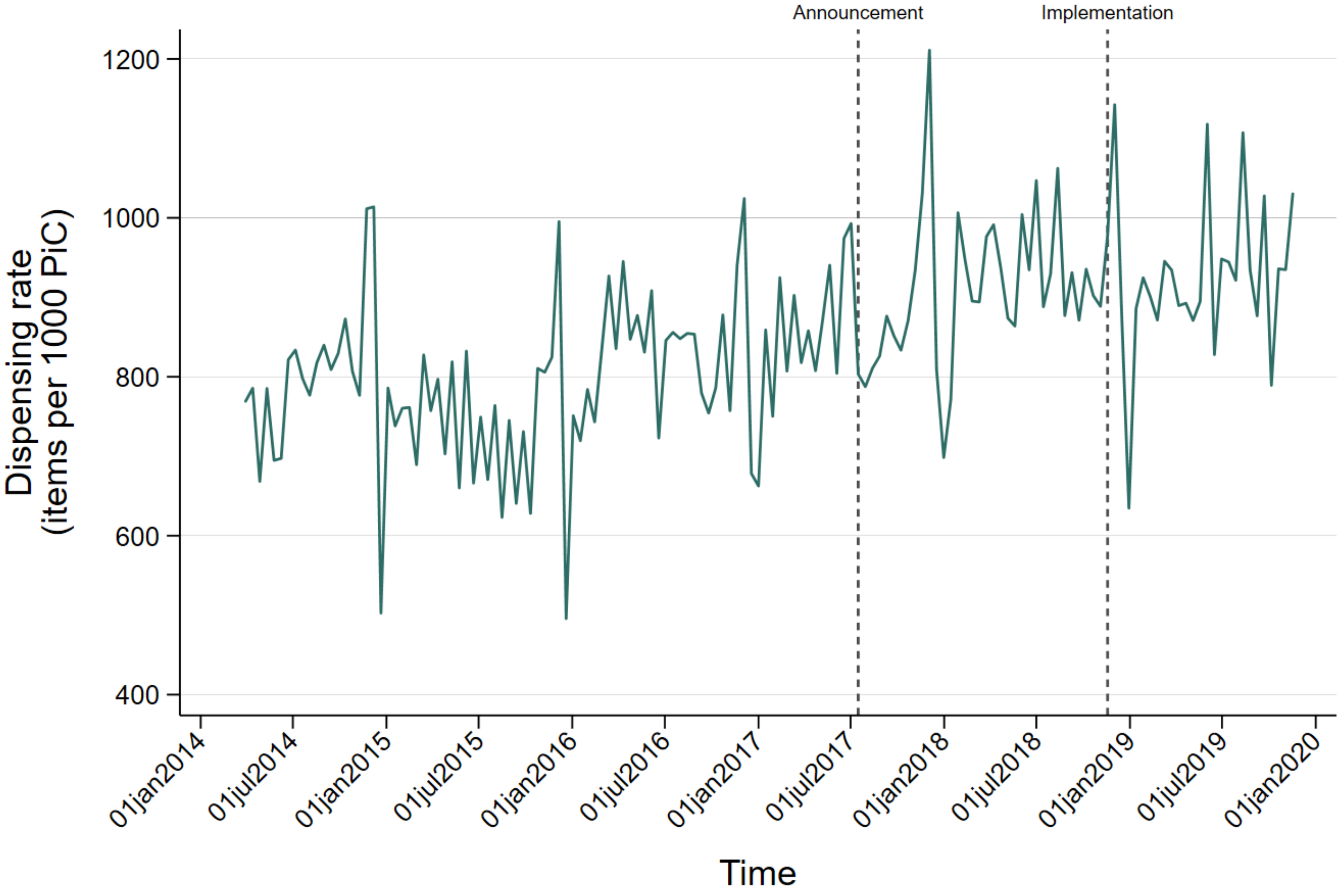


Figure 22. Time series of dispensing rate (items per 1000 persons in custody per fortnight, PiC) for anti-epileptic medications in Scottish prisons during the study period, showing dates of policy announcement and implementation.



8.8 Discussion

Implementation of a comprehensive smoke-free policy in Scottish prisons was associated with increased overall provision of treatment to support smoking cessation or abstinence, reflecting a substantial increase in the dispensing of nicotine replacement therapy and a smaller decline in dispensing of other medications (primarily varenicline) in this category. Implementation was also associated with a sustained reduction in dispensing of medications for respiratory illness. A modest reduction in dispensing for acute angina at the point of announcement and temporary changes in dispensing for sensory and gastrointestinal symptoms were not corroborated in sensitivity analyses using an alternative modelling approach. We found no evidence of increased dispensing for depression and anxiety, and, when examining medications most specific to these indications, a suggestion of short-term reductions in dispensing.

To our knowledge, this is the first analysis to use medication dispensing to assess the impact of smoke-free policies in institutional settings on outcomes other than smoking cessation or abstinence attempts, and forms part of the first study internationally to assess implementation of a comprehensive smoke-free policy across an entire prison system.

Previous studies have reported changes in prescribing of nicotine replacement therapy following smoke-free policies in psychiatric hospitals, although these were simple comparisons done before and after policy implementation that did not account for secular trends, seasonality, or autocorrelation (Scharf et al., 2011, Scheeres et al., 2020, Cormac et al., 2010). Our observation of increased nicotine replacement therapy dispensing is consistent with these studies and findings from the qualitative data collected as part of TIPs, which described extensive preparations across the Scottish Prison Service for increased demand for cessation or abstinence support (Hunt, 2021). The observed decline in dispensing of other medications used to support cessation or abstinence attempts might be explained by multiple factors, including a decline in opportunities to prescribe varenicline for the licensed indication of cessation of tobacco smoking; the increased availability of nicotine replacement therapy, which is recommended as first line in local formularies in Scotland and is substantially cheaper than other medications used to support cessation or abstinence attempts; and widespread availability and uptake of rechargeable e-cigarette devices (Brown et al., 2021).

Our finding of decreased dispensing for respiratory conditions following policy implementation is consistent with studies of the association between ambient air quality and medication dispensing, which found a consistent positive association between dispensing for chronic respiratory conditions and airborne pollutant levels (Johnson et al., 2019, Elliott et al., 2013, Menichini and Mudu, 2010), and with observed reductions in respiratory symptoms and hospital admissions after community smoke-free legislation (Rando-Matos et al., 2017). By documenting the impact of a clearly defined intervention in a closed setting with substantial improvement in measured air quality (Semple et al., 2020), our study addresses some limitations of existing community-based outcome studies, for which exposure measurement is more challenging (Menichini and Mudu, 2010).

Fewer studies have investigated the association between air quality (indoor or outdoor) and dispensing for non-respiratory outcomes than for respiratory outcomes (Hollingworth et al., 2016). We found a potential modest impact of policy announcement on dispensing for acute angina, and no clear effect in either direction for dispensing for gastro-oesophageal reflux disease and conjunctivitis, none of which were replicated in secondary analyses using indicator saturation (i.e., where dates of interest are identified by testing for potential breaks at every point in the time series rather than prespecified). These findings might reflect low rates of dispensing (for cardiovascular and sensory illnesses) or weaker associations with first-hand or second-hand smoke exposure (for gastrointestinal and sensory illnesses) for these outcomes. The inconclusive results for cardiovascular dispensing contrast with the strong evidence of a reduction in cardiovascular events following smoking bans in community settings (Mackay et al., 2010b) and might reflect the relatively young population in Scottish prisons (mean age 36 years in 2019–20) (Scottish Government, 2020c), although this population are at risk of accelerated onset of long-term conditions and multimorbidity (Graham, 2007). Long-term studies of cardiovascular impacts of smoke-free policies, especially among older people in custody and those serving longer sentences, are warranted.

Our findings on smoking-associated illness among people in custody are corroborated by a parallel arm of TIPs, which reported reductions in recorded staff sickness absence overall and for cardiothoracic conditions after policy implementation (Hunt, 2021).The absence of changes in antidepressant or hypnotic or anxiolytic drug dispensing among people in custody is reassuring, especially considering the broader evidence base that smoking cessation can have mental health benefits (Taylor et al., 2014), but should be interpreted with caution since medication dispensing is a crude indicator of potential mental health impacts and might not capture heterogeneous effects – e.g., among people in custody at high risk of poor mental health. In TIPs surveys, two-thirds of people in custody reported that the smoking ban had made them more anxious and only 12% agreed it had made them happier, although response rates were low (Hunt, 2021).

A major strength of this study is its national coverage, with comprehensive outcome data covering almost all dispensing episodes in Scottish prisons during the study period (with the exception of nicotine replacement therapy for one prison, which was omitted from analyses for that outcome). Our time-series analysis used data collected over a longer duration than most similar studies (Frazer et al., 2016b, Turner et al., 2020), which increases the likelihood of detecting subtle effects and adequately accounting for seasonal and secular trends. Our use of pharmacy contract data collected for the purposes of financial reimbursement is likely to maximise validity in terms of data quality and completeness. Use of a consistent single source of administrative data for outcome measurement throughout the time series also helps mitigate against artefactual changes over time (instrumentation bias). The absence of effect in a control series of medications increases our confidence in inferring a causal relationship between the smoke-free policy and observed changes in dispensing (Turner et al., 2020). We were not able to include a control series of prisons where the intervention was not implemented, since the policy was introduced in all Scottish prisons simultaneously, or to investigate heterogeneity of impacts within the prison population. We also were unable to include data on rechargeable e-cigarette use, which might have affected dispensing to support smoking cessation or abstinence following their introduction two months before implementation of the smoke-free policy (Hunt, 2021).

Medication dispensing has not, to our knowledge, previously been used to investigate smoke-free policies in custodial settings, although it has been extensively used as an outcome in studies of the health impacts of outdoor air quality (Menichini and Mudu, 2010) and as part of a composite outcome for monitoring respiratory symptoms following implementation of community smoke-free policies in one study (Dove et al., 2011).The use of medication dispensing as a proxy indicator of health impacts has advantages and limitations. Medication dispensing is an objective indicator of health impacts that avoids response bias and captures relatively mild conditions or those usually managed in primary care, which might have substantial human and economic costs. Most other studies of public or institutional smoke-free policies have focused on hospital admissions or mortality, which represent only one component of the broader health impact of smoke-free policies. Although dispensing might not always reflect use, it does reflect demand and thus is a reasonable proxy for symptoms: this might be especially true in closed settings such as prisons. However, some of our medication categories, such as antibiotics and antidepressants, were non-specific for the outcomes of interest because data on reason for dispensing were not available: this might have resulted in bias towards the null for relative effect estimates, although this should not have affected estimates of absolute changes. In particular, antidepressant dispensing is a crude indicator of consequences for mental health, and data from the survey and qualitative components of the TIPs suggest that these impacts should not be overlooked (Hunt, 2021).

Our results suggest that smoke-free prison policies have beneficial effects on acute respiratory illness during imprisonment. However, since most people in prison globally are in pre-trial detention or serving short sentences, with the average time served by people in prison custody in Scotland less than 6 months (Scottish Government, 2020c), the long-term impact of such policies will depend on whether these policies encourage sustained abstinence from smoking outside the prison environment. Evidence to date suggests that smoking relapse rates are high after release from smoke-free prisons, although such policies might reduce the intensity of smoking after release (Puljević and Segan, 2019). Prison smoke-free policies must therefore form part of a comprehensive package of tobacco control measures encompassing both community and custodial settings, and broader efforts to address health inequalities among people who experience incarceration (World Health Organisation, 2014a). In addition to work to quantify and support sustained behavioural change, future studies of smoke-free prison policies should investigate longer-term health impacts among people in custody and staff, perhaps using linkage between prison records and primary or secondary healthcare data on diagnoses and hospital admissions.

Contributors

All authors contributed to study conceptualisation and planning of the analysis. EJT drafted the protocol with contributions from all other authors. TB and AB liaised with relevant agencies to obtain the pharmacy contract and population data respectively. EJT did the analyses with assistance from DFM. EJT and NM had full access to and verified the study data. All authors had access to a de-identified study dataset and all syntax used in the analyses. EJT drafted the manuscript. All authors contributed to interpreting the results of analyses and critically revising the manuscript, and all have provided final approval of the version to be published. EJT and KH were jointly responsible for the decision to submit the manuscript. KH is Principal Investigator of the Tobacco in Prisons study.

Data sharing

The aggregate dispensing data used in this study are available to researchers on request from NHS National Services Scotland, and the original study protocol is available online[4].

Declaration of interests

HS was a member of Action on Smoking and Health (ASH) Scotland's Board (2017–20) and the Policy and Development Committee (2013–20), chair of the Scottish Tobacco-free Alliance Research Group (2012–20), and a council member for the Tobacco-free Alliance (2015–20). KH was previously a member of the National Institute for Health Research (NIHR) Public Health Research funding board.

Acknowledgments

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[4] For the study protocol for this analysis, see https://osf.io/j8uzd/

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Chapter 9 Discussion

In this chapter, I aim to bring together the introductory literature review and empirical chapters, to provide an overarching synthesis of the work undertaken. I start by summarising the key findings of the thesis as a whole and highlighting how they add to the existing literature. I then move on to describe the strengths and limitations of the thesis as a combined body of work, before concluding by identifying its implications for research, policy, and practice.

9.1 Summary of key contributions in the context of existing evidence

In this thesis, I have shown that multiple forms of severe disadvantage commonly co-occur in the population and that people affected by this intersection experience profound health inequalities, including a high burden of preventable or treatable conditions. Although the experiences of interest featured to some extent in recent health inequalities policy, there was limited acknowledgement of their co-occurrence. As the evaluation of smokefree prisons has demonstrated, interventions in relevant settings and services may have the potential to improve health. I have suggested that policy and practice to understand and redress these inequalities could benefit from methodological developments, in the use of administrative data from different sectors, and conceptual developments, in how the experiences of interest are understood in the context of broader social processes which generate and perpetuate these and other axes of inequality.

In this section, I elaborate on the key contributions made by the thesis, in the context of existing literature. I use the research objectives set out in Chapter 3 as a broad structure whilst also seeking to highlight cross-cutting themes.

RO1: To examine whether and how the concept of 'inclusion health' is reflected in policy discourses on health inequalities in the UK, through analysis of flagship policy reviews

The discourse analysis described in Chapter 4 is one of the few efforts to date at a critical examination of the meanings and uses of 'inclusion health'. Existing analyses of how health inequalities are represented in policy have largely focused on socioeconomic inequalities (e.g., Fisher et al., 2016, Smith et al., 2009, Graham, 2004, Vallgårda, 2010, Vallgårda, 2008), whilst those examining inclusion and exclusion have not had health as their primary focus (e.g., Levitas, 2006, Welshman, 2013, Madanipour et al., 2015). To date, these traditions have remained largely distinct – exceptions have been largely limited to commentaries (for instance, by Labonte, 2004, Carlisle, 2001, Vallgårda, 2010). By bringing together these strands of work in an empirical analysis using transparent and rigorous methods, Chapter 4 contributes to ongoing discussions about the appropriate scope, methods, and goals of inclusion health and of broader health inequalities practice and research.

Chapter 4 also supports the other empirical work in this thesis, in two key ways. First, it provides an insight into the policy landscape into which their findings are likely to be received and assimilated: one in which ‘inclusion health’ concerns are evident but conceptually under-developed and with limited recognition of intersecting inequalities. Second, its findings on the conceptual underpinnings – and often shortcomings – of this field have informed the discussion of the thesis’s limitations, especially in relation to how experiences were operationalised in the systematic review and cohort study. I elaborate on this further in subsequent sections of the discussion.

RO2: To synthesise existing evidence from high-income countries on the association between lifetime exposure to more than one of the following: homelessness, imprisonment, substance use, sex work, or severe mental illness, and the following outcomes: all-cause and cause-specific mortality, morbidity, and self-rated health or quality of life

The systematic review (Chapter 5) synthesised for the first time evidence on health outcomes associated with these experiences in combination, providing an overview of the research landscape to date. This extends the findings of a previous review examining morbidity and mortality associated with each of these experiences in isolation (Aldridge et al., 2018). Given that – as Chapter 6 went on to demonstrate for the Glasgow City area – their co-occurrence is not uncommon, this synthesis represents a useful contribution to the existing literature.

The review identified a lack of longitudinal studies from the UK; those including combinations of more than two exposures; and those examining outcomes other than infections, external causes, and mental ill-health. These are gaps which I sought to address through creation and analysis of the linked cohort described in Chapters 6 and 7.

RO3: To use cross-sectoral administrative record linkage using datasets from healthcare services, local government, and the prison system, to create a novel cohort containing information on exposure to homelessness, justice involvement, opioid dependence, and/or psychosis among residents of Glasgow City

Chapter 6 has demonstrated the feasibility and value of linking multiple administrative datasets from health and non-health sources to investigate questions of relevance to healthy public policy and public health practice. It builds on existing precedents for the use of administrative data to identify cohorts of people affected by the experiences of interest – as set out in Table 1 in Section 6.1. Few studies have sought to combine such datasets to investigate overlapping experiences, particularly from the starting point of a large population sample. This cohort represents the first occasion on which the component datasets have been linked together, and for the CJSWR, the first known use for record linkage or health research.

However, the linkage process was time-consuming and challenging, and has highlighted a number of weaknesses in the current system for data sharing and linkage in Scotland. These difficulties are not unique to Scotland and have been documented in several case studies from elsewhere in the UK and internationally (Mourby et al., 2019, Lugg-Widger et al., 2018, Jones et al., 2019a, Jones et al., 2019b, Haneef et al., 2020, van Panhuis et al., 2014). This wider literature suggests that the greatest barriers are encountered in research involving multiple organisations and geographies; linkage between health and non-health data; and datasets which do not share a common set of unique identifiers – all of which were features of this project. The implications of these challenges, and potential solutions, are described in more detail below, in Section 9.4.

RO4: To use the cohort created in RO3 to characterise the prevalence of different combinations of these experiences, and their demographic associations

In substantive terms, the study described in Chapter 6 is one of relatively few studies attempting to quantify the overlap between the exposures of interest in a general population sample, and appears to be the first to do so using individual-level (rather than aggregate) data. As argued in Section 2.5.1, a population perspective on their intersections is likely to be especially valuable for planning holistic policy responses in which resources and collaboration can be targeted towards the experiences most likely to co-occur and the services best placed to provide support.

The broad findings of Chapter 6 coincide with those from individual surveys in the UK and Scottish context suggesting significant overlap between opioid dependence, justice involvement, and homelessness – including the NESI survey of people using injecting equipment provision; the Scottish Prisoner Survey; and the Addiction Prevalence Testing programme in Scottish prisons (Health Protection Scotland, 2019, Scottish Public Health Observatory, 2021). Despite different methods, the findings reported here are also similar to those from the Hard Edges project with respect to intersections and demographics (Bramley et al., 2019b).

In contrast, the relationship between severe mental illness and the other experiences of interest is less-well studied in the UK context. For instance, in their systematic review of psychosis among people with homelessness, Ayano et al. (2019) identified only three studies from the UK, all conducted prior to 2000 and with samples of less than 200 people. The observation that, in the Glasgow City cohort, psychotic disorder showed relatively little overlap with the other experiences and had a somewhat distinct demographic profile, is interesting given that prevalence studies from other countries have typically found much higher degrees of overlap with imprisonment and homelessness (Baillargeon et al., 2009, Fazel and Seewald, 2012, Ayano et al., 2019). In contrast, the co-occurrence observed in our study between psychosis and opioid dependence appears to be consistent with international estimates (Hunt et al., 2018, Danilewitz and Bahji, 2021). Stakeholder feedback suggests this may reflect some degree of success of UK models of care in buffering potential adverse social consequences among people with severe mental illness, though this is speculative and does not account for the finding from this study and others that vulnerability to co-occurring opioid dependence is not similarly mitigated (Carrà et al., 2012, Hunt et al., 2018). As suggested in the next section, further work to understand mechanisms of co-occurrence and individual trajectories of disadvantage would be beneficial here.

It is notable that the extent of existing evidence about health outcomes observed in the systematic review did not clearly align with the relative frequency of different exposure combinations observed in the cohort analysis. For instance, homelessness and imprisonment combined was the most prevalent of the multiple exposures observed in the Glasgow City cohort, yet accounted for only 3% of data points within the review (n=48/1,480) and none of those relating to NCDs. Similarly, for the most common combination of three exposures in the Glasgow cohort (homelessness, opioid dependence, and imprisonment), only seven data points were identified in the review (0.5% of the total, n=7/1,480), and these were restricted to all-cause mortality, infections, and external causes.

For local and national decision-makers seeking to understand potential health implications of the patterns of co-occurrence observed in Chapter 6, the existing literature is therefore lacking. This highlights the potential contribution to be made by a longitudinal analysis of health outcomes among the cohort, to which we now turn.

RO5: To build on cohort creation and description (RO3 & 4) to address a key evidence gap identified in the systematic review (RO2): the association between different combinations of experiences and premature mortality, including mortality from avoidable causes and non-communicable diseases

Chapter 7 provides one of the few examples of a longitudinal study using a large population-based sample to investigate health outcomes among people at the intersections of homelessness, justice involvement, opioid dependence, and psychosis.

As described above, comparison between the systematic review (Chapter 5) and the characterisation of the Glasgow City cohort (Chapter 6) suggested a potential mismatch between patterns of co-occurrence of these experiences and those combinations best represented in health research to date. By examining a range of exposure combinations and outcomes, Chapter 7 helps address this limitation in the existing evidence base.

In the systematic review, and updated searches since, only one study investigating avoidable mortality among people with any combination of the experiences of interest could be identified (Lumme et al., 2016). That study examined the intersection of severe mental illness and substance use, which was among the less frequent combinations observed in the Glasgow City cohort (Chapter 6). The extent to which excess mortality associated with the co-occurrence of the experiences of interest can be averted through the efforts of healthcare and public health is therefore an important outstanding question within existing literature.

The analysis described in Chapter 7 was able to address this question by investigating avoidable mortality across all the experiences of interest and their intersections. In finding a substantially higher rate and proportion of avoidable deaths among people with multiple versus single disadvantages, and single versus none, the cohort analysis has substantiated and extended previous studies suggesting high rates of avoidable mortality associated with each of these experiences in isolation (as described in Section 2.4.7). The extent of avoidable mortality associated with these experiences has highlighted the scope for action through existing public health and healthcare interventions, as discussed below under ‘Implications for policy and practice’.

The high burden of NCD mortality among people with any exposure of interest observed in Chapter 7 is particularly striking given the relative neglect of NCDs in research and services for these populations to date (Chapter 5 and Aldridge et al., 2018). The systematic review identified only 18 studies internationally examining morbidity and mortality from NCDs among people with more than one of the experiences of interest: of these, 11 focused on just one set of exposures (severe mental illness plus substance use), and only one was conducted in the UK. By investigating NCD mortality across a range of exposure combinations in a population-based cohort from the UK, Chapter 7 therefore represents an important contribution to an under-developed evidence base. Together these findings suggest that research priorities to date in this field have not been commensurate with disease burden, which may in turn have skewed the delivery of services away from what is in fact a key area of need.

While a higher burden of NCDs among people with any one of the experiences of interest appears to be a consistent finding, both the cohort analysis and systematic review were less clear-cut as to the additional NCD burden associated with multiple versus single forms of disadvantage. The meta-analyses carried out as part of the systematic review suggested higher mortality for those with multiple exposures across most outcome measures but drew on only three studies, all comparing the additional risk of NCD mortality associated with substance use among people with severe mental illness (Supplementary material accompanying Chapter 6). Pooled results for prevalence generally found no significant association with multiple compared to single exposures but also drew on a very limited number of studies. In the cohort analysis (Chapter 7), point estimates for adjusted hazard ratios were higher among those with multiple versus single exposures across all combinations studied but some showed overlapping confidence intervals and/or minimal difference between point estimates (0Supplementary material accompanying Chapter 7). There are a number of potential explanations for these results, including a genuine lack of difference in NCD burden between those with multiple versus single exposures; the impact of competing risks from other causes of death; and/or insufficient statistical power within the cohort. Further work to quantify NCD burden (including disentangling measures of occurrence from those of survival) and explore potential mechanisms among people with multiple versus single exposures will be required to resolve these uncertainties.

RO6: To use administrative data on medication dispensing to evaluate the health impacts of a comprehensive national smoke-free prisons policy in Scotland, as part of the Tobacco In Prisons study (TIPs)

The evaluation of smoke-free prisons (Chapter 8) has extended the very limited evidence to date on the health impacts of smoke-free prison policies, including their potential unintended consequences. This addresses a key gap in international tobacco control literature as identified by a Cochrane review of the field (Frazer et al., 2016b). It also adds to relatively few studies evaluating the effectiveness of interventions to prevent ill-health – and in particular NCDs – among people experiencing imprisonment and other forms of disadvantage relevant to this thesis (Luchenski et al., 2018, Kinner and Young, 2018). The value of this contribution is underlined by findings elsewhere in the thesis on the extent of tobacco smoking among people with a history of imprisonment (Section 2.4.7) and the associated burden of NCDs (Chapter 5 and Chapter 7).

In evaluating an intervention specific to prisons, Chapter 8 contributes to the broader literature on settings-based approaches, which seek to promote health through the organisations and environments in which everyday life takes place (Whitelaw et al., 2001, Dooris, 2009). Prisons have traditionally been an important focus for settings-based health promotion, though such efforts have been critiqued for taking individualistic approaches which may be ineffective and/or exacerbate inequalities (Woodall, 2016). Smoke-free prisons as implemented in Scotland may avoid these pitfalls, sharing as it does a number of characteristics with policies tending to reduce health inequalities (Macintyre, 2007). For instance, it targeted a disadvantaged group but was implemented universally within that group, avoiding the need for discretionary action; it focused on regulation of a health-damaging commodity; and it was accompanied by intensive support in the form of extensive provision for smoking cessation/abstinence (Hunt, 2021). However, the broader literature is inconclusive on the equity impacts of smoke-free environments (Hill et al., 2014) and our study was unable to account for potential differential impacts within the prison population, for instance according to sentence length or mental health status. These will be important areas for future work, as acknowledged in Section 9.3.

From a methodological perspective, Chapter 8 has demonstrated the feasibility and value of using medication dispensing to evaluate the health impacts of smoke-free policies, as part of my overarching focus on the use of administrative data in research to inform healthy public policy. This analysis provides an example of how administrative data can support robust evaluations of large-scale policy changes using natural experimental methods, grounded in causal inference. The ease and speed with which data were obtained for the evaluation described in Chapter 8 stands in stark contrast to the challenges encountered in the cohort study described in Chapter 6, illustrating the disparity between the processes and infrastructure to support the research use of routine data from a single NHS source versus routine data from multiple health and non-health sources requiring individual-level linkage. This is a theme to which I return in Section 9.3.

9.2 Strengths and limitations

As the strengths and limitations of each individual analysis have been considered in their respective articles, this section seeks instead to consider the strengths and limitations of the thesis as a unified body of work.

Among the strengths of this thesis is the multi-method approach, which has explored the overall topic from different angles and using different techniques. As the summary above has demonstrated, I was able to compare findings across the different chapters where the research questions overlapped (e.g. the systematic review and cohort study); use the findings from one methodological approach to provide greater nuance and context to another (through the discourse analysis and the quantitative analyses); and extend the use of administrative data from descriptive epidemiology into policy evaluation (as in the Tobacco in Prisons Study analysis). Though the diversity of methods used was an unintended consequence of the difficulties encountered with cohort construction, it has made for a richer experience than the project as originally planned and enabled the thesis to take a broader perspective on the field of study.

The combined outputs from the project benefit from strong policy relevance and timeliness, given continued interest in the issue of severe and multiple disadvantage in Scotland and beyond, and evidence of ongoing challenges in this area. For instance, rates of drug-related death in Scotland have continued to rise and are now among the highest recorded in the world, prompting significant policy interest in improving the health of people with opioid dependence and addressing co-occurring forms of disadvantage (National Records of Scotland, 2021a). I have been able to share insights from this work with the Scottish Drug Deaths Taskforce, through membership of subgroups on multiple and complex needs and on drug-related harms among women. The work on non-communicable disease burden associated with these experiences is especially pertinent, given that NCDs have been identified as an important potential contributor to drug-related death risk (Advisory Council on the Misuse of Drugs, 2016).

The project's focus on administrative data is a particular strength in this regard, given their real-world relevance; ability to capture interactions with services; and potential to support pragmatic policy evaluation. Greater use of administrative data has been previously highlighted as a means of ensuring that the social determinants of health receive the policy attention they deserve, as well as identifying opportunities for targeted prevention and care (Taylor-Robinson and Kee, 2018). In the case of the cohort study, the availability of detailed descriptive epidemiology on the characteristics and outcomes of people in contact with homeless services, the justice system, drug treatment, and mental healthcare provides an insight on opportunities to intervene with a population at very high risk of poor outcomes. The findings relating to non-communicable diseases are a good example of this, highlighting an apparent substantial unmet need for prevention and treatment across these settings which has been poorly documented in the literature to date.

One potential weakness is the geographical restriction of the cohort study to the Glasgow City area, after the national study originally planned fell through (see Section 6.1). This may limit the transferability of findings from the cohort study to other locations, especially since Glasgow has the highest concentration of deprivation in Scotland and, along with other areas in West Central Scotland, a much-publicised phenomenon of excess mortality relating to historic experiences of deindustrialisation, deprivation, and urban planning (Walsh et al., 2016). However, this localised approach also has benefits. The argument has been made elsewhere in this thesis that the experiences of interest are highly context-dependent. Some of these contextual processes – such as housing markets or access to care for mental health or drug problems – may operate at local and regional levels, meaning that estimates from these geographical areas are valuable. For instance, Scotland’s 32 local authorities – of which Glasgow City is the largest by population – are responsible for homelessness provision; for criminal justice social work services; and for collaborating with health boards as part of Alcohol and Drug Partnerships in work to prevent and treat problem substance use. They are therefore a worthwhile geography in which to quantify intersections and interactions between these experiences.

Other limitations in the nature and availability of the available data mean that results of the cohort study and systematic review should be understood as associations with the experiences of interest, rather than causal effects. This limits the potential to speculate about the impact of preventing these experiences or their co-occurrence in the first place.

Causal inference in this context is challenging for several reasons. First, the experiences of interest are closely associated with other factors which themselves are independently associated with health and which may therefore confound the observed relationships. These factors include socioeconomic position across the lifecourse (with poverty in childhood appearing to be especially influential) and other forms of adversity such as childhood trauma (Bramley and Fitzpatrick, 2018, Houchin, 2005, Bramley et al., 2019b, Liu et al., 2021, Kirkbride et al., 2012). Second, there is the potential for reverse causality, with poor health potentially increasing an individual’s subsequent risk of some of the experiences of interest: for instance, Waugh et al’s analysis of linked homelessness data in Scotland suggested that statutory homelessness interactions are frequently preceded by a period of increased healthcare utilisation (Waugh et al., 2018). Finally, the limitations of existing administrative datasets – in terms of variables collected and/or the time periods available – mean that such datasets do not lend themselves to the application of many epidemiological methods for exploring causality, such as inverse probability weighting (Hernán and Robins, 2020). Those datasets that do contain these richer data – such as traditional cohort studies or household surveys – are often limited in other ways which may hinder causal inference, especially biases arising from issues with recruitment and retention (e.g., Gorman et al., 2014).

However, the descriptive work reported in this thesis is still of value, for several reasons.

First, there is good reason to believe that these experiences do exert some causal influence on health – for instance, from qualitative research describing potential pathways and mechanisms (as summarised in Section 2.4.6) and from interventional studies aiming to modify exposure, such as randomised controlled trials of permanent supported housing initiatives (Onapa et al., 2021). Moreover, the degree of confounding would have to be substantial to entirely account for the magnitude of effect estimates observed in this and other studies.

Second, such associations still describe groups at higher risk, whether or not the experience of interest is directly responsible: this provides opportunities for intervening on those risks through services and policies. One example might be the targeted delivery of NCD prevention and treatment in settings such as homeless accommodation and healthcare services; prisons and community justice settings; drug treatment services; and psychiatric care.

Third, documenting inequalities is an important first step to remediating them, and as described in Section 9.1, this work has contributed to this effort. As the natural experiment described in Chapter 8 demonstrates, timely access to high quality and well-characterised administrative datasets can facilitate the use of study designs and statistical techniques better able to support causal inference. Where an intervention modifies the exposure of interest in some way (imagine, for instance, a policy that reduces the number of people exposed to imprisonment or shortens the average duration of homelessness episodes), evaluation may not only tell us about the effectiveness of that intervention but also allow causal inferences to be made about the relationship between the target exposure and health. It is hoped that the findings presented here can be used to demonstrate the value of cross-sectoral administrative linkage and advocate for measures that facilitate research of this kind in future.

In this project, whilst the focus on multiple exposures was key to its novel contribution, it did limit the potential for exploring their nuances in as much detail as might be ideal. As a result, the relatively crude categorisation of exposures used in the systematic review and cohort study may imply an unfounded homogeneity of experience among those affected, resulting in an over-estimation of risk for some individuals or outcomes, and an under-estimation for others. There may also be a risk of contributing to the stigma associated with these experiences: I was especially conscious of this in the cohort analysis, which operationalised exposures as cumulative and therefore ‘irreversible’ markers of disadvantage rather than dynamic processes from which people may emerge and recover. While reflecting the pragmatic daily compromises of research, these are important limitations which reproduce those seen in much of the existing research and policy discourse on this topic, as highlighted in the literature review (Chapter 2) and discourse analysis (Chapter 4). Throughout the thesis and associated articles, I have aimed to frame the findings in a way that acknowledges these limitations, whilst still recognising the value in raising the profile and understanding of co-occurring experiences – particularly where needs are not currently being met.

On a related note, the focus on the experiences of interest as indicators of social exclusion, and their association with health outcomes, might divert attention from underlying societal drivers of these experiences such as income and wealth distribution; housing and labour markets; and discrimination. This carries the risk that policy and practice responses are oriented towards ‘downstream’ interventions aiming to mitigate poor outcomes among people with these experiences rather than preventing their occurrence in the first instance. Similar concerns have been raised about the ways in which adverse childhood experiences have been understood and operationalised in policy and practice (Walsh et al., 2019, Walsh, 2020). There is an analogy here with Rose’s work on prevention, and the relative merits of targeting high-risk individuals versus shifting the distribution of risk within the population (Rose, 1985), though there is arguably an even greater imperative to prevent the occurrence of difficult and distressing life experiences such as homelessness or justice involvement than there is for asymptomatic hypertension or hypercholesterolaemia. Evidence from other sectors and the health inequalities literature more broadly suggests that effective response is likely to require both prevention and mitigation, combining both population-wide and individual-level approaches (NHS Health Scotland, 2016, Olstad and McIntyre, 2019).

As highlighted in the discourse analysis (Chapter 4) and discussed in the next section, future research which defines these experiences not as static categories but on the basis of differential exposure to dynamic social processes may go some way towards addressing these concerns about unmeasured heterogeneity, inadvertent stigmatisation, and ‘downstream drift’.

As a final theme, it is worth reflecting here on some of the broader challenges arising from the use of administrative data in the final three empirical papers of the thesis, in keeping with the thesis’s secondary aim to investigate the potential contribution of such methods to this field.

Administrative data are by nature shaped by the way services are delivered: for instance, by the definitions used; thresholds or criteria for access; and those services’ view on the events considered worth recording. There is often a mismatch between what is captured in administrative data and people’s lived experience, as well as between administrative data and theoretical constructs we find useful in understanding the world, such as typologies of homelessness or substance use (Deeny and Steventon, 2015). Most people would define their health in much broader terms than the proxies that administrative data can provide: diagnosed conditions, healthcare interactions, and mortality. Such proxies are typically composite indicators reflecting the interaction of multiple different forces. For instance, healthcare episode data potentially conflate felt and expressed need with service availability and access.

There is also a risk that in claiming to record ‘objective’ outcomes through administrative data, we overlook the ways in which disease categories are socially constructed and the diagnostic process influenced by *a priori* assumptions. For instance, clinician’s awareness of an individual’s status in relation to the exposures of interest may affect diagnostic labels used to code deaths (Davey Smith et al., 1994), affecting the estimation of relative inequalities and potentially reinforcing stigma.

Similarly, it is important to recognise how data availability and utilisation may shape our worldview and ways of knowing.

On the one hand, greater availability and utilisation of data from non-health sources may have the advantage of making the wider determinants of health more ‘visible’ and enabling a research agenda better able to inform healthy public policy. This may be particularly pertinent for the experiences of interest in this thesis: as Mathieson et al put it, “the availability of data, or the lack thereof, can in itself be ‘exclusionary’, and people experiencing exclusionary processes wherever they live around the world – the stateless and displaced, marginalised indigenous people, and those living in extreme poverty – are often the least likely to be counted or included in research” (p. 9, Mathieson et al., 2008). This is part of a broader phenomenon in which disadvantaged populations are less likely to participate in – and benefit from – health research, resulting in an evidence base which is poorly generalisable and individualistic in focus (Rogers, 2004, Bonevski et al., 2014).

In this thesis, this potential exclusionary effect was particularly evident for sex work. In keeping with the previous review looking at each experience in isolation, the systematic review found that evidence on health outcomes was especially limited for combinations involving sex work Chapter 5, in particular Figure 4; and

Aldridge et al. (2018)). Unfortunately, the cohort analysis was unable to redress this gap due to the absence of administrative data on sex work. Though the stigmatised, criminalised, and hidden nature of experiences like sex work can make data collection challenging, successful models – for instance, for rough sleeping – do exist which might enable a more informed approach to policy-making and service provision (Russell and Thomas, 2018).

On the other hand, a reliance on using administrative data carries risks that what is measured (or measurable) is what comes to matter, and that what cannot be measured disappears from view. For instance, poor availability and quality of administrative data on healthcare activity outside hospitals in Scotland may contribute to a disproportionate focus on secondary care in political and organisational priorities.

Relying on administrative data can miss individuals not engaged with services, who might be most at risk of poor outcomes. Important potential biases can also be introduced through the linkage process, if there is differential error in correctly identifying records common to multiple datasets: such biases can be difficult to detect and quantify (Harron et al., 2017a, Harron et al., 2017b). In this study, we were only able to obtain fairly basic data with which to assess linkage success (compared to reporting recommendations such as GUILD; Gilbert et al., 2018), which partly reflects limited experience and familiarity among linkage providers with administrative datasets from non-health sources. For records which could not be matched to a unique health identifier, we were also unable to distinguish between potential explanations with different implications for bias – such as migration or missing/poor quality data. In future, it is hoped that these issues may be addressed by standardised approaches to the assessment and reporting of linkage success across providers; more sophisticated probabilistic algorithms for matching; prospective rather than retrospective linkages; and the use of sensitivity analyses based on different linkage thresholds.

The use of administrative data should therefore be complemented with rigorous conceptual work, qualitative research, and stakeholder engagement in order to understand the broader context in which the data are generated, and should be accompanied by critical reflection on their value and limitations.

9.3 Implications for research

The work described here has identified several potential directions for future research.

The discourse analysis (Chapter 4) identified the need for more detailed work on the conceptual basis of ‘inclusion health’ and its integration with existing theory on health inequalities. This chapter highlighted the potential for future research examining underlying processes of exclusion and disadvantage, rather than static categories. This is an area where greater availability of and access to longitudinal administrative data from across different policy sectors may be particularly valuable. For instance, administrative data offer the potential to monitor individual-level socioeconomic, educational, labour market, and social security exposures over time in a much more detailed and dynamic way than feasible through repeated cross-sectional surveys or a cohort study involving active follow-up (e.g., Pattaro et al., 2020). As my experience suggests, however, this can be challenging in practice: I reflect in more detail below about possible solutions.

The systematic review (Chapter 5) provided an overview of the existing landscape of research in this field, including important gaps and potential biases in how the evidence has evolved to date. In particular, this chapter highlighted a need for future research funding and activity to better reflect the relative prevalence and health burden of different combinations of experiences: for instance, by prioritising combinations of experiences which are most common or associated with the poorest outcomes.

Challenges encountered during systematic review also highlighted several potential areas for methodological development within the field more broadly, as shown in Table 8.

Table 8. Challenges encountered during systematic review and associated suggestions for methodological development

Challenge	Potential methodological developments
Identifying multiple exposures when searching bibliographic databases whilst achieving the appropriate balance of sensitivity and specificity	Alternative searching practices, including application of text-mining and machine learning (Marshall and Wallace, 2019)
Lack of tools for quality assessment of observational studies of exposures, rather than interventions – especially for cross-sectional studies	Adaptation and further validation of existing theoretically-informed tools such as ROBINS-I (Sterne et al., 2016). Work on such a tool for exposures – ROBINS-E – is underway (Bristol, 2021).
Labour-intensive process for manual production of effect direction plots	Development of tailored R package may be beneficial, especially in light of recent methodological developments supporting use of such plots (Boon and Thomson, 2021).

The creation and characterisation of the cohort described in Chapter 6 and Chapter 7 offers multiple opportunities for future work.

First, there is scope to apply more sophisticated approaches to exposure measurement than feasible in this work, particularly in relation to their timing and sequencing, and the recognition of heterogeneity of experiences (such as rough sleeping versus housing insecurity, or different types of community supervision and sentencing for those passing through the justice system).

Stakeholders (including people with lived experience) attending knowledge exchange events for the project were particularly interested in opportunities to investigate trajectories of social and health disadvantage throughout the lifecourse and to operationalise them as dynamic and cumulative processes in a way that existing cross-sectional and short-term longitudinal studies (including this one) have been unable to. The accumulation of a range of administrative datasets in Scotland relevant to early life experiences, from health and non-health data sources, should make this increasingly feasible in future. Given the paucity of evidence on the health of people in contact with community justice services highlighted in Section 2.4.7, the opportunities offered by further applications of the CJSWR dataset in this regard are especially exciting.

Second, it would be valuable to explore a broader range of outcomes, including those relating to primary and secondary care utilisation and costs. For instance, it would be particularly interesting to combine the methods used here with those recently developed by colleagues to quantify missed appointments in general practice and hospital settings as a means of understanding patterns of engagement with healthcare (McQueenie et al., 2019). Findings on avoidable and NCD mortality also raise further questions, primarily the relative contribution of incidence versus case-fatality and of specific conditions within these composite measures.

Third, and is especially promising, is the prospect of using these datasets and methods to support the evaluation of policy and service changes in Scotland – such as Minimum Unit Pricing of alcohol, a forthcoming homelessness prevention duty for public bodies, or shifts from custodial to community sentences – for their impacts on health among people with these experiences.

However, it is important to note that the realisation of the opportunities for future research described above depends to a great extent on improvements in the infrastructure, governance processes, and technical capacity for data sharing and linkage in the UK. Despite significant investment in this field in recent years – for instance through the creation of the Administrative Data Research Network and Centres – and policy rhetoric about its importance, there remain major challenges for anyone wishing to undertake research using administrative data, especially if seeking to link data across sectors.

Delays in access to data are especially challenging for researchers seeking to produce timely research that responds to the needs of decision-makers. This was a key limitation identified by our stakeholder advisory group, given major policy changes taking place in the interim. For instance, a wholesale shift towards rapid rehousing for homelessness in Scotland means that the experience of homelessness is likely to have changed markedly since the period for which data were available. This becomes even more pertinent when seeking to undertake evaluations, where the success of the research often depends on the ability to respond rapidly to a change in policy context.

Table 9 identifies key lessons from this project with regard to infrastructure, funding, and governance for administrative data research. I have drawn on these reflections in contributing to a number of policy consultations, including institutional responses to the Goldacre Review of health data and the Economic and Social Research Council's consultation on research data infrastructure (MRC/CSO Social and Public Health Sciences Unit, 2021a, MRC/CSO Social and Public Health Sciences Unit, 2021b). The lessons identified in this thesis also provided the foundation for another project I am currently co-leading as part of the National Institute for Health Research's funding call on 'Unlocking data to inform public health policy and practice', which seeks to understand the perspectives of evidence users working across the public sector on cross-sectoral data sharing and linkage (National Institute for Health Research, 2021).

These lessons are especially relevant in the context of the COVID-19 pandemic, which has given new impetus to data sharing efforts (as well as amplifying existing challenges): a recent study of Scottish local authorities found growing demand for cross-sectoral data sharing, particularly between health and other sectors (Gangneux and Joss, 2021).

Table 9. Key lessons from this project for administrative data research infrastructure, funding, and governance. Content in this table is adapted from the Institute of Health and Wellbeing's response to the Goldacre Review, which I drafted with feedback from colleagues.

Reflection	Recommendation
Effective research on the health of the public demands that we look beyond the healthcare system in isolation, but at present, limitations in the infrastructure, funding, governance, experience, and norms surrounding the use of data from non-health sources make this extremely challenging. Examples of success are few and efforts are piecemeal and uncoordinated.	A strategic approach to data acquisition and curation, that reflects priority areas for research and evaluation and recognises datasets as assets to research, development, and innovation.
Barriers are primarily procedural, institutional, and cultural, rather than technical. Technical enablers such as analytical platforms and trusted research environments are often well-established and often work relatively smoothly in comparison to other elements of the system.	Greater political and organisational recognition and support for the value of administrative data in research and evaluation, as well as the procedural improvements described below
The data infrastructure is fragmented, with variation in data availability; governance processes; and conditions for access between different parts of the system. This hinders population-scale research and comparisons across different geographies, and can result in methodological limitations – as in this project, where deaths data were only available at the regional rather than Scotland-wide or UK-wide level.	Greater joint working within and across UK nations to ensure consistent and comparable data, and integration of datasets.

Reflection	Recommendation
At present, governance processes are frequently lengthy, opaque, and difficult to navigate. This results in delays and duplications, and is not proportionate to – or necessarily effective in mitigating – the risks involved. Such challenges are amplified when seeking to undertake cross-sectoral, multidisciplinary, and/or responsive research, despite the added value of these approaches. The knock-on impacts of such delays include: • Projects being abandoned or modified to the detriment of their scope and methodological quality; • The persistence of gaps in our evidence base, particularly around influences on health beyond the healthcare system; • Missed opportunities for timely and responsive work; • Work of this kind being perceived as high-risk by funders, and therefore less likely to be successful in gaining support; and • Negative consequences for individual professional development and career progression.	Potentially productive approaches to addressing these issues include: • Closer integration between approvals processes relating to importance and quality of the research (e.g., peer review for funding, publication) and those relating to research conduct and minimising potential risks and harms (e.g., review for ethics and information governance), in a way that balances appropriate scrutiny with efficient and timely responses; • Clarity on governance processes and expected timelines, including clear guidance on ownership and accountability for decision-making at each step to avoid attrition by indecision or delay; • Broad membership of governance panels including research users, service users, and members of the public; • Structured and transparent processes for decision-making – such as published risk assessment matrices that can be used in planning projects and writing applications, as well as accessed by the public; and

Reflection	**Recommendation**
	- Rapid, low-threshold access to low-risk datasets (e.g., aggregate or synthetic data) can be used to scope research ideas and undertake preparatory work.
The ‘use and destroy model’ currently the norm within Scotland, in which datasets linked for one project cannot be reused for another, is an inefficient use of the resources involved in extracting, cleaning, and matching datasets and is a barrier to reproducible and responsive research. This was the reason I was unable to use national datasets as planned for this project, and had to scale back to Glasgow City alone.	Alternative models – in the form of ongoing secure relational databanks – are well-established and provide efficient and timely access to priority datasets, including cross-sectoral linkages, without compromising on information governance and security. The Welsh SAIL (Secure Anonymised information Linkage) databank is an excellent example.
There is a lack of specialist support for those seeking to use and link administrative data: whilst the role exists, demand typically outstrips capacity and postholders tend to be spread very thinly, resulting in individual (often junior) researchers having to navigate the system on an ad hoc basis – for instance in scoping datasets, identifying data controllers, and negotiating access and agreements. This is often inefficient, resulting in duplication of effort and a lack of institutional memory.	Investment, support and recognition for specialist roles in data management and access, including through long-term funding, clear career pathways, and appropriate academic recognition. These roles should act as a single point of access for researchers providing specialist support and advice on dataset availability; governance applications; negotiations with data controllers; and data transfer.

In developing this project, I also became conscious of the lack of published evidence on the perspectives of people with lived experience of these issues on cross-sectoral data sharing and linkage. This is important given that people with experiences of disadvantage and marginalisation may have lower levels of trust in public institutions and sources of authority; less real or perceived power over how their data is used; and greater reason for concern about stigma, inappropriate categorisation, and use of data for the purposes of enforcement or social control; all of which are factors known to affect perceived acceptability in the general population (Aitken et al., 2016, Sexton et al., 2017). These concerns are often well-founded given the history of previous research abuses in this field (for instance, of people in prison) as well as more recent controversies, such as data sharing initiatives between homelessness services and immigration enforcement in the UK, (Taylor, 2018, Kouyoumdjian, 2022).

Research to date on public attitudes to data sharing and linkage has tended to recruit general population samples or select on the basis of specific health conditions (Aitken et al., 2016). Other work has highlighted diverse and nuanced attitudes among people with the experiences of interest towards involvement in research more generally (Souleymanov et al., 2016), but data-intensive research is likely to have unique meanings and implications in terms of privacy, consent, research burden, and power relations.

The limited evidence examining acceptability among people affected by the experiences of interest to this thesis does however suggest substantial support for these methods. A participatory exercise conducted by Luchenski et al found that people affected by homelessness and other forms of social exclusion held generally positive views of linkage between sensitive health and social data for the purposes of research, and an expectation that this already happened as a matter of course (Luchenski et al., 2017). In the Vancouver At Home trial of Housing First, at least 87% of participants with homelessness and mental illness consented to their records being linked across healthcare, justice, and income assistance databases (Somers et al., 2016a).

These findings echo the views expressed at a public engagement workshop I convened prior to commencement of this study in collaboration with Glasgow Homeless Network, where the topic of administrative record linkage was discussed. People attending the workshop who had lived or living experience of the issues under study were positive about the potential of these methods and their use in both research and practice. For instance, they identified the potential of data linkage research to investigate the impacts of the welfare benefits system on health, as well as the potential of greater data sharing to enhance continuity of care between different services and minimise the burden associated with navigating systems of care. Their primary concerns related to the validity of ‘episode-based’ datasets in reflecting people’s lived experience of the issues of interest, an important limitation acknowledged above in Section 9.2. Although this informal public engagement is reassuring, there is a clear need for in-depth research on the views and involvement of people with lived experience of disadvantage and marginalisation in data-intensive research.

With regard to the findings of the Tobacco In Prisons study reported , the implications for research are two-fold. First, from a methodological perspective, this evaluation has demonstrated the feasibility and value of routinely collected data on medication dispensing as an indicator of health impacts, especially where such impacts may be subtle and therefore less likely to be detected from hospitalisation or mortality data. There may therefore be scope to use such data more widely in policy and service evaluation. Second, it has highlighted a need for longer-term data on the health impacts of prison smoke-free policies, including potential differential effects between subgroups of the prison population. One key area of uncertainty is the extent to which smoke-free prison policies can support sustained abstinence or cessation from smoking after release (Kinner and Young, 2018). This will be the focus of a follow-up TIPs study, in which I am involved.

9.4 Implications for policy and practice

In this section, I reflect on what the findings from the thesis mean for public health practice, relevant services, and healthy public policy. Although only one chapter of the thesis explicitly sought to draw conclusions about what works to improve health and reduce inequalities among people affected by the experiences of interest, it is possible to draw on the findings of the other chapters and the wider literature to identify potential practical implications. I focus first on opportunities for prevention, understood in the broadest sense, before moving on to highlight principles that could inform the design and delivery of services and policies, with a particular focus on the role of joint working and the routine use of administrative data. I conclude with some reflections on the ways the thesis might inform broader understandings of the experience of interest, drawing on the research utilisation literature.

The findings on the overlap between these experiences suggests that across different services seeking to address each of these issues, many of the same people will be involved. While contact with multiple services appears to be a marker of risk for poor outcomes, it also offers multiple opportunities for intervention. In considering the possibilities for such interventions, the notion of primary, secondary, and tertiary prevention may be beneficial (Porta, 2016): Table 10 uses findings from the thesis to identify potential examples of activities at each level. These are highlighted as examples based on specific findings from the thesis, but the scope for preventative activity at each level is clearly much broader.

Table 10. Examples of primary, secondary, and tertiary prevention interventions that could be delivered by services in contact with people affected by the experiences of interest

Level of intervention	Example	Rationale	Potential interventions supported by wider literature
Primary			
Averting the experiences of interest and their co-occurrence	Prevention of homelessness among people leaving prison	Homelessness & imprisonment was the most common combination of experiences in the Glasgow City cohort, with 33% of those with a custodial episode also having been assessed as homeless during the study period (see Supplementary material accompanying Chapter 6). Across Scotland as a whole, 6% of those assessed as homeless report leaving an institution such as a prison or hospital as the primary reason for homelessness, though it is suggested this may be an under-estimate (Scottish Government, 2020b).	• Timely housing assessments early in prison stays • Support for tenancy sustainment, e.g. using critical time interventions • Close collaboration between prison throughcare staff and local authority housing officers • Targeted initiatives for those on remand, given limited access to support services, uncertain lengths of stay, and unexpected release (Centre for Homelessness Impact & Campbell Collaboration, 2021, Dore, 2015, Scottish Prison Service, 2016b)

Level of intervention	Example	Rationale	Potential interventions supported by wider literature
Secondary Rapidly resolving the experiences of interest and their co-occurrence	Identification of people with problem drug use within criminal justice services with the goal of supporting their treatment and recovery	Combinations involving opioid dependence and justice involvement relatively common within Glasgow City cohort. These combinations were associated with high rates of all-cause mortality in both the systematic review and cohort analysis. The wider literature suggests that periods of imprisonment are a major risk factor for mortality among people who use opioids (Merrall et al., 2010, Gan et al., 2021), though the proportion of drug-related deaths in Scotland associated with recent release from prison has fallen in recent years (National Records of Scotland, 2021a).	• Expanding community-based diversion programmes which provide drug treatment and recovery support as an alternative to criminal sanctions or to the use of remand. Such programmes appear to be effective in reducing drug use and may also reduce further offending (Jones et al., 2016, Mitchell et al., 2012, Hayhurst et al., 2019) but are currently under-utilised in Scotland, with diversion tending to happen relatively late within the journey through the criminal justice system (Price et al., 2021, Scottish Parliament Justice Committee, 2018) • Optimising treatment for problem drug use during periods of imprisonment by implementation of national guidelines and equivalence of care with community services, particularly for those on remand where access to and continuity of care has been highlighted as a problem (Clinical Guidelines on Drug Misuse and Dependence Update 2017 Independent Expert Working Group, 2017, Scottish Parliament Justice Committee, 2018)

Level of intervention	Example	Rationale	Potential interventions supported by wider literature
Tertiary			
Mitigating the health impacts of the experiences of interest and their co-occurrence	Prevention and treatment of common NCDs in services for people with these experiences, as part of settings-based approaches	The cohort study demonstrated a high burden of NCD mortality among people in contact with services for the experiences of interest, with an apparent higher burden for those with multiple versus single experiences of disadvantage. This is largely consistent with findings from the systematic review.	There is a lack of evidence on tailored interventions for NCDs for people affected by the experiences of interest (Al-Shakarchi et al., 2020, Hanlon et al., 2018). However, this can be bridged in the short-term by integrating existing evidence on NCD prevention and treatment with established approaches to supporting people experiencing marginalisation and disadvantage (Luchenski et al., 2018, Bennett et al., 2020, Varghese et al., 2019, Magwood et al., 2020), such as: • Assertive outreach • Case management • Peer support • Trauma-informed care • Multi-component interventions • Enhancing access to high quality primary care The findings of Chapter 8 are also relevant here as an example of a settings-based approach to NCD prevention.

Existing evidence also points to a range of opportunities to prevent these experiences and their co-occurrence even before people come into contact with services, by population-wide efforts to address underlying drivers such as poverty (especially in childhood), other forms of childhood adversity, disrupted schooling, lack of secure high-quality employment opportunities, unaffordable or poor quality housing, and discrimination (Bramley et al., 2019b, Fitzpatrick et al., 2013, Harland et al., 2021, Hughes et al., 2017, Advisory Council on the Misuse of Drugs, 2018, Advisory Council on the Misuse of Drugs, 2015). As highlighted in Chapter 4, such efforts – which might be termed primordial prevention – may help resolve apparent tensions between different approaches to health inequalities, by addressing structural forces common to multiple axes of inequality (Hill, 2015).

Efforts towards prevention and early intervention appear to be most impactful when targeted at critical transitions, such as leaving the family home or the care system; entering the labour market; exiting institutional settings such as hospitals or military service; or experiences of bereavement or relationship breakdown (McCarthy et al., 2020).

To argue for such preventative activity should not be mistaken for a strong claim about causality between the specific experiences of interest and the health inequalities observed here, but instead reflects that preventing experiences of social disadvantage and marginalisation is a generally worthwhile goal independent of any benefit for health.

Service and policy responses must also reflect the finding that a substantial proportion of people in the Glasgow cohort experienced only one form of disadvantage yet were also at high risk of premature mortality, albeit to a somewhat lesser extent than their multiply-disadvantaged peers. The principle of proportionate universalism, in which responses to health inequalities are accessible to all but include higher intensity or additional interventions for those experiencing the greatest need, may be valuable in this respect (Carey et al., 2015). Recent Scottish homelessness policy developments provide a useful example of how proportionate universalism can be implemented, with universal provision (rapid rehousing for all households experiencing homelessness) complemented by more intensive specialist services at a smaller scale (Housing First for people experiencing multiple disadvantage) (Scottish Government, 2020a).

Such interventions should be guided by the wider literature about factors which promote uptake and engagement among people affected by the experiences of interest, including multi-component interventions, co-ordination and continuity of care, psychologically-informed practice, assertive outreach, peer support, and involvement and empowerment of service users (Luchenski et al., 2018, Centre for Homelessness Impact & Campbell Collaboration, 2021, Magwood et al., 2020).

One particularly central theme in this literature, which was also highlighted as part of public engagement for this project, is the question of joint working and the co-ordination of policy and services (Bramley et al., 2019b, Perry et al., 2020, McCarthy et al., 2020). The requirement for people experiencing 'multi-adversity' to interface with several services with distinct remits appears to create a treatment burden analogous to that described by people with multi-morbidity and has been identified as a barrier to delivering effective and acceptable care (Rosbach and Andersen, 2017, Balda, 2016, Rosengard et al., 2007). In their systematic review of effective interventions for 'inclusion health populations', Luchenski et al concluded that effective interventions tended to be multi-faceted in nature with some degree of co-ordination at the individual level (e.g., through navigator roles) or integration of services (Luchenski et al., 2018). At a policy level, there are also frequent calls for greater cross-sectoral co-ordination and coherence, most notably in the realm of criminal justice and drug policy (e.g., Csete and Wolfe, 2017).

However, as identified in the discourse analysis, 'joint working' can easily become a buzzword, perceived as inherently positive whilst being understood very differently by different sectors and services and potentially very difficult to realise in practice (Chapter 4; Chircop et al., 2015). These difficulties reflect organisational and political factors (such as diverging strategic goals; power imbalances; and distinct professional or disciplinary worldviews) as much as they do logistical and technical ones (such as budget sharing and interoperability of systems). Similarly, qualitative work with people working in this area has highlighted diverse understandings of integration and legitimate concerns about some models, such as co-located services

(Bradbury and Lewer, 2021). It is therefore important that any efforts towards this end articulate the goals and parameters of collaboration; acknowledge and plan for potential challenges; and undertake careful evaluation of different models, encompassing both process and outcome dimensions. The potential of administrative data linkage to track individual service interactions across different organisations and sectors may be valuable as part of quantitative approaches to the latter.

Sharing and linkage of administrative data could also support the practice of joint working, as well as its evaluation. Throughout the engagement activities I undertook over the course of this project, professional stakeholders and people with lived experience alike often returned to the implications of its methods for collaboration between different services. Whilst acknowledging the value of linked administrative data for research, they also raised the question of prospects for its use within services – for instance, through a real-time equivalent of the cohort linkage accessible to staff providing frontline services enabling greater integration of individual care records within and between organisations. Whilst all acknowledged that this would be complex to achieve, they pointed to a number of potential benefits for those using and delivering services. People with lived/living experience particularly valued its potential to avoid people having to provide the same history on multiple occasions in different services, something they often found (re-)traumatising; this has been noted elsewhere (Russell and Thomas, 2018, The ALLIANCE, 2021, Scottish Government, 2021b). This ideal vision also reflected the acceptability of record linkage across administrative datasets among those I engaged with during this project, and the frequent assumption that it was happening already on a routine basis. There are some developments in regard to data sharing across organisations for the purposes of service delivery – for instance, as reflected in the recent option appraisal for a rough sleeping data system in Scotland (Russell and Thomas, 2018) – but given the difficulties of achieving even retrospective linkages, as described above, realisation may be some way off. Nonetheless, it is worth highlighting here given its salience for stakeholders and the potential value in providing a technological underpinning to potential efforts towards service integration.

A more responsive system for data sharing and linkage across the relevant services might also be valuable for public health surveillance and action, as well as improving individual experiences of care. In this context, surveillance refers to the routine and systematic collection and interpretation of data to inform operational and strategic decision-making in support of public health goals (Groseclose and Buckeridge, 2017). Targeted public health surveillance efforts for the experiences of interest in this thesis might be particularly valuable given that they – and the people they affect – are poorly ascertained in existing sources of data used to inform public health practice and policy, such as household surveys. For example, Kinner and Forsyth (2016) have described the use of administrative data from the Australian unemployment benefits database on a routine basis to monitor mortality among people released from prison. This is one of very few examples where cross-sectoral administrative data linkage has been undertaken for the purposes of routine ongoing surveillance with the intention of monitoring trends and informing practical responses in a timely way, rather than for one-off research projects. Crucially, however, though Kinner and Forsyth demonstrated technical feasibility, they identified barriers in the form of governance, resources, and political will.

The examples above demonstrate – as with the implications for research – that realising the potential benefits of administrative data sharing and linkage for policy and practice requires suitable infrastructure, proportionate processes, and adequate investment.

The discussion above has highlighted a number of ways in which the research described in this thesis might be used directly for informing the design and delivery of services and policy; what the literature on research utilisation has referred to as instrumental uses (Masood et al., 2020). The work described in this thesis might also have indirect, or conceptual, uses, by bringing greater attention to the idea of co-occurring experiences or changing the ways in which they are imagined. This has parallels with what Weiss refers to as the ‘enlightenment’ model of evidence use, in which concepts from research come to permeate ways of thinking in policy and practice, exerting an influence on problem definition, agenda setting, and the scope of action (Weiss, 1977, Weiss, 1979).

This conceptual role may be especially valuable in the field under study here, where existing paradigms (e.g., provision of multiple distinct, narrowly-focused services with potentially exclusionary thresholds or criteria) are under scrutiny and new models (e.g., greater integration of services and coherence across policy areas) are being considered. As noted in Chapter 4, the intersection between these experiences is poorly characterised in existing health inequalities policy and their associated health outcomes often defined narrowly in terms of specific conditions like infections and mental illness; similarly, comparing the results of the systematic review (Chapter 5) and cohort analysis (Chapter 6 and Chapter 7) highlights an apparent mismatch between the existing research landscape and the population prevalence of different combinations, as well as the burden of disease. More broadly, as others have highlighted, greater use of administrative data from across society may also serve to reinforce the importance of the social determinants of health, in the face of increasing – though poorly evidenced – interest in the role of genomic and other individual-level factors (Taylor-Robinson and Kee, 2018).

It is therefore hoped that the work documented here may serve a useful purpose in conceptual terms, by informing a more nuanced understanding of the extent of co-occurrence and associated health inequalities that is in turn reflected in priorities for policy and practice, as well as research.

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Appendices

Where articles are already published, links are provided to supplementary material in the public domain. Where articles are not yet published, supplementary material is included in full here.

Supplementary material accompanying Chapter 4

Supplement to Tweed et al (2021), Critical Public Health

Supplementary material accompanying Chapter 5

Supplement to Tweed et al (2021), Journal of Epidemiology and Community Health - methods

Supplement to Tweed et al (2021), Journal of Epidemiology and Community Health – results

Supplementary material accompanying Chapter 6

Section S6.1. Additional details for source datasets.

Table S6.1.1. Definition of Homeless persons and persons threatened with homelessness from 1987 Housing (Scotland) Act, updated in the 2001 Housing (Scotland) Act (Source: https://www.legislation.gov.uk/ukpga/1987/26/section/24#commentary-c12770551)

Homeless persons and persons threatened with homelessness:

- A person is homeless if he has no accommodation in the United Kingdom or elsewhere.

- A person is to be treated as having no accommodation if there is no accommodation which he, together with any other person who normally resides with him as a member of his family or in circumstances in which the local authority consider it reasonable for that person to reside with him—

    1. is entitled to occupy by virtue of an interest in it or by virtue of an order of a court, or
    2. has a right or permission, or an implied right or permission to occupy, or in England and Wales has an express or implied licence to occupy, or
    3. occupies as a residence by virtue of any enactment or rule of law giving him the right to remain in occupation or restricting the right of any other person to recover possession.

(2A) A person shall not be treated as having accommodation unless it is accommodation which it would be reasonable for him to continue to occupy.

(2B) Regard may be had, in determining whether it would be reasonable for a person to continue to occupy accommodation, to the general circumstances prevailing in relation to housing in the area of the local authority to whom he has applied for accommodation or for assistance in obtaining accommodation.

- A person is also homeless if he has accommodation but—

    1. he cannot secure entry to it, or

    2. it is probable that occupation of it will lead to abuse (within the meaning of the Protection from Abuse (Scotland) Act 2001 (asp 14)), or

    - it is probable that occupation of it will lead to abuse (within the meaning of the Protection from Abuse (Scotland) Act 2001 (asp 14)), from some other person who previously resided with that person, whether in that accommodation or elsewhere, or

    - it consists of a movable structure, vehicle or vessel designed or adapted for human habitation and there is no place where he is entitled or permitted both to place it and to reside in it; or

    - it is overcrowded within the meaning of section 135 and may endanger the health of the occupants; or

  - it is not permanent accommodation, in circumstances where, immediately before the commencement of his occupation of it, a local authority had a duty under section 31(2) in relation to him.

- A person is threatened with homelessness if it is likely that he will become homeless within 2 months.

- For the purposes of subsection (3)(e), “permanent accommodation” includes accommodation—

    - of which the person is the heritable proprietor,

    - secured by a Scottish secure tenancy,

    - secured by an assured tenancy that is not a short assured tenancy,

    - where paragraph 1 or 2 of schedule 6 to the Housing (Scotland) Act 2001 (asp 10) is satisfied in relation to the person, secured by a short Scottish secure tenancy.

    - secured by a private residential tenancy

Table S6.1.2. Circumstances whereby a court is required and/or may choose to obtain and consider a report from a local authority officer (that is, a Criminal Justice Social Work Report)

Source: National Outcomes and Standards for Social Work Services in the Criminal Justice System: Criminal Justice Social Work Reports and Court-Based Services Practice Guidance

When the offender is a person specified in section 27(1)(b)(i) to (vi) of the Social Work (Scotland) Act 1968, which includes a person who is:

- Under the supervision of a court
- Under supervision or subject to a community service order following release from prison or detention
- Subject to a community service order or a probation order which includes an unpaid work requirement
- Subject to a supervised release order
- Subject to a community reparation order
- Under 16 years of age and subject to a restriction of liberty order
- Aged 16 or 17 years and subject to a supervision requirement

When the court is:

- Passing an extended sentence
- Making a supervised release order [replaced by Community Pay-Back Order*]
- Making a probation order [replaced by Community Pay-Back Order*]
- Making a drug treatment and testing order
- Making a community service order [replaced by Community Pay-Back Order*]
- Considering a custodial sentence for those aged between 16 and 21 years of age
- Considering a custodial sentence for those aged over 21 years of age who have not previously been sentenced to imprisonment or detention in the UK

*****The Community Pay-Back Order replaced probation orders, community service orders, and supervised attendance orders for offences committed after 1 February 2011.

Table S6.1.3. ICD-10 codes used to identify individuals with a diagnosis of psychotic disorder in the PsyCIS clinical registry.

- Adults aged 18-65 with one of the following ICD-10 diagnoses, diagnosed by a consultant psychiatrist
    - F20-29 Schizophrenia, schizotypal and delusional disorder
    - F30-F31 Mania and Bipolar Disorder
    - F32.3 Severe Depression with psychotic symptoms
    - F33.3 Recurrent depressive disorder, current episode severe with psychotic symptoms
    - F33.4 Recurrent depressive disorder, currently in remission*
    - F06.0 Organic Hallucinosis
    - F06.1 Organic catatonic disorder
    - F06.2 Organic delusional (schizophrenia- like) disorder
    - F06.30 Organic mood (affective) disorders
    - F06.31 Organic depressive disorder with psychotic symptoms
    - F53.1 Severe mental and behavioural disorders associated with the puerperium, not elsewhere classified
    - F1x.5 Mental and behavioural disorders due to psychoactive substance: psychotic disorder

*Where individual has previous diagnosis of psychosis and active ongoing treatment with anti-psychotic medication.

Section S6.2. Details of linkage process and success rates

Linkage process

CHI seeding – the process of matching records from administrative datasets not containing a Community Health Index (CHI) number to the CHI register – was undertaken by the West of Scotland Safe Haven for the HL1, PR2, and CJSWR datasets. The CJSWR dataset already contained CHI numbers for some records, reflecting the incorporation of the criminal justice social work function into Glasgow City Health and Social Care Partnership as part of health and social care integration during the study period.

Before seeding, datasets were checked for consistency in the formatting and length of fields.

CHI seeding was carried out on a deterministic basis supplemented by manual review, using forename, surname, and date of birth OR forename & surname soundex codes combined with date of birth. Soundex codes are anonymised representation of surnames consisting of the initial letter of the surname and three digits, used to enable matching of names despite spelling variations (e.g., Mohammed vs Muhamed, MacDonald vs McDonald). Manual assessments of postcodes were included in supplementary reviews but not in the primary matching process due to migration over time potentially resulting in false negatives.

No reference datasets with known true- and false-matches were available to assess sensitivity or specificity of the CHI seeding process.

Once CHI seeding was complete, all linkages were undertaken on a deterministic basis using CHI numbers.

Results of linkage

The flow charts below describe the linkage process for each of the non-health datasets requiring CHI seeding. CHI seeding was undertaken on the entire datasets provided by the data controllers, which were not restricted to the specific dates of this study: totals for the number of records and of unique individuals may therefore not match those presented in the results for this article.

In contrast to the HL1 and CJSWR datasets, which originated from Glasgow City Health and Social Care Partnership and whose geographical scope therefore fell entirely within the area covered by the West of Scotland Safe Haven, the PR2 (prisons) dataset was national. This allowed us to identify Glasgow City residents who had experienced imprisonment regardless of where in Scotland they had been imprisoned.

Figure S6.2.1. Flowchart demonstrating CHI seeding process for HL1 dataset

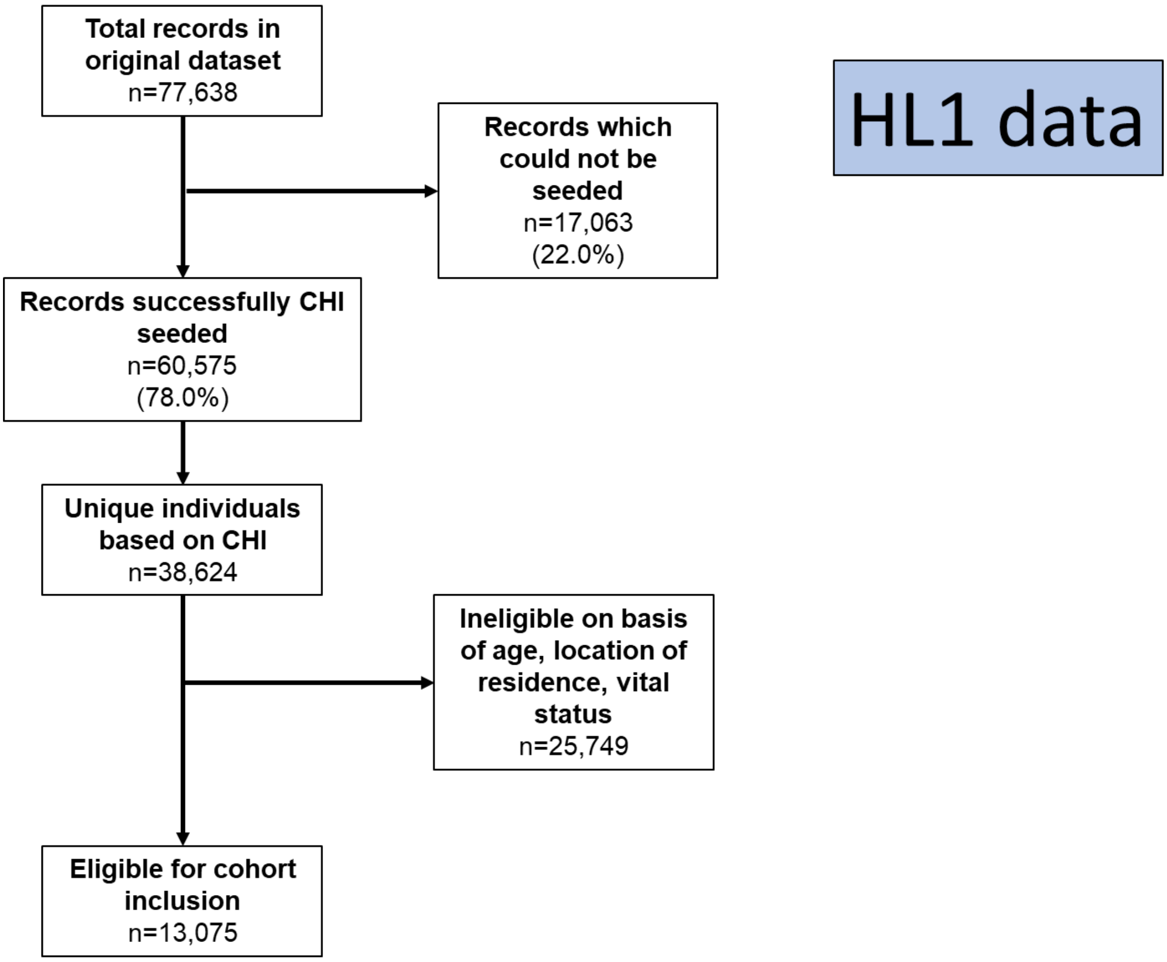


Table S6.2.1. Comparison of demographic characteristics between records in HL1 dataset which could and could not be assigned a CHI number (Note that the figures below relate to records, rather than individuals)

HL1	**Able to be assigned a CHI**		
	Yes	**No**	**Total**
Total number of records (%)	60,575 (78.0)	17,063 (22.0)	77,638 (100.0)
Percentage male	57.9	52.5	57.9
Mean age	44	43	44

Figure S6.2.2. Flowchart demonstrating CHI seeding process for CJSWR dataset

-

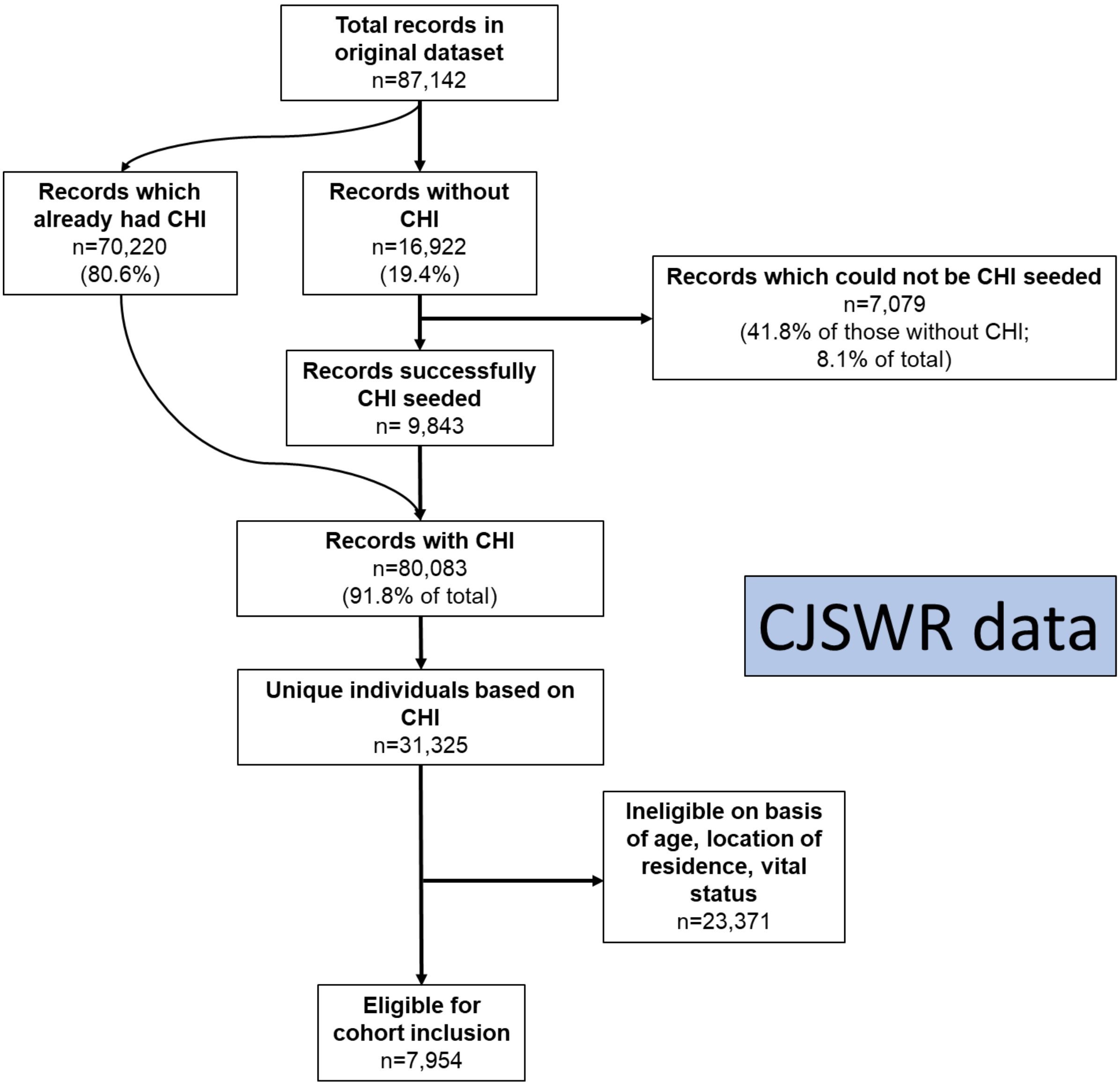
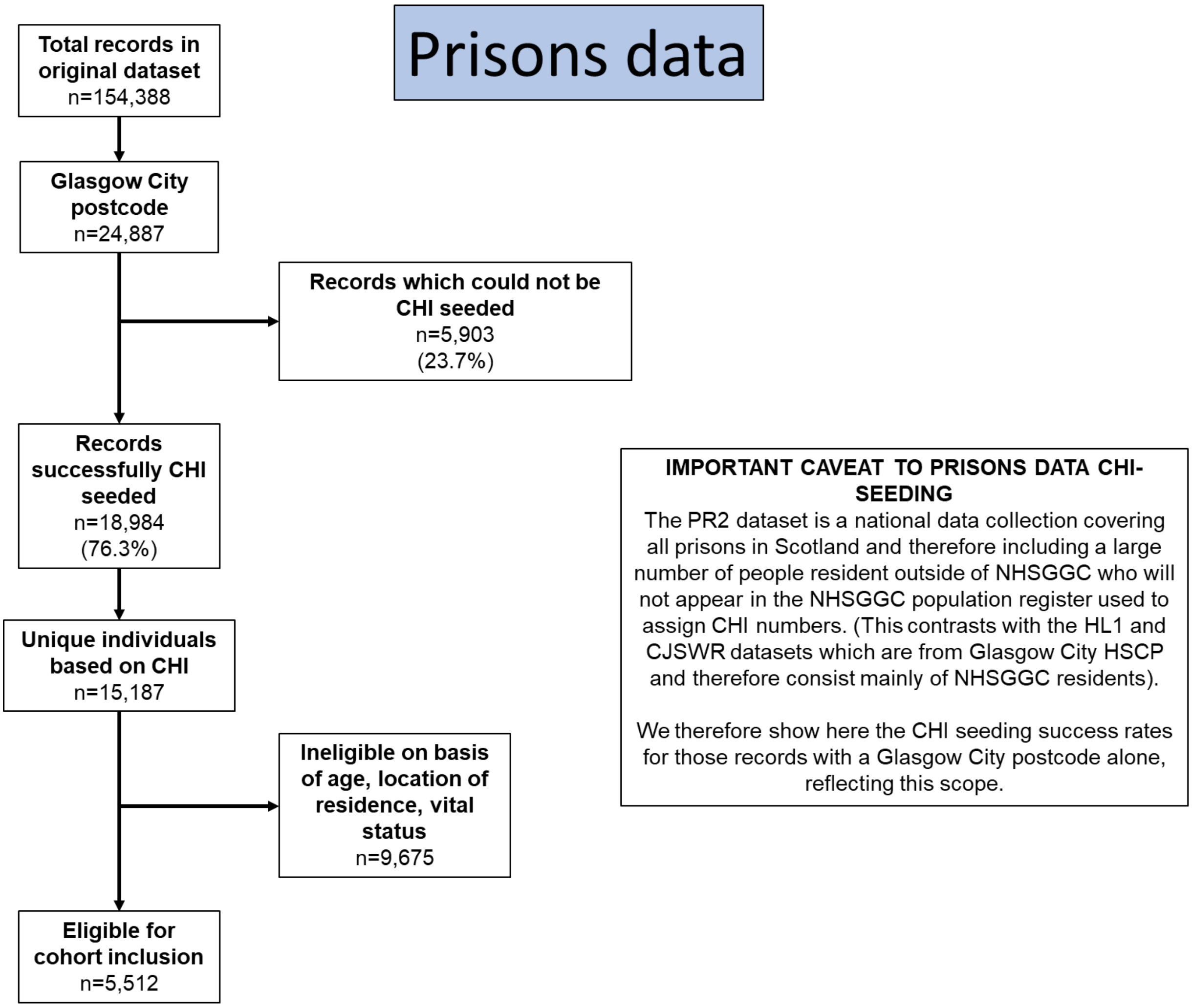


Table S6.2.2. Comparison of demographic characteristics between records in CJSWR dataset which could and could not be assigned a CHI number. (Note that the figures below relate to records, rather than individuals; records for whom a CHI number was available in the original CJSWR dataset are included under the 'Yes' category)

CJSWR	Able to be assigned a CHI		
	Yes	No	Total
Total number of records (%)	80,083 (91.8)	7,079 (8.2)	87,142 (100.0)
Percentage male	85.4	85.0	85.4
Mean age	42	44	42

Figure S6.2.3. Flowchart demonstrating CHI seeding process for PR2 dataset



IMPORTANT CAVEAT TO PRISONS DATA CHI-SEEDING

The PR2 dataset is a national data collection covering all prisons in Scotland and therefore including a large number of people resident outside of NHSGGC who will not appear in the NHSGGC population register used to assign CHI numbers. (This contrasts with the HL1 and CJSWR datasets which are from Glasgow City HSCP and therefore consist mainly of NHSGGC residents).

We therefore show here the CHI seeding success rates for those records with a Glasgow City postcode alone, reflecting this scope.

Comparative data on demographic characteristics for records in the PR2 dataset which could and could not be assigned a CHI number could not be provided by the Safe Haven in time for submission; it is hoped such data will be forthcoming early in 2022.

Section S6.3. Additional results.

Table S6.3.1. Number and prevalence of individuals with single versus multiple exposures during the study period, 2010-11 – 2013/14.

Exposures of interest	This exposure only (%)	Multiple exposures (%)	Total
Any homelessness (HL)	9,463 (72.4)	3,612 (27.6)	13,075
Any opioid dependence (ODep)	4,123 (55.6)	3,289 (44.4)	7,412
Any psychosis (PSY)	3,255 (85.9)	536 (14.1)	3,791
Any justice involvement - custodial (CUST)	2,755 (50.0)	2,757 (50.0)	5,512
Any criminal justice social work report (CJSWR)			
Of which imprisoned (also counted under CUST)	1,596 (47.9)	1,739 (52.1)	3,335
Of which not imprisoned (COMM)	3,338 (72.3)	1,281 (27.7)	4,619

Any justice involvement is counted as a single exposure: that is, where individuals have both prison & criminal justice social work report exposures but no other exposures, they will be included in the singly- rather than multiply-exposed category.

Table S6.3.2. Number and prevalence of individuals with specific co-occurring exposures during the study period, 2010-11 – 2013/14.

This table describes the overlap between specific pairs of exposures – it shows, for individuals with the index exposure listed in each row, what number and percentage also had the additional experience listed in the column (with or without any other exposure). For instance, it can be used to identify that 1,825/5,512 (33.1%) of individuals with prison experience during the study period also experienced homelessness during that period (and potentially other exposures as well).

Index exposure	Total N with this experience (% of total population)	Of whom also experienced HL (% of those with index exposure)	Of whom also experienced ODep (% of those with index exposure)	Of whom also experienced CUST (% of those with index exposure)	Of whom also experienced COMM (% of those with index exposure)	Of whom also experienced PSY (% of those with index exposure)
Any homelessness (HL)	13,075 (2.4%)	-	1,840 (14.1%)	1,825 (14.0%)	782 (6.0%)	249 (1.9%)
Any opioid dependence (ODep)	7,412 (1.4%)	1,840 (24.8%)	-	1,667 (22.5%)	641 (8.7%)	215 (2.9%)
Any justice - custodial (CUST)	5,512 (1.0%)	1,825 (33.1%)	1,667 (30.2%)	-	-	137 (2.5%)
Any justice – community only (COMM)	4,619 (0.9%)	782 (16.9%)	641 (13.9%)	-	-	79 (1.7%)
Any psychosis (PSY)	3,791 (0.7%)	249 (6.6%)	215 (5.7%)	137 (3.6%)	79 (2.1%)	-

Table S6.3.3. Duration of imprisoned time for those individuals experiencing imprisonment during the exposure period.

Since imprisonment is the only exposure mutually exclusive with the others, these summary data on total time spent imprisoned (for those individuals experiencing imprisonment during the exposure period) are presented here to inform interpretation of the observed overlap between imprisonment and other exposures, for the primary analysis (1st April 2010 – 31st March 2014).

Of a total 1,460 days in the study period:

	Percentage of study period spent imprisoned (%)				**% People imprisoned for: (n)**	
	Mean (SD)	**Median (IQR)**	**Min**	**Max**	**≥25% study period**	**≥50% study period**
Total	16.6 (19.3)	8.9 (3.0 – 22.9)	0.0	99.6	23.0 (1,266)	7.7 (426)
Summary of multiple vs single exposures:						
CUST only	14.9 (19.3)	7.3 (2.4 – 19.0)	0.0	99.6	19.5 (537)	7.2 (198)
CUST + others	18.2 (19.1)	11.4 (4.0 – 26.2)	0.0	94.9	26.4 (729)	8.3 (228)
Detailed exposure combinations						
CUST only	14.9 (19.3)	7.3 (2.4 – 19.0)	0.0	99.6	19.5 (537)	7.2 (198)
HL + CUST	19.6 (19.9)	12.8 (4.0 – 29.2)	0.0	92.9	29.9 (297)	9.6 (95)
ODep + CUST	15.3 (18.0)	8.6 (3.4 – 20.2)	0.1	94.9	19.3 (163)	5.7 (48)
PSY + CUST	6.6 (8.0)	2.7 (0.6 – 9.7)	0.1	35.1	*≤5 individuals*	*≤5 individuals*
HL + ODep + CUST	21.2 (19.7)	14.9 (6.0 – 31.1)	0.1	92.2	32.3 (252)	10.8 (84)
HL + PSY + CUST	12.4 (14.1)	7.3 (1.5 – 15.0)	0.1	57.1	20.0 (7)	*≤5 individuals*
ODep + PSY + CUST	11.8 (12.7)	7.7 (2.6 – 18.2)	0.1	49.9	*≤5 individuals*	*≤5 individuals*
HL + ODep + PSY + CUST	11.7 (12.3)	9.5 (2.9 – 13.5)	0.1	46.3	*≤5 individuals*	*≤5 individuals*

Figure S6.3.1. Distribution of percentage of study period spent imprisoned, by single vs multiple exposures

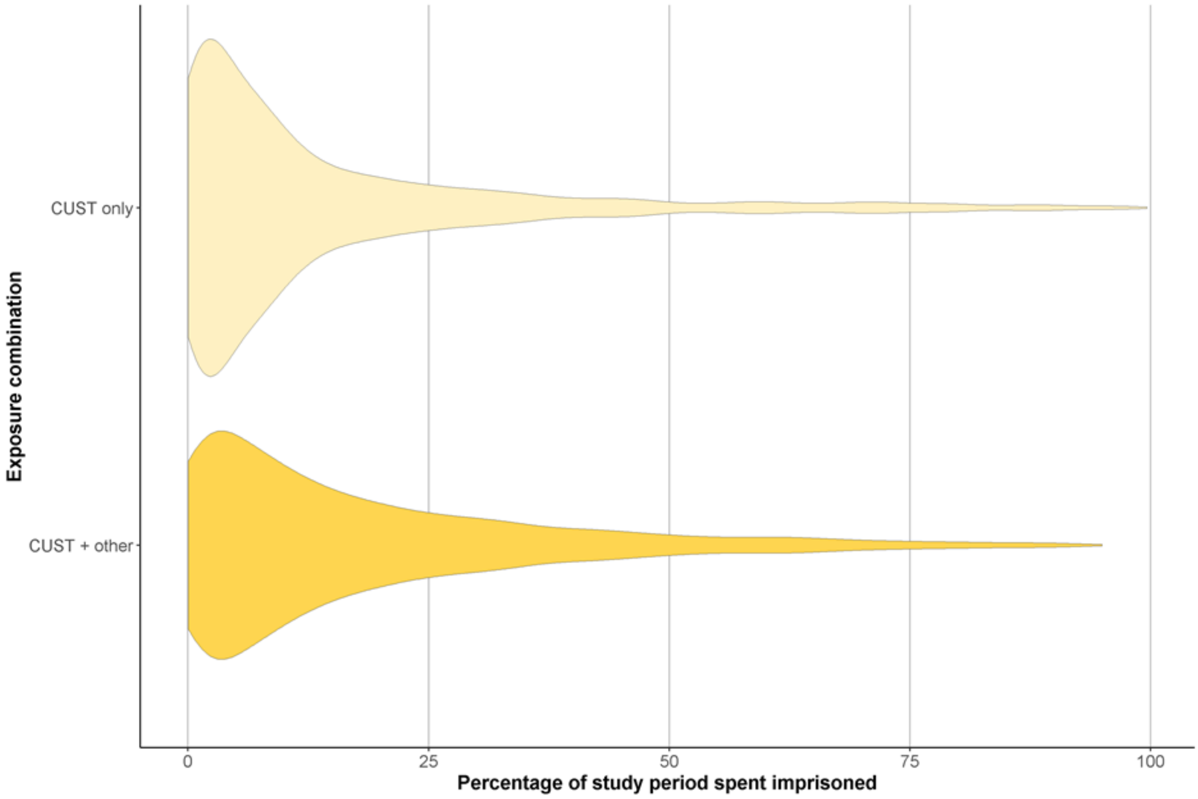


Table S6.3.4. Ethnicity profile for individuals with experience of homelessness, imprisonment, and courts, 2010/11 – 2013/14.

Ethnicity was categorised based on information from source datasets using the classification used in Scotland’s Census: https://www.scotlandscensus.gov.uk/variables-classification/ethnic-group

The ‘White’ category includes the following options for self-described ethnicity:

White:

- Scottish
- Other British
- Irish
- Gypsy/Traveller
- Polish
- Other white ethnic group, please write in

Ethnicity data was not included in the datasets used to identify individuals with opioid dependence (Prescribing Information System) or to identify the Glasgow City population as a whole (Community Health Index register) so these datasets are not described below, and ethnicity data is not reported for different combinations of experiences.

Dataset	Experience	Total individuals 2010/11 – 2013/2014	Number (%) recorded as White ethnicity
HL1	Homelessness or housing insecurity	13,075	10,326 (79.0)*
PsyCIS	Psychosis diagnosis	3,791	3,462 (91.3)
Criminal Justice Social Work Report	Justice involvement – community (+/- custodial)	7,954	7,203 (90.6)
PR2	Justice involvement - custodial	5,512	5,261 (95.5)

*Note relatively high proportion of those with ethnicity recorded as “Other” – 12% - in the HL1 dataset.

The proportion of the overall Glasgow City population recorded as White ethnicity in the 2011 Census was 88% (UK Data Explorer, 2021).

Table S6.3.5. Number of episodes for selected exposures during the study period, by exposure combination, 2010/11 – 2013/14.

	Number of individuals	Number of episodes			
		Mean (SD)	Median (IQR)	Min	Max
Homelessness					
Any HL	13,075	1.2 (0.6)	1 (1-1)	1	9
HL only	9,463	1.1 (0.4)	1 (1-1)	1	8
HL + other exposures	3,612	1.6 (1.0)	1 (1-2)	1	9
Justice - custodial					
Any CUST	5,512	2.3 (2.1)	1 (1-3)	1	24
CUST only	2,755	1.8 (1.6)	1 (1-2)	1	16
CUST + other exposures	2,757	2.8 (2.4)	2 (1-4)	1	24
Justice – community only					
Any COMM	4,619	1.5 (1.1)	1 (1-2)	1	16
COMM only	3,338	1.4 (1.0)	1 (1-1)	1	16
COMM + other exposures	1,281	1.7 (1.3)	1 (1-2)	1	13

Figure S6.3.2. Number of episodes during study period, among people with experience of these

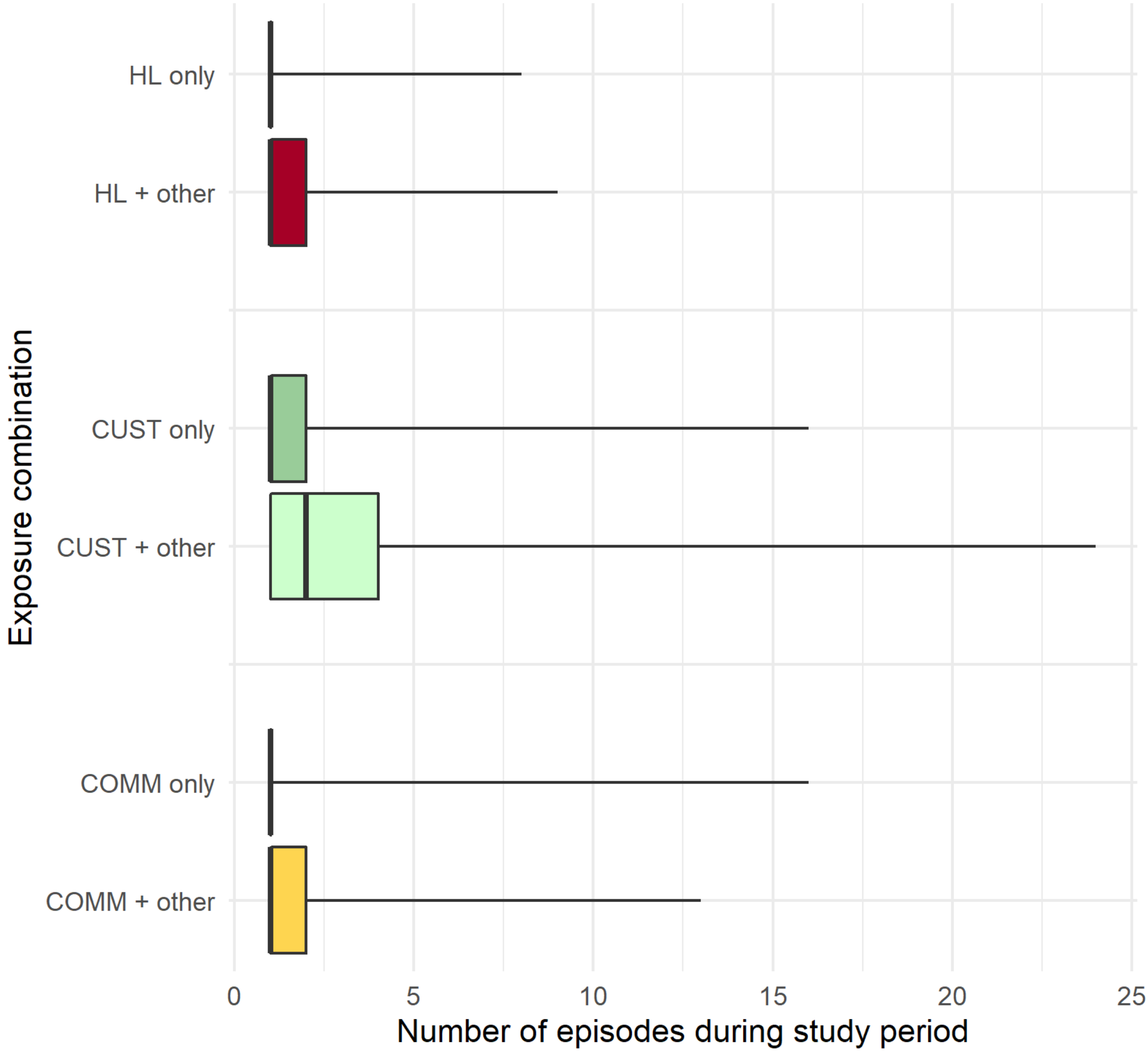


Table S6.3.6 – Sensitivity analysis: impact of varying study period length on period prevalence of exposure combinations

Note that prisons data are only available for the period 2010/11 to 2013/14 so the ‘extended’ study period from 2010/11 to 2015/16 is missing data on imprisonment for the final two years; the results for imprisonment and associated combinations should therefore be interpreted in light of this.

Exposure combination*	Number (period prevalence, %)		
	Study period – primary analyses 2010/11 - 2013/14	Study period – restricted 2012/13 - 2013/14	Study period - extended 2010/11 - 2015/16*
Total population	536,653 (100.0)	574,092 (100.0)	507,643 (100.0)
No exposures of interest	508,541 (94.8)	554,666 (96.6)	474.701 (93.5)
Any exposure of interest	28,112 (5.2)	19,426 (3.4)	32,942 (6.5)
Summary of exposure combinations:			
Any homelessness (HL)	**13,075 (2.4)**	**6,790 (1.2)**	**16,846 (3.3)**
HL only	9,463 (1.8)	5,002 (0.9)	12,162 (2.4)
HL + other exposures	3,612 (0.7)	1,788 (0.3)	4,684 (0.9)
Any opioid dependence (ODep)	**7,412 (1.4)**	**6,743 (1.2)**	**7,601 (1.5)**
ODep only	4,123 (0.8)	4,753 (0.8)	3,792 (0.8)
ODep + other exposures	3,289 (0.6)	1,990 (0.4)	3,809 (0.8)
Any justice - custodial (CUST)	**5,512 (1.0)**	**3,598 (0.6)**	**5,272 (1.0)**
CUST only	2,755 (0.5)	2,080 (0.4)	2,364 (0.5)
CUST + other exposures	2,757 (0.5)	1,518 (0.3)	2,908 (0.6)
Any justice – community only (COMM)	**4,619 (0.9)**	**2,687 (0.5)**	**6,761 (1.3)**
COMM only	3,338 (0.6)	2,077 (0.4)	4,748 (0.9)
COMM + other exposures	1,281 (0.2)	610 (0.1)	2,013 (0.4)
Any psychosis (PSY)	**3,791 (0.7)**	**2,935 (0.5)**	**4,281 (0.8)**
PSY only	3,255 (0.6)	2,651 (0.5)	3,565 (0.7)
PSY + other exposures	536 (0.1)	284 (0.1)	716 (0.1)

(continues overleaf)

*Listed in order of prevalence during the study period of primary analyses, 2010-2014

Table S6.3.6 (continued)

Exposure combination*	Number (period prevalence, %)		
	2010/11 - 2013/14	2012/13 - 2013/14	2010/11 - 2015/16*
Exposures in combination: mutually exclusive category, ordered by frequency**			
Homelessness (HL) only	9,463 (1.8)	5,002 (0.9)	12,162 (2.4)
Opioid dependence (ODep) only	4,123 (0.8)	4,753 (0.8)	3,792 (0.8)
Justice – community (COMM) only	3,338 (0.6)	2,077 (0.4)	4,748 (0.9)
Psychosis (PSY)	3,255 (0.6)	2,651 (0.5)	3,565 (0.7)
Justice – custodial (CUST) only	2,755 (0.5)	2,080 (0.4)	2,364 (0.5)
HL + CUST	994 (0.2)	513 (0.1)	1,096 (0.2)
ODep + CUST	846 (0.2)	605 (0.1)	712 (0.1)
HL + ODep	820 (0.2)	535 (0.1)	971 (0.2)
HL + ODep + CUST	780 (0.2)	354 (0.1)	945 (0.2)
HL + COMM	574 (0.1)	229 (<0.1)	952 (0.2)
ODep + COMM	433 (0.1)	275 (0.1)	575 (0.1)
HL + ODep + COMM	195 (<0.1)	68 (<0.1)	344 (0.1)
HL + PSY	159 (<0.1)	65 (<0.1)	229 (0.1)
ODep + PSY	135 (<0.1)	129 (<0.1)	151 (<0.1)
PSY + CUST	61 (<0.1)	26 (<0.1)	55 (<0.1)
PSY + COMM	56 (<0.1)	27 (<0.1)	93 (<0.1)
HL + PSY + CUST	35 (<0.1)	10 (<0.1)	52 (<0.1)
HL + PSY + ODep	26 (<0.1)	6 (<0.1)	39 (<0.1)
ODep + PSY + CUST	25 (<0.1)	6 (<0.1)	26 (<0.1)
HL + ODep + PSY + CUST/COMM	19 (<0.1)	5 (<0.1)	31 (<0.1)
HL + PSY + COMM	10 (<0.1)	3 (<0.1)	25 (<0.1)
OST + PSY + COMM	10 (<0.1)	7 (<0.1)	15 (<0.1)

*Listed in order of prevalence during the study period of primary analyses, 2010-2014

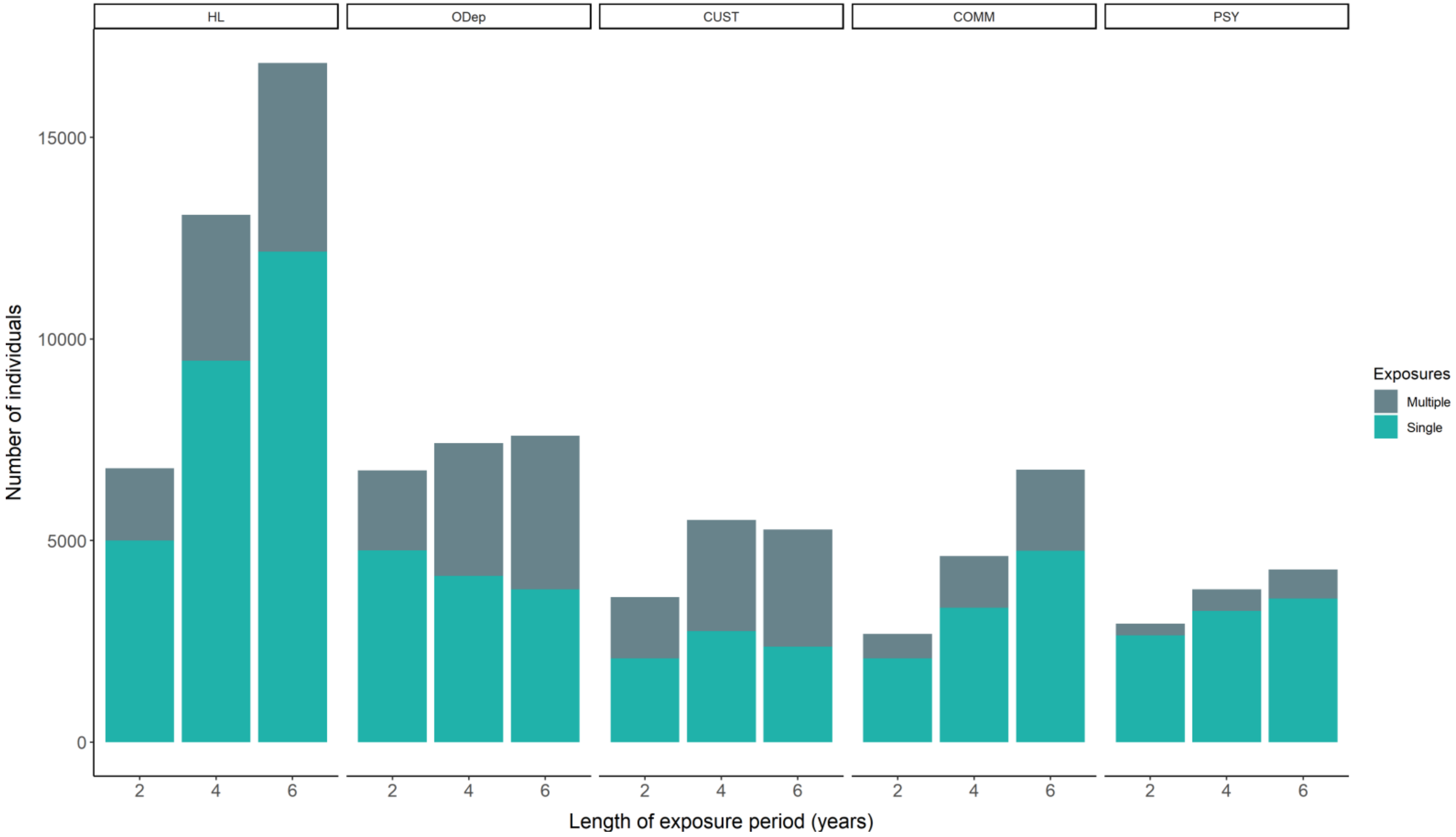
**Results for HL + ODep + PSY + COMM and HL + ODep + PSY + CUST are grouped here due to small numbers to avoid presenting potentially disclosive information.

Table S6.3.7. Sensitivity analysis: impact of varying study period length on prevalence of single versus multiple exposures

Exposures of interest	Multiple exposures - N (%)		
	2010/11 - 2013/14	2012/13 - 2013/14	2010/11 - 2015/16*
Any homelessness (HL)	3,612 (27.6)	1,788 (26.3)	4,684 (27.8)
Any opioid dependence (ODep)	3,289 (44.4)	1,990 (29.5)	3,809 (50.1)
Any prison experience (CUST)	2,757 (50.0)	1,518 (42.2)	2,908 (55.2)
Any court report without imprisonment (COMM)	1,281 (27.7)	610 (22.7)	2,013 (29.8)
Any psychosis (PSY)	536 (14.1)	284 (9.7)	716 (16.7)

Figure S6.3.3. Overlap between exposures of interest: sensitivity analyses for change in exposure period.

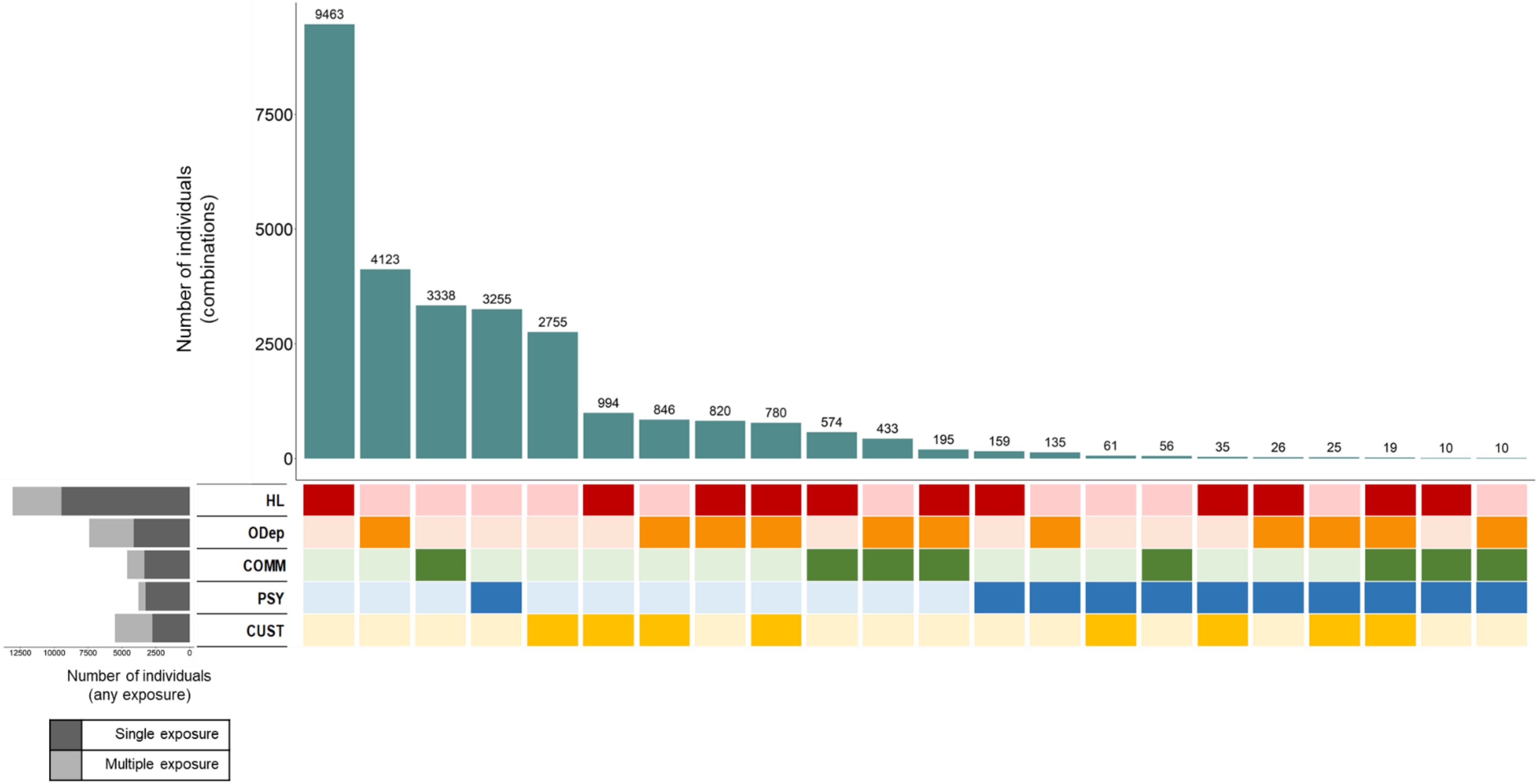
(a) **Number of individuals with each exposure of interest, and proportion with single vs multiple exposures, by length of study period.**



Note that prisons data were only available for the period 2010/11 to 2013/14 so the ‘extended’ study period from 2010/11 to 2015/16 is missing data on imprisonment for the final two years; the results for imprisonment (CUST) should therefore be interpreted in light of this.

(b) Prevalence of individual combinations for the four-year exposure period (primary analysis); 01/04/2010 – 31/03/2014

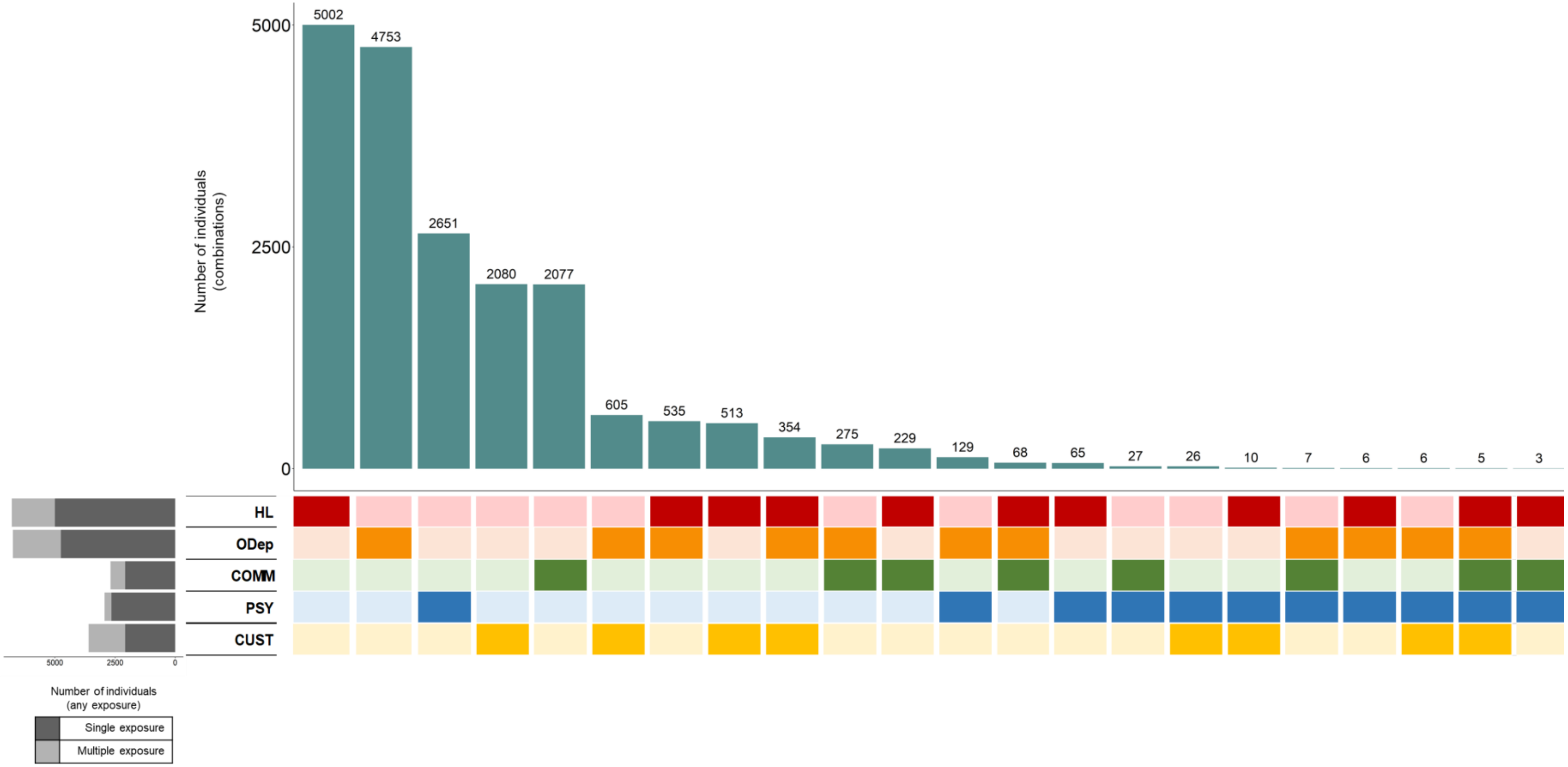
(figure also shown in manuscript; figure 11)



Note that exposure combinations are ordered by frequency of mutually exclusive categories.

HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; COMM – justice involvement in community without imprisonment; PSY – psychosis; CUST – imprisonment.

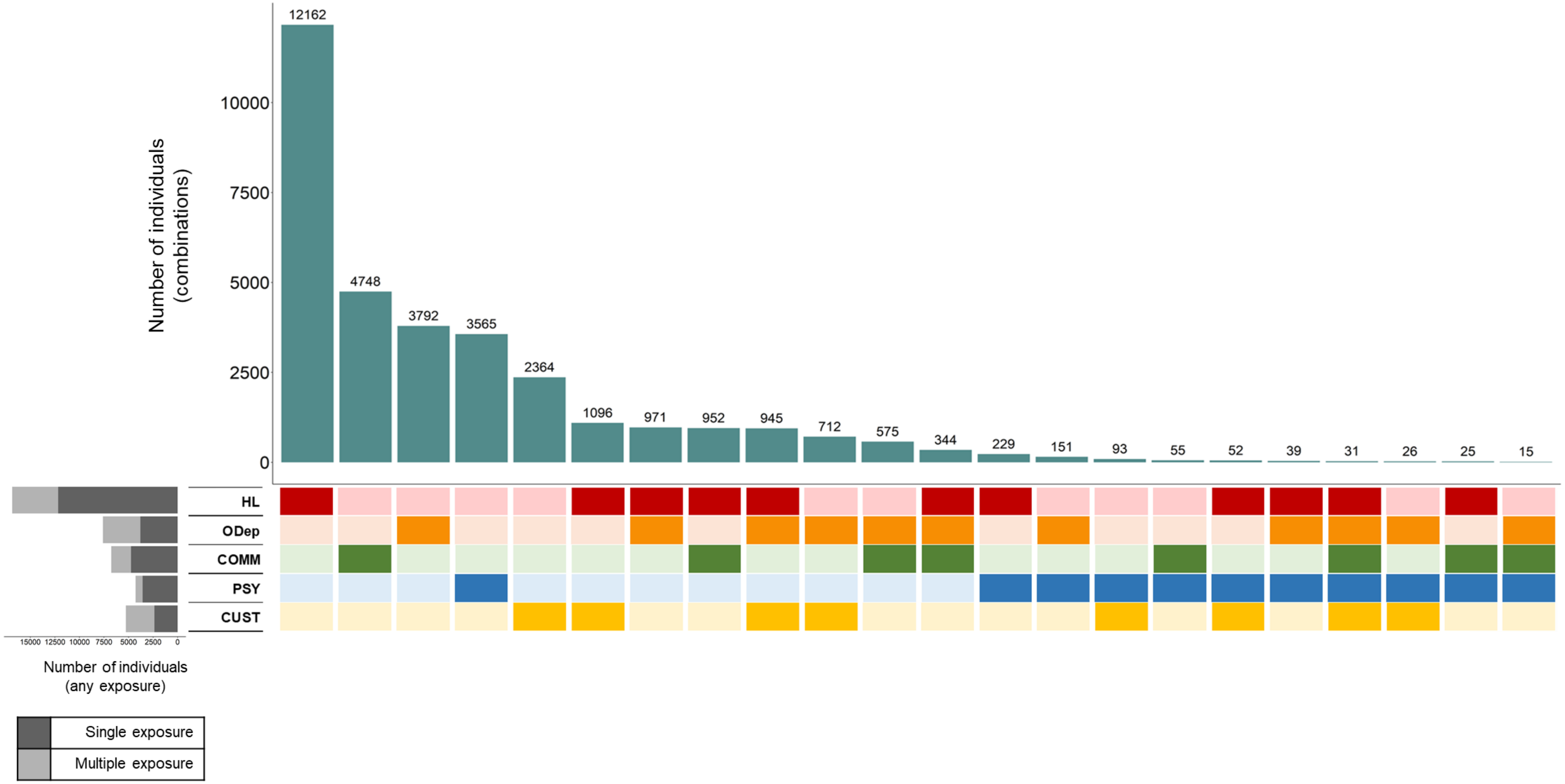
(c) Prevalence of individual combinations for the two-year exposure period; 01/04/2012 – 31/03/2014



Note that exposure combinations are ordered by frequency of mutually exclusive categories.

HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; COMM – justice involvement in community without imprisonment; PSY – psychosis; CUST – imprisonment.

(d) Prevalence of individual combinations for the six-year exposure period; 01/04/2010 – 31/03/2016



Note that exposure combinations are ordered by frequency of mutually exclusive categories as observed in primary analyses, in order to facilitate comparison and interpretation. HL – homelessness and housing insecurity; ODep – opioid dependence indicated by receipt of opioid substitution therapy; COMM – justice involvement in community without imprisonment; PSY – psychosis; CUST – imprisonment.

Prisons data were only available for the period 2010/11 to 2013/14 so the ‘extended’ study period from 2010/11 to 2015/16 is missing data on imprisonment for the final two years; the results for imprisonment (CUST) should therefore be interpreted in light of this.

Table S6.3.8. Sensitivity analysis of period prevalence during study period for primary analysis (01/04/2010 – 31/03/2014), comparing use of register-based population denominator and census-based population denominator

Exposure combination*	Number of individuals	Period prevalence (95% CI)	
		Register denominator	Census denominator
Homelessness (HL) only	9,463	1.8 (1.8 – 1.8)	2.1 (2.0 – 2.1)
Opioid substitution therapy (ODep) only	4,123	0.8 (0.7 – 0.8)	0.9 (0.9 – 0.9)
Justice – community (COMM) only	3,338	0.6 (0.6 – 0.6)	0.7 (0.7 – 0.8)
Psychosis (PSY)	3,255	0.6 (0.6 – 0.6)	0.7 (0.7 – 0.7)
Justice – custodial (CUST) only	2,755	0.5 (0.5 – 0.5)	0.6 (0.6 – 0.6)
HL + CUST	994	0.2 (0.2 – 0.2)	0.2 (0.2 – 0.2)
ODep + CUST	846	0.2 (0.1 – 0.2)	0.2 (0.2 – 0.2)
HL + ODep	820	0.2 (0.1 – 0.2)	0.2 (0.2 – 0.2)
HL + ODEP + CUST	780	0.2 (0.1 – 0.2)	0.2 (0.2 – 0.2)
HL + COMM	574	0.1 (0.1 – 0.1)	0.1 (0.1 – 0.1)
ODEP + COMM	433	0.1 (0.1 – 0.1)	0.1 (0.1 – 0.1)
HL + ODEP + COMM	195	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
HL + PSY	159	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
ODEP + PSY	135	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
PSY + CUST	61	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
PSY + COMM	56	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
HL + PSY + CUST	35	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
HL + PSY + ODEP	26	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
ODEP + PSY + CUST	25	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
HL + ODEP + PSY + CUST/COMM	19	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
HL + PSY + COMM	10	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
ODEP + PSY + COMM	10	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)
Total any exposure	28,112	5.2 (5.2 – 5.3)	6.2 (6.1 – 6.2)
Total population denominator	-	536,653	456,237

*Listed in order of prevalence during the study period of primary analyses, 2010-2014

Supplementary material accompanying Chapter 7

Section S7.1. List of ICD-10 codes used in classification of mortality from avoidable causes of death, comprising preventable and treatable causes

Source:

OECD/Eurostat (2019). Avoidable mortality: OECD/Eurostat lists of preventable and treatable causes of death (November 2019 version). https://www.oecd.org/health/health-systems/Avoidable-mortality-2019-Joint-OECD-Eurostat-List-preventable-treatable-causes-of-death.pdf

All of the causes listed below have an age threshold of 0-74 years of age for inclusion in the definition of avoidable mortality.

Causes of death	Preventable	Treatable	ICD-10 code(s)	Stated rationale
Intestinal diseases	X		A00-A09	Most of these infections can be prevented through prevention measures (e.g. improve water and food safety)
Diphtheria, Tetanus, Poliomyelitis	X		A35, A36, A80	Most of these infections can be prevented through vaccination
Whooping cough	X		A37	Most of these infections can be prevented through vaccination
Meningococcal infection	X		A39	Most of these infections can be prevented through vaccination
Sepsis due to streptococcus pneumonia and sepsis due to Haemophilus influenzae	X		A40.3, , A41.3	Most of these infections can be prevented through vaccination
Haemophilus influenzae infections	X		A49.2	Most of these infections can be prevented through vaccination
Sexually transmitted infections (except HIV/AIDS)	X		A50-A60, A63, A64	These infections can be prevented through prevention measures.
Varicella	X		B01	Most of these infections can be prevented through vaccination.
Measles	X		B05	Most of these infections can be prevented through vaccination.
Rubella	X		B06	Most of these infections can be prevented through vaccination.
Viral hepatitis	X		B15-B19	This condition is preventable and will not require treatment if prevented
HIV/AIDS	X		B20-B24	This condition is preventable and will not require treatment if prevented
Malaria	X		B50-B54	This condition is preventable and will not require treatment if prevented
Haemophilus and pneumococcal meningitis	X		G00.0, G00.1	Most of these infections can be prevented through vaccination.
Tuberculosis	X (50%)	X (50%)	A15-A19, B90, J65	Reduction in deaths from tuberculosis in several countries has been about evenly achieved through greater prevention

Causes of death	Preventable	Treatable	ICD-10 code(s)	Stated rationale
				(reduction in incidence) and earlier detection and more effective treatment (higher survival rates).
Scarlet fever		X	A38	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment
Sepsis		X	A40 (excl. A40.3),A41 (excl. A41.3)	Case-fatality rates can be reduced through greater quality of care and reduced patient adverse events, and early detection and appropriate antibiotic treatment
Cellulitis		X	A46, L03	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
Legionnaires disease		X	A48.1	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
Streptococcal and enterococci infection		X	A49.1	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
Other meningitis		X	G00.2, G00.3, G00.8, G00.9	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
Meningitis due to other and unspecified causes		X	G03	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
Lip, oral cavity and pharynx cancer	X		C00-C14	This condition can be largely prevented through prevention measures (e.g. reduce smoking).
Oesophageal cancer	X		C15	This condition can be largely prevented through prevention measures (e.g. reduce smoking).
Stomach cancer	X		C16	This condition can be largely prevented through prevention measures (e.g. reduce smoking and alcohol consumption, and improve nutrition).
Liver cancer	X		C22	This condition can be largely prevented through prevention measures (e.g. reduce smoking and alcohol consumption).
Lung cancer	X		C33-C34	This condition can be largely prevented through prevention measures (e.g., reduce smoking).
Mesothelioma	X		C45	This condition can be largely prevented through prevention measures (e.g. reduce asbestos exposure).
Skin (melanoma) cancer	X		C43	This condition can be largely prevented through prevention measures (e.g. reduce sun exposure).
Bladder cancer	X		C67	This condition can be largely prevented through prevention measures (e.g., reduce smoking).
Cervical cancer	X (50%)	X (50%)	C53	Cervical cancer can be prevented through vaccination and screening can also find pre-cancerous abnormalities that can be treated to prevent cancer, but five-year survival after cancer detection is also relatively high and rising.
Colorectal cancer		X	C18-C21	Case-fatality rates have been reduced through earlier detection and treatment. Five-year survival after detection is relatively high and rising.

Causes of death	Preventable	Treatable	ICD-10 code(s)	Stated rationale
Breast cancer (female only)		X	C50	Case-fatality rates have been reduced through earlier detection and treatment. Five-year survival after detection is relatively high and rising.
Uterus cancer		X	C54, C55	Case-fatality rates have been reduced through earlier detection and treatment. Five-year survival after detection is relatively high and rising.
Testicular cancer		X	C62	Case-fatality rates have been reduced through earlier detection and treatment. Five-year survival after detection is relatively high and rising.
Thyroid cancer		X	C73	Case-fatality rates have been reduced through early detection and appropriate treatment.
Hodgkin’s disease		X	C81	Case-fatality rates have been reduced through early detection and appropriate treatment.
Lymphoid leukaemia		X	C91.0, C91.1	Case-fatality rates have been reduced through early detection and appropriate treatment.
Benign neoplasm		X	D10-D36	Case-fatality rates have been reduced through early detection and appropriate treatment.
Nutritional deficiency anaemia	X		D50-D53	This condition can be largely prevented through prevention measures (e.g. improve nutrition).
Diabetes mellitus	X (50%)	X (50%)	E10-E14	Type 1 diabetes is not preventable, but appropriate treatments can reduce mortality. Type 2 diabetes is largely preventable (e.g. improve nutrition), but appropriate treatments can also reduce mortality.
Thyroid disorders		X	E00-E07	Case-fatality rates can be reduced through early detection and appropriate treatment.
Adrenal disorders		X	E24-E25 (except E24.4), E27	Case-fatality rates can be reduced through early detection and appropriate treatment.
Epilepsy		X		
Aortic aneurysm	X (50%)	X (50%)	I71	This condition is both preventable through prevention measures (similar risk factors as for ischaemic heart diseases) and treatable.
Hypertensive diseases	X (50%)	X (50%)	I10-I13, I15	This condition is both preventable through prevention measures (e.g. reduce smoking, improve nutrition and physical activity) and treatable.
Ischaemic heart diseases	X (50%)	X (50%)	I20-I25	Reduction in deaths from IHD over the past decades in several countries has been about evenly achieved through greater prevention (reduction in incidence) and earlier detection and more effective treatment (higher survival rates).
Cerebrovascular diseases	X (50%)	X (50%)	I60-I69	Reduction in deaths from CVD over the past decades in several countries has been about evenly achieved through greater prevention (reduction in incidence) and earlier detection and more effective treatment (higher survival rates).
Other atherosclerosis	X (50%)	X (50%)	I70, I73.9	This condition is both preventable through prevention measures (e.g. improve nutrition) and treatable.

Causes of death	Preventable	Treatable	ICD-10 code(s)	Stated rationale
Rheumatic and other heart disease		X	I00-I09	Case-fatality rates can be reduced through appropriate treatment.
Venous thromboembolism		X*	I26, I80, I82.9	The majority of venous thrombosis events result from hospitalisations. These cases are treatable to the extent that they are linked to the quality of care that people receive.
Influenza		X	J09-J11	Most of the deaths can be prevented through prevention measures (e.g. vaccination).
Pneumonia due to Streptococcus pneumonia or Haemophilus influenzae	X		J13-J14	Most of these infections can be prevented through vaccination.
Chronic lower respiratory diseases	X		J40-J44	This condition can be largely prevented through prevention measures (e.g. reduce smoking).
Lung diseases due to external agents	X		J60-J64, J66-J70, J82, J92	This condition can be largely prevented through prevention measures (e.g. reduce exposure to chemical, gases and other agents).
Upper respiratory infections		X	J00-J06, J30-J39	Case-fatality rates can be reduced through appropriate treatment.
Pneumonia, not elsewhere classified or organism unspecified		X	J12, J15, J16- J18	Case-fatality rates can be reduced through early detection and appropriate antibiotic treatment.
Acute lower respiratory infections		X	J20-J22	Case-fatality rates can be reduced through appropriate treatment.
Asthma and bronchiectasis		X	J45-J47	Case-fatality rates can be reduced through appropriate treatment (e.g. medication).
Adult respiratory distress syndrome		X	J80	Case-fatality rates can be reduced through appropriate treatment.
Pulmonary oedema		X	J81	Case-fatality rates can be reduced through appropriate treatment.
Abscess of lung and mediastinum pyothorax		X	J85, J86	Case-fatality rates can be reduced through appropriate treatment.
Other pleural disorders		X	J90, J93, J94	Case-fatality rates can be reduced through appropriate treatment.
Gastric and duodenal ulcer		X	K25-K28	Case-fatality rates can be reduced through early detection and appropriate treatment.
Appendicitis		X	K35-K38	Case-fatality rates can be reduced through early detection and appropriate treatment.
Abdominal hernia		X	K40-K46	Case-fatality rates can be reduced through early detection and appropriate treatment.
Cholelithiasis and cholecystitis		X	K80-K81	Case-fatality rates can be reduced through early detection and appropriate treatment.
Other diseases of gallbladder or biliary tract		X	K82-K83	Case-fatality rates can be reduced through early detection and appropriate treatment.
Acute pancreatitis		X	K85.0,1,3,8,9	Case-fatality rates can be reduced through early detection and appropriate treatment.

Causes of death	Preventable	Treatable	ICD-10 code(s)	Stated rationale
Other diseases of pancreas		X	K86.1,2,3,8,9	Case-fatality rates can be reduced through early detection and appropriate treatment.
Nephritis and nephrosis		X	N00-N07	Case-fatality rates can be reduced through early detection and appropriate treatment.
Obstructive uropathy		X	N13,N20-N21, N35	Case-fatality rates can be reduced through early detection and appropriate treatment.
Renal failure		X	N17-N19	Case-fatality rates can be reduced through early detection and appropriate treatment.
Renal colic		X	N23	Case-fatality rates can be reduced through early detection and appropriate treatment.
Disorders resulting from renal tubular dysfunction		X	N25	Case-fatality rates can be reduced through early detection and appropriate treatment.
Unspecified contracted kidney, small kidney of unknown cause		X	N26-N27	Case-fatality rates can be reduced through early detection and appropriate treatment.
Inflammatory diseases of genitourinary system		X	N34.1,N70-N73,N75.0,N75.1,N76.4,6	Case-fatality rates can be reduced through early detection and appropriate treatment.
Prostatic hyperplasia		X	N40	Case-fatality rates can be reduced through early detection and appropriate treatment.
Tetanus neonatorum	X		A33	Most of these infections can be prevented through vaccination.
Obstetrical tetanus	X		A34	Most of these infections can be prevented through vaccination.
Pregnancy, childbirth and the puerperium		X	O00-O99	Effective treatment is available in most cases to avoid maternal mortality.
Certain conditions originating in the perinatal period		X	P00-P96	Case-fatality rates can be reduced through early detection and appropriate treatment.
Certain congenital malformations (neural tube defects)	X		Q00, Q01, Q05	These conditions can be prevented through prevention measures (improve maternal nutrition, e.g. folic acid consumption).
Congenital malformations of the circulatory system (heart defects)		X	Q20-Q28	These conditions can be treated through surgical operations
Drugs, medicaments and biological substances causing adverse effects in therapeutic use		X*	Y40-Y59	These conditions are treatable through better drug prescription and adherence.
Misadventures to patients during surgical and medical care		X*	Y60-Y69,Y83-Y84	These conditions are treatable through better quality of care that patients receive.

Causes of death	Preventable	Treatable	ICD-10 code(s)	Stated rationale
Medical devices associated with adverse incidents in diagnostic and therapeutic use		X*	Y70–Y82	These conditions are treatable through better quality of care that patients receive.
Transport Accidents	X		V01-V99	Deaths can be prevented through public health interventions (e.g. road safety measures).
Accidental Injuries	X		W00-X39, X46-X59	Deaths can be prevented through public health interventions (e.g. injury prevention campaigns).
Intentional self-harm	X		X66-X84	Deaths can be prevented through public health interventions (e.g. suicide prevention campaigns).
Event of undetermined intent	X		Y16-Y34	Deaths can be prevented through public health interventions (e.g. harm prevention campaigns).
Assault	X		X86-Y09	Deaths can be prevented through public health interventions.
Alcohol-specific disorders and poisonings	X		E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K85.2, K86.0, Q86.0, R78.0, X45, X65, Y15	Deaths can be largely prevented through public health interventions (e.g. alcohol control policies).
Other alcohol-related disorders	X		K73, K74.0-K74.2, K74.6	Deaths can be largely prevented through public health interventions (e.g. alcohol control policies).
Drug disorders and poisonings**	X		F11-F16, F18-F19, X40-X44, X85, Y10-Y14	Deaths can be largely prevented through public health interventions (e.g. drug control policies).
Intentional self-poisoning by drugs**	X		X60-X64	Deaths can be largely prevented through public health interventions (e.g. drug control policies).

* Some of these conditions that are mainly acquired when people are hospitalised or in contact with health services might also be considered to be preventable, in the sense that the incidence of these health care-associated infections or health problems might be reduced through greater prevention in health care facilities.

** Drug-related deaths include both illegal and legal drugs.

Section S7.2. List of ICD-10 codes used in classification of mortality from non-communicable diseases

Source:

World Health Organisation (2014). WHO Global Monitoring Framework on Noncommunicable Diseases: Indicator Definitions and Specifications. Geneva, WHO.

Cause of death	ICD-10 code(s)
Cancer	C00-C97
Cardiovascular disease	I00-I99
Chronic respiratory disease	J30-J98
Diabetes mellitus	E10-E14

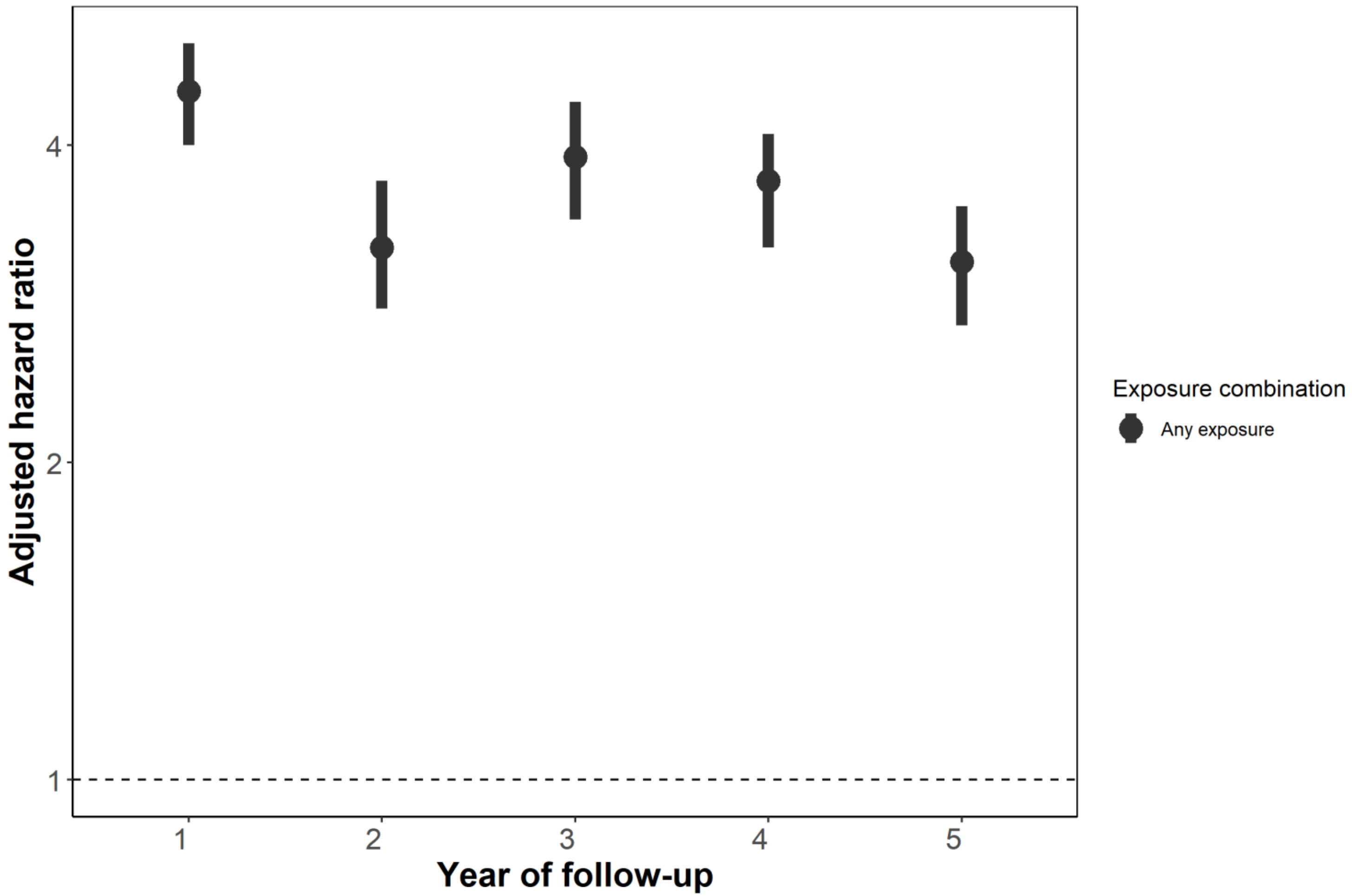
Section S7.3. Additional results

Table S7.3.1. Adjusted hazard ratios for all-cause mortality among the cohort by exposure combination, incorporating interaction between exposure and year of follow-up

	Adjusted hazard ratio for all-cause mortality* (95% confidence interval)				
	Year 1 (01/04/2014 – 31/03/2015)	**Year 2** (01/04/2015 – 31/03/2016)	**Year 3** (01/04/2016 – 31/03/2017)	**Year 4** (01/04/2017 – 31/03/2018)	**Year 5** (01/04/2018 – 31/03/2019)
Exposure status					
Unexposed	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Any exposure	4.5 (4.0 – 5.0)	3.2 (2.8 – 3.7)	3.9 (3.4 – 4.4)	3.7 (3.2 – 4.1)	3.1 (2.7 – 3.5)
Homelessness					
HL only	2.6 (2.0 – 3.4)	2.2 (1.6 – 3.0)	2.7 (2.0 – 3.5)	2.2 (1.6 – 2.9)	1.7 (1.2 – 2.3)
HL + other	11.6 (9.1 – 14.7)	6.1 (4.3 – 8.7)	10.3 (8.0 – 13.4)	7.7 (5.8 – 10.2)	7.6 (5.7 – 10.1)
Opioid dependence					
ODep only	8.7 (7.0 – 10.9)	6.3 (4.7 – 8.2)	5.8 (4.4 – 7.5)	7.5 (6.0 – 9.4)	6.2 (4.8 – 7.9)
ODep + other	15.1 (12.1 – 18.9)	8.7 (6.4 – 11.9)	12.0 (9.3 – 15.4)	10.0 (7.8 – 13.0)	9.2 (7.1 – 12.1)
Justice – custodial					
CUST only	5.8 (4.0 – 8.3)	2.9 (1.7 – 5.1)	3.0 (1.8 – 5.0)	2.9 (1.8 – 4.7)	2.6 (1.5 – 4.4)
CUST + other	13.8 (10.7 – 17.9)	7.9 (5.5 – 11.3)	9.4 (6.9 – 12.8)	8.1 (5.9 – 11.1)	9.2 (6.8 – 12.4)
Justice – community					
COMM only	2.3 (1.4 – 3.7)	2.3 (1.4 – 3.7)	2.4 (1.5 – 3.8)	1.7 (1.0 – 2.8)	1.0 (0.5 – 2.0)
COMM + other	7.5 (4.7 – 12.0)	6.1 (3.5 – 10.5)	7.0 (4.3 – 11.4)	5.1 (3.0 – 8.7)	3.7 (2.0 – 6.9)
Psychosis					
PSY only	2.2 (1.6 – 3.1)	2.2 (1.5 – 3.0)	3.0 (2.3 – 3.9)	2.8 (2.1 – 3.7)	2.1 (1.5 – 2.9)
PSY + other	11.3 (6.7 – 19.2)	5.4 (2.4 – 12.1)	4.8 (2.1 – 10.7)	8.4 (4.7 – 14.9)	7.9 (4.3 – 14.5)

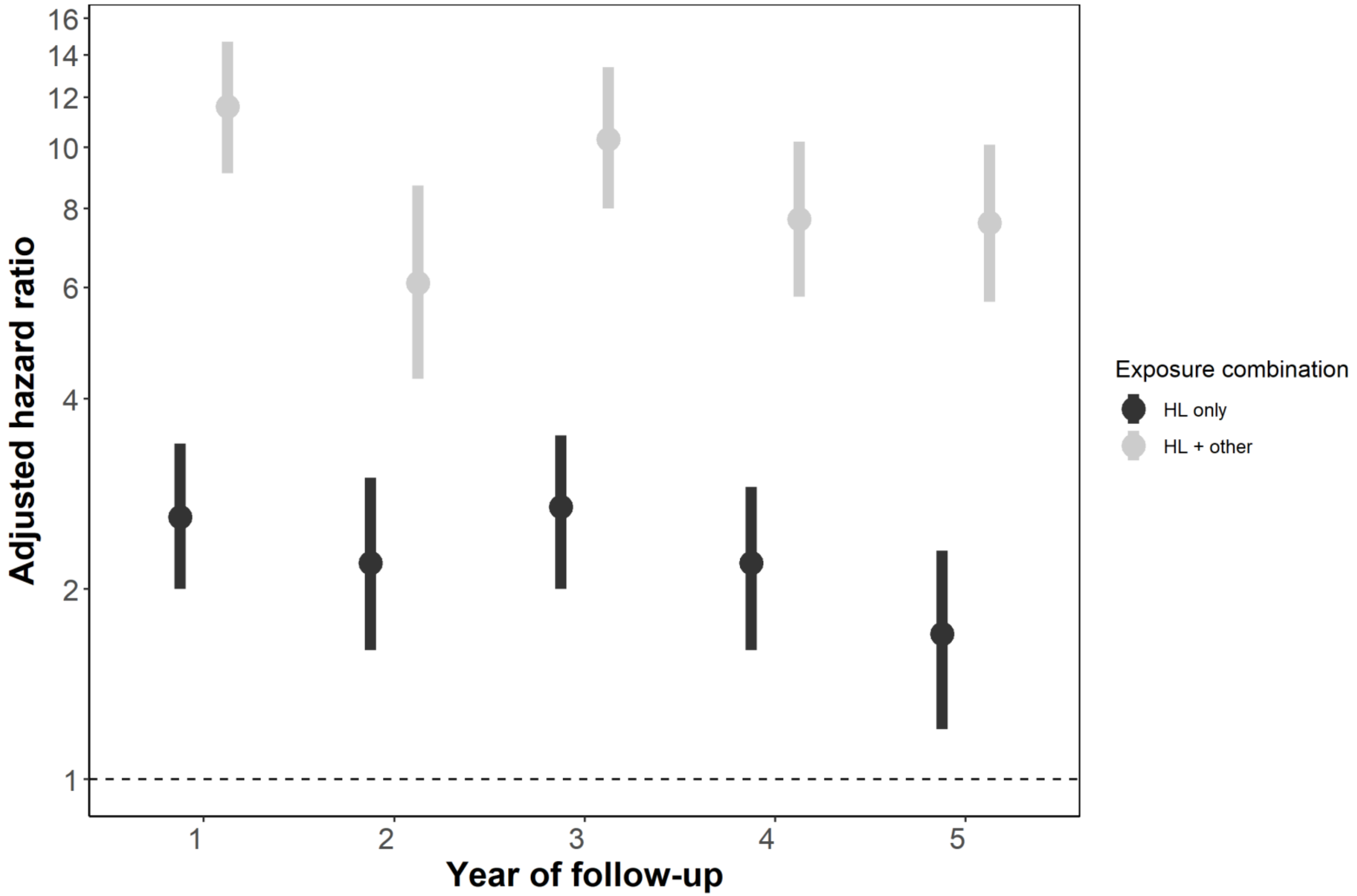
Exposure combinations are ordered by frequency of any flag for that exposure. *Unexposed population as reference group. Adjusted for age, gender, SIMD quintile, calendar year, and interaction term between calendar year and exposure combination.

Figure S7.3.1. Adjusted hazard ratio for all-cause mortality among those with any versus no exposures of interest, accounting for interaction between exposure and year of follow-up



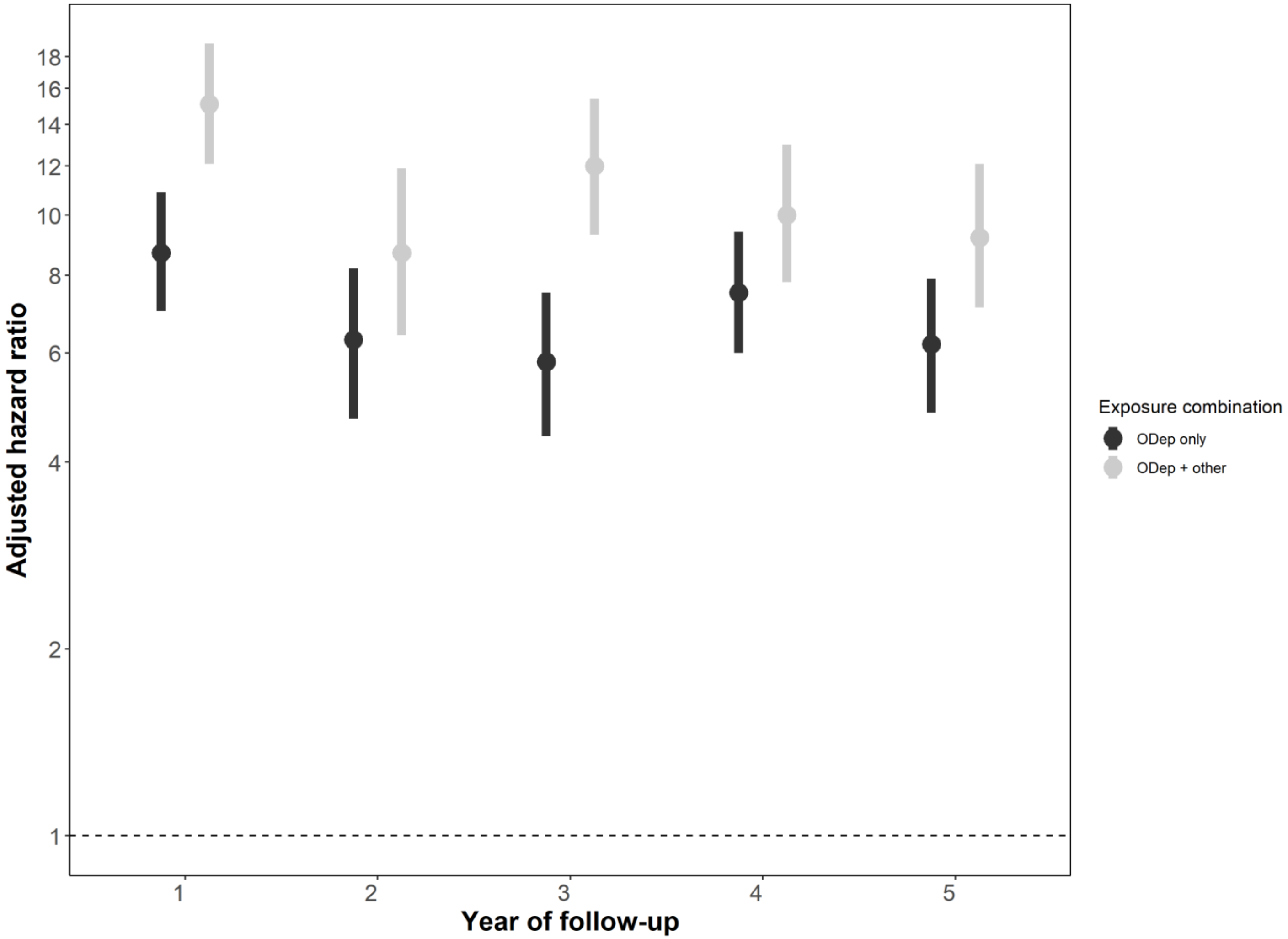
Unexposed population as reference group. Adjusted for age, gender, SIMD quintile, calendar year, and interaction term between calendar year and exposure combination.

Figure S7.3.2. Adjusted hazard ratio for all-cause mortality among those with homelessness alone or in combination with other exposures compared to the unexposed population, accounting for interaction between exposure and year of follow-up



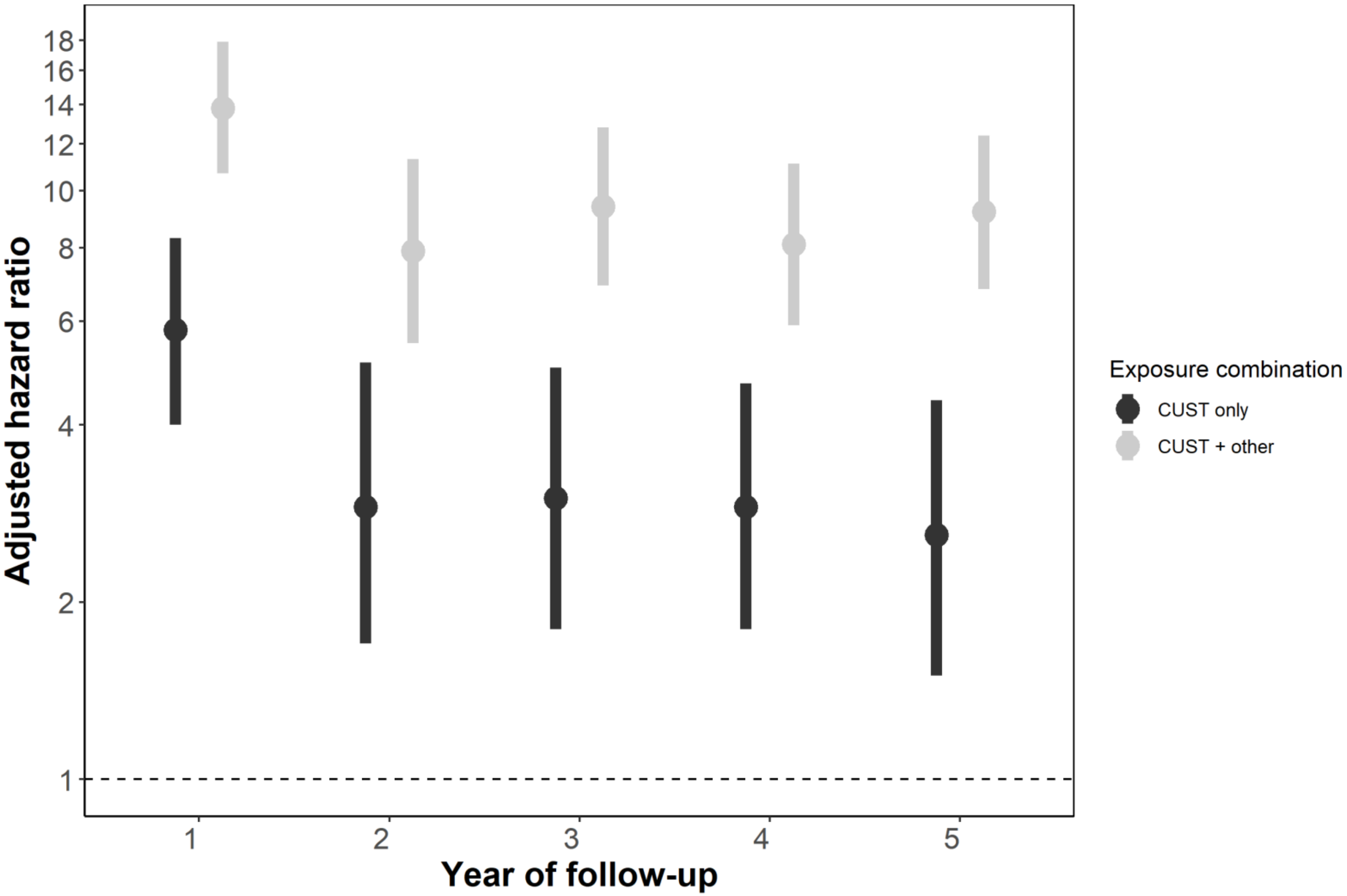
Unexposed population as reference group. Adjusted for age, gender, SIMD quintile, calendar year, and interaction term between calendar year and exposure combination.

Figure S7.3.3. Adjusted hazard ratio for all-cause mortality among those with opioid dependence alone or in combination with other exposures compared to the unexposed population, accounting for interaction between exposure and year of follow-up



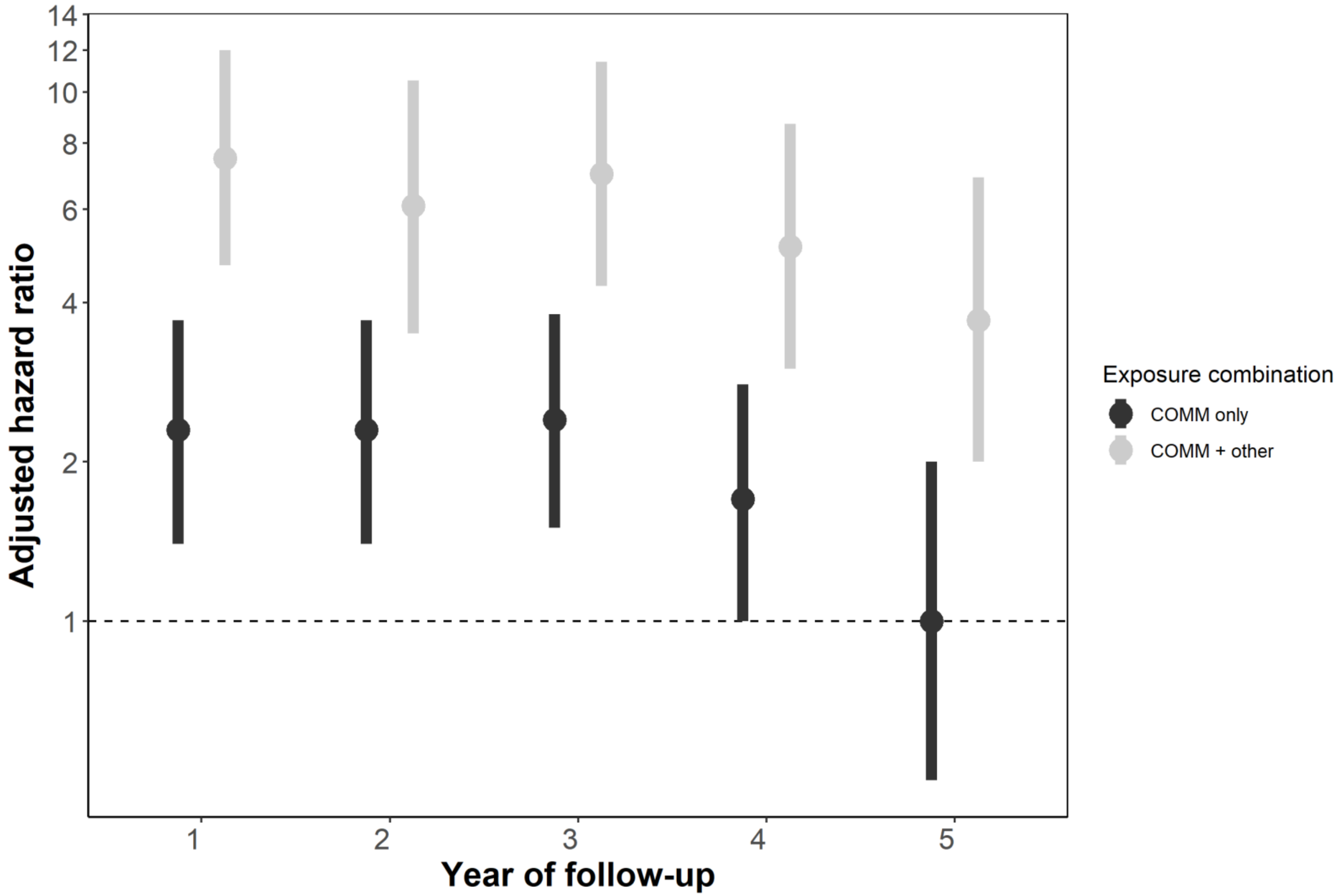
Unexposed population as reference group. Adjusted for age, gender, SIMD quintile, calendar year, and interaction term between calendar year and exposure combination.

Figure S7.3.4. Adjusted hazard ratio for all-cause mortality among those with imprisonment alone or in combination with other exposures compared to the unexposed population, accounting for interaction between exposure and year of follow-up



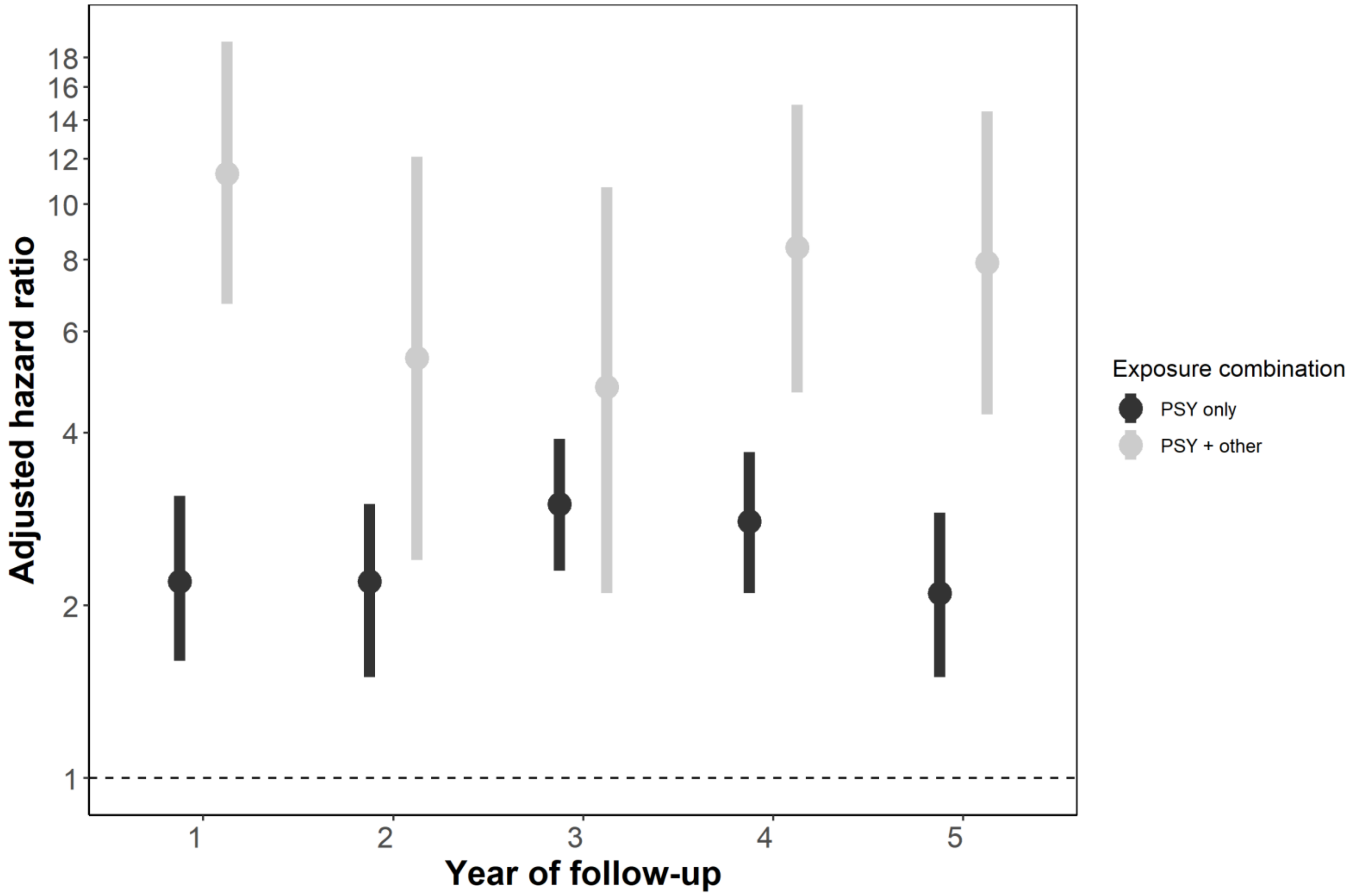
Unexposed population as reference group. Adjusted for age, gender, SIMD quintile, calendar year, and interaction term between calendar year and exposure combination.

Figure S7.3.5. Adjusted hazard ratio for all-cause mortality among those with community justice involvement alone or in combination with other exposures compared to the unexposed population, accounting for interaction between exposure and year of follow-up



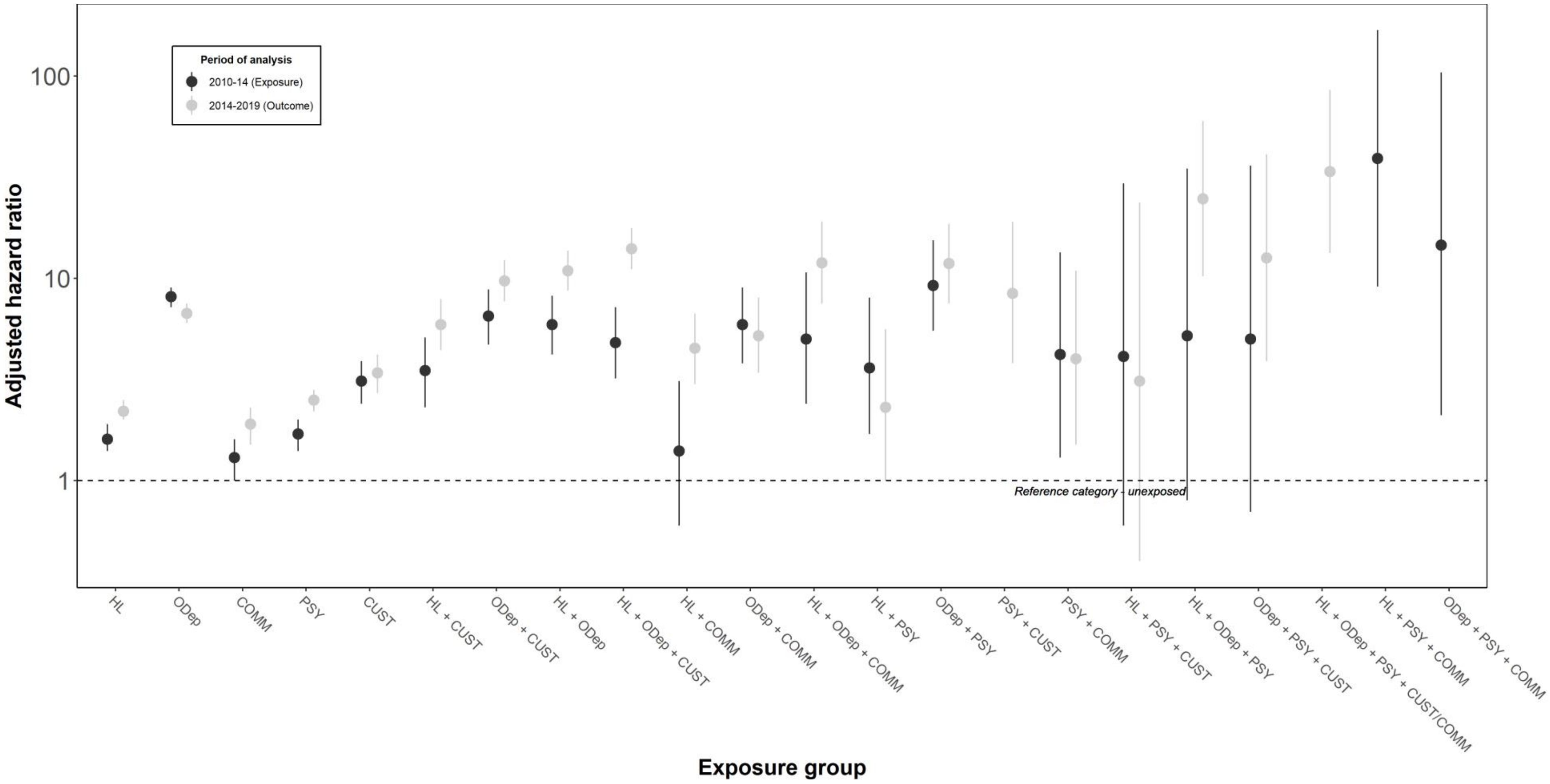
Unexposed population as reference group. Adjusted for age, gender, SIMD quintile, calendar year, and interaction term between calendar year and exposure combination.

Figure S7.3.6. Adjusted hazard ratio for all-cause mortality among those with psychosis alone or in combination with other exposures compared to the unexposed population, accounting for interaction between exposure and year of follow-up



Unexposed population as reference group. Adjusted for age, gender, SIMD quintile, calendar year, and interaction term between calendar year and exposure combination.

Figure S7.3.7. Adjusted hazard ratios for all-cause mortality by exposure combination and period of analysis, comparing the exposure period (01/04/2010 – 31/03/2014) to the outcome period used for primary analyses of mortality (31/03/2019)



Ordered by frequency of mutually exclusive categories.

Unexposed population as reference group. Adjusted for age, gender, SIMD quintile, calendar year, and interaction term between calendar year and exposure combination.

Table S7.3.2. Adjusted hazard ratios for all-cause mortality by exposure combination and period of analysis, comparing the exposure period (01/04/2010 – 31/03/2014) to the outcome period used for primary analyses of mortality (01/04/2014 – 31/03/2019)

Exposures of interest	**Adjusted hazard ratios (95% CI)**	
	Exposure period (01/04/2010 – 31/03/2014)	**Outcome period (01/04/2014 – 31/03/2019)**
Unexposed	1.00	1.00
Homelessness (HL) only	1.6 (1.4 -1 .9)	2.2 (2.0 – 2.5)
Opioid dependence (ODep) only	8.1 (7.2 – 9.0)	6.7 (6.0 – 7.5)
Justice – community (COMM) only	1.3 (1.0 – 1.8)	1.9 (1.5 – 2.3)
Psychosis (PSY)	1.7 (1.4 – 2.0)	2.5 (2.2 – 2.8)
Justice – custodial (CUST) only	3.1 (2.4 – 3.9)	3.4 (2.7 – 4.2)
HL + CUST	3.5 (2.3 – 5.1)	5.9 (4.4 – 7.9)
ODep + CUST	6.5 (4.7 – 8.8)	9.7 (7.7 – 12.3)
HL + ODep	5.9 (4.2 – 8.2)	10.9 (8.7 – 13.7)
HL + ODep + CUST	4.8 (3.2 – 7.2)	14.0 (11.1 – 17.7)
HL + COMM	1.4 (0.6 – 3.1)	4.5 (3.0 – 6.7)
ODep + COMM	5.9 (3.8 – 9.0)	5.2 (3.4 – 8.0)
HL + ODep + COMM	5.0 (2.4 – 10.7)	11.9 (7.5 – 18.6)
HL + PSY	3.6 (1.7 – 8.0)	2.3 (1.0 – 5.6)
ODep + PSY	9.2 (5.5 – 15.4)	11.8 (7.5 – 18.6)
PSY + CUST	-	8.4 (3.8 – 19.0)
PSY + COMM	4.2 (1.3 – 13.4)	4.0 (1.5 – 10.9)
HL + PSY + CUST	4.1 (0.6 – 29.4)	3.1 (0.4 – 23.7)
HL + PSY + ODep	5.2 (0.8 – 34.8)	24.7 (10.2 – 59.8)
ODep + PSY + CUST	5.0 (0.7 – 36.0)	12.6 (3.9 – 41.1)
HL + ODep + PSY + any justice involvement*	-	33.7 (13.3 – 85.5)
HL + PSY + COMM	39.1 (9.1 – 168.3)	-
ODep + PSY + COMM	14.6 (2.1 – 104.1)	-

Exposure combinations are ordered by frequency of mutually exclusive categories.

Table S7.3.3. Test for interaction between multiple exposures on a multiplicative scale

Exposure of interest*	Adjusted hazard ratio for multiplicative interaction with other exposures (95% CI)	P value
Any homelessness	1.0 (0.8 – 1.2)	0.975
Any opioid dependence	1.6 (1.3 – 1.9)	<0.001
Any justice involvement - custodial	1.2 (0.9 – 1.6)	0.173
Any justice involvement - community	1.3 (0.9 – 1.8)	0.136
Any psychosis	1.4 (1.0 – 1.9)	0.062

* Ordered by frequency of any exposure to experience of interest

Table S7.3.4. Number and proportion of avoidable deaths (of which preventable and treatable) by exposure combination

		Number of deaths (% of total deaths, by row)		
	All-cause	**Avoidable**	**Preventable***	**Treatable***
Total population	11,484	8,121 (70.7)	5,901.5 (51.4)	2,219.5 (19.3)
No exposures of interest	10,103	7,017 (69.5)	4,964.5 (49.1)	2,052.5 (20.3)
Any exposure of interest	1,381	1,104 (79.9)	937 (67.8)	167 (12.1)
Any homelessness (HL)	**511**	**412 (80.6)**	**357 (69.9)**	**55 (10.8)**
HL only	241	185 (76.8)	146 (60.6)	39 (16.2)
HL + other exposures	270	227 (84.1)	211 (78.1)	16 (5.9)
Any opioid dependence (ODep)	**657**	**551 (83.9)**	**501.5 (76.3)**	**49.5 (7.5)**
ODep only	347	286 (82.4)	250.5 (72.2)	35.5 (10.2)
ODep + other exposures	310	265 (85.5)	250 (81.0)	14 (4.5)
Any prison experience (CUST)	**307**	**257 (83.7)**	**234 (76.2)**	**23 (7.5)**
CUST only	88	74 (84.1)	63 (71.6)	11 (12.5)
CUST + other exposures	219	183 (83.6)	171 (78.1)	12 (5.5)
Any justice involvement without imprisonment (COMM)	**149**	**128 (85.9)**	**107.5 (72.1)**	**20.5 (13.8)**
COMM only	77	66 (85.7)	53 (68.8)	13 (16.9)
COMM + other exposures	72	62 (86.1)	54.5 (75.7)	7.5 (10.4)
Any psychosis (PSY)	**276**	**195 (70.7)**	**147.5 (53.4)**	**47.5 (17.2)**
PSY only	227	154 (67.8)	109.5 (48.2)	44.5 (19.6)
PSY + other exposures	49	41 (83.7)	38 (77.6)	3 (6.1)

Note that exposure combinations are ordered by frequency of any flag for that exposure.

*OECD/Eurostat definition of preventable and treatable deaths includes some causes which are classified as 50% preventable, 50% treatable (and therefore 100% avoidable). Figures in these columns may therefore include non-integers reflecting the preventable and/or treatable fraction within a given population group.

Table S7.3.5. Mortality from avoidable causes, by exposure combination and age group

	Number of individuals at start of follow-up (person-years at risk)	Age-stratified rate per 100,000 person-years (95% CI)				Crude HR* (95% CI)	Adjusted HR** (95% CI)
		18-29 yrs	30-44 yrs	45-59 yrs	60-74 yrs		
Exposure status							
Unexposed	508,541 (2,367,741.8)	7.6 (5.7 – 10.1)	53.6 (48.6 – 59.1)	322.1 (308.6 – 336.3)	1,355.3 (1,316.2 – 1,395.5)	1.0	1.0
Any exposure	28,112 (134,354.0)	152.9 (115.5 – 202.3)	663.4 (601.3 – 731.9)	1,401.1 (1,284.3 – 1,528.5)	2,450.2 (2,087.9 – 2,875.4)	2.8 (2.6 – 3.0)	4.1 (3.9 – 4.4)
Homelessness							
HL only	9,463 (45,335.5)	32.4 (13.5 – 77.9)	250.7 (187.8 – 334.7)	1,1002.3 (822.3 – 1,221.8)	2,201.3 (1,458.0 – 2,802.2)	1.4 (1.2 – 1.6)	2.5 (2.1 – 2.9)
HL + other	3,612 (170,041.3)	437.5 (272.0 – 703.7)	1,306.3 (1,094.7 – 1,558.8)	2,355.5 (1,899.6 – 2,920.9)	1,853.4 (695.6 – 4,938.3)	4.5 (3.9 – 5.1)	10.2 (8.8 – 11.7)
Opioid dependence							
ODep only	4,123 (19,631.2)	410.3 (102.6 – 1,640.7)	1,048.8 (880.2 – 1,249.8)	2,081.4 (1,768.8 – 2,449.4)	5,399.1 (3,197.6 – 9,116.2)	4.9 (4.4 – 5.5)	8.0 (7.1 – 9.1)
ODep + other	3,289 (15,431.7)	905.2 (471.0 – 1,739.6)	1,420.3 (1,210.9 – 1,665.9)	2,754.7 (2,273.0 – 3,338.4)	3,276.8 (461.6 – 23,262.3)	5.8 (5.1 – 6.6)	13.2 (11.5 – 15.0)
Justice – custodial							
CUST only	2,755 (13,137.2)	207.9 (115.1 – 375.3)	414.4 (270.2 – 635.6)	1,275.7 (897.2 – 1,814.0)	3,168.1 (1,754.5 – 5,720.7)	1.9 (1.5 – 2.4)	4.0 (3.1 – 5.0)
CUST + other	2,757 (12,948.2)	672.8 (418.3 – 1,082.3)	1,262.6 (1,032.6 – 1,543.8)	2,541.8 (2,014.3 – 3,207.4)	0.0 (-)	4.8 (4.1 – 5.5)	11.2 (9.6 – 13.1)
Justice – community							
COMM only	3,338 (16,302.2)	145.8 (72.9 – 291.6)	310.8 (198.2 – 487.2)	618.2 (417.7 – 914.8)	2,128.3 (1,260.5 – 3,593.6)	1.4 (1.1 – 1.7)	2.3 (1.8 – 2.9)
COMM + other	1,281 (6,154.0)	296.9 (111.4 – 791.2)	916.8 (641.0 – 1,311.3)	1,599.2 (1,062.7 – 2,406.6)	5,173.2 (2,153.2 – 12,428.8)	3.4 (2.6 – 4.4)	7.0 (5.4 – 9.1)
Psychosis							
PSY only	3,255 (15,491.5)	94.1 (13.3 – 667.9)	298.8 (173.5 – 514.5)	979.9 (776.6 – 1,236.5)	2,436.5 (1,924.4 – 3,084.9)	3.4 (2.9 – 3.9)	2.4 (2.0 – 2.8)
PSY + other	536 (2,533.4)	921.6 (297.2 – 2,857.5)	1,263.7 (774.2 – 2,062.7)	2,248.8 (1,450.8 – 3,485.6)	3,818.6 (955.0 – 15,268.5)	5.5 (4.0 – 7.4)	9.0 (6.6 – 12.4)

Exposure combinations are ordered by frequency of any flag for that exposure. *Unexposed population as reference group. ** Unexposed population as reference group. Adjusted for age, gender, SIMD quintile, and calendar time. All models except those for psychosis include an interaction term between exposure and calendar time.

Table S7.3.6. Number and proportion of deaths from non-communicable diseases by exposure combination

	Number (% of total deaths, by row)	
	All-cause	**NCD deaths**
Total population	11,484	8,080 (70.4)
No exposures of interest	10,103	7,539 (74.6)
Any exposure of interest	1,381	541 (39.2)
Any homelessness (HL)	**511**	**179 (35.0)**
HL only	241	126 (52.3)
HL + other exposures	270	53 (19.6)
Any opioid dependence (ODep)	**657**	**181 (27.5)**
ODep only	347	116 (33.4)
ODep + other exposures	310	65 (21.0)
Any justice involvement - custodial (CUST)	**307**	**67 (21.8)**
CUST only	88	25 (28.4)
CUST + other exposures	219	42 (19.2)
Any justice involvement - community (COMM)	**149**	**57 (38.3)**
COMM only	77	35 (45.5)
COMM + other exposures	72	22 (30.6)
Any psychosis (PSY)	**276**	**163 (59.1)**
PSY only	227	147 (64.8)
PSY + other exposures	49	16 (32.7)

Exposure combinations are ordered by frequency of any flag for that exposure.

Table S7.3.7. Mortality from non-communicable diseases (NCD), by exposure combination

	Number of individuals at start of follow-up (person-years at risk)	Number of NCD deaths (% of all deaths)	Age-stratified rate per 100,000 person-years (95% CI)				Crude HR* (95% CI)	Adjusted HR** (95% CI)
			18-29 yrs	30-44 yrs	45-59 yrs	60-74 yrs		
Exposure status								
Unexposed	508,541 (2,367,741.8)	7,539 (74.6)	5.4 (3.8 – 7.5)	42.1 (37.8 – 47.0)	336.6 (322.7 – 351.0)	1,515.4 (1,474.0 – 1,557.9)	1.0	1.0
Any exposure	28,112 (134,354.0)	541 (39.2)	34.3 (19.0 – 62.0)	150.0 (122.0 – 184.4)	809.7 (722.1 – 907.9)	2,401.2 (2,042.8 – 2,822.5)	1.3 (1.2 – 1.4)	2.2 (2.0 – 2.4)
Homelessness								
HL only	9,463 (45,335.5)	126 (52.3)	6.5 (0.9 – 46.0)	103.6 (66.1 – 162.3)	726.2 (575.5 – 916.4)	1,965.1 (1,411.0 – 2,737.0)	0.9 (0.7 – 1.0)	1.7 (1.4 – 2.0)
HL + other	3,612 (170,041.3)	53 (19.6)	77.2 (25.0 – 239.4)	127.4 (72.4 – 224.4)	936.5 (665.8 – 1,317.3)	2,316.8 (964.3 – 5,566.2)	1.0 (0.7 – 1.3)	2.7 (2.0 – 3.5)
Opioid dependence								
ODep only	4,123 (19,631.2)	116 (33.4)	205.2 (28.9 – 1,456.5)	268.5 (189.9 – 379.7)	1,019.2 (807.7 – 1,286.1)	4,627.8 (2,628.2 – 8,148.8)	1.9 (1.5 – 2.2)	3.6 (3.0 – 4.3)
ODep + other	3,289 (15,431.7)	65 (21.0)	201.1 (50.3 – 804.3)	206.9 (136.3 – 314.3)	1,059.5 (777.2 – 1,444.4)	3,276.8 (461.6 – 23,262.3)	1.3 (1.0 – 1.7)	3.7 (2.9 – 4.8)
Justice – custodial								
CUST only	2,755 (13,137.2)	25 (28.4)	56.7 (18.3 – 175.8)	19.7 (2.8 – 140.1)	452.7 (250.7 – 817.4)	2,808.1 (1,549.6 – 5,352.8)	0.6 (0.4 – 0.9)	1.4 (0.9 – 2.1)
CUST + other	2,757 (12,948.2)	42 (19.2)	158.3 (59.4 – 421.8)	132.9 (71.5 - 247.0)	1,002.4 (692.1 – 1,451.8)	0.0 (-)	1.0 (0.8 – 1.4)	2.9 (2.2 – 4.0)
Justice – community								
COMM only	3,338 (16,302.2)	35 (45.5)	36.5 (9.1 – 145.8)	81.8 (34.0 – 196.5)	420.3 (261.3 – 676.2)	1,672.3 (926.1 – 3,019.6)	0.7 (0.5 – 0.9)	1.2 (0.9 – 1.7)
COMM + other	1,281 (6,154.0)	22 (30.6)	0.0 (-)	152.8 (63.6 – 367.1)	764.9 (423,6 – 1,381.1)	6,207.9 (2,788.9 – 13,818.0)	1.1 (0.7- 1.7)	2.7 (1.8 – 4.1)
Psychosis								
PSY only	3,255 (15,491.5)	147 (64.8)	0.0 (-)	229.8 (123.7 – 427.1)	897.1 (703.5 – 1,144.0)	2,542.4 (2,018.1 – 3,203.0)	3.0 (2.5 – 3.5)	2.2 (1.8 – 2.6)
PSY + other	536 (2,533.4)	16 (32.7)	0.0 (-)	315.9 (118.6 – 841.7)	1,124.4 (605.0 – 2,089.7)	3,818.6 (955.0 – 15,268.5)	2.0 (1.2 – 3.2)	3.7 (2.3 – 6.1)

Exposure combinations are ordered by frequency of any flag for that exposure.

Table S7.3.8. Years of Potential Life Lost – sum total, mean per decedent, and mean per 100,000 people at risk, by exposure combination

Exposures of interest	Sum total	Mean per decedent (95% CI)	Mean per 100,000 people at risk (95% CI)
Unexposed	114344.9	11.3 (11.1 – 11.5)	22,484.9 (22,354.8 – 22,615.6)
Homelessness (HL) only	5058.1	21.0 (19.6 – 22.4)	53,451.4 (51,987.3 – 54,944.0)
Opioid dependence (ODep) only	8966.5	25.8 (25.1 – 26.6)	217,475.9 (213,008.8 – 222,036.2)
Justice – community (COMM) only	2369.7	24.5 (21.6 – 27.4)	56,572.1 (54,038.0 – 59,171.0)
Psychosis (PSY)	3474.5	15.3 (14.1 – 16.5)	106,742.7 (103,208.3 – 110,337.4)
Justice – custodial (CUST) only	2369.7	26.9 (24.1 – 29.7)	86,014.7 (82,596.6 – 89,560.1)
HL + CUST	1453.7	29.1 (25.7 – 32.4)	146,248.8 (138,854.7 -153,994.4)
ODep + CUST	2142.0	28.6 (27.0 – 30.1)	253,194.3 (242,581.6 – 264,146.0)
HL + ODep	2292.1	28.7 (26.9 – 30.4)	279,527.6 (268,185.1 – 291,194.8)
HL + ODep + CUST	2500.9	31.7 (30.1 – 33.2)	320,622.1 (308.196.5 – 333,459.1)
HL + COMM	600.3	24.0 (19.4 – 28.7)	104,588.6 (96,331.9 – 113,238.5)
ODep + COMM	649.6	28.2 (25.0 – 31.5)	150,026.8 (138,795.5 – 162,112.8)
HL + ODep + COMM	677.1	33.9 (30.6 – 37.1)	347,226.9 (321,516.4 – 374,346.1)
HL + PSY	111.3	22.3 (10.0 – 34.5)	69,976.6 (57,429.8 – 84,078.8)
ODep + PSY	512.8	25.6 (22.7 – 28.6)	379,819.0 (347,824.0 – 41,4351.8)
PSY + CUST	163.2	27.2 (11.4 – 43.0)	267,571.1 (227,765.6 – 311,529.7)
PSY + COMM	88.5	22.1 (6.5 – 37.8)	158,066.9 (127,632.7 – 195,575.3)
HL + PSY + CUST	<3 deaths		
HL + PSY + ODep	142.8	28.6 (19.4 – 37.8)	549,220.8 (463,551.1 – 647,892.1)
ODep + PSY + CUST	82.5	27.5 (24.0 – 31.0)	329,837.1 (260,868.1 -407,134.5)
HL + ODep + PSY + any justice involvement*	163.9	32.8 (22.2 – 43.3)	862,549.1 (736,107.2 – 1,005,839.8)
HL + PSY + COMM	<3 deaths		
ODep + PSY + COMM	<3 deaths		

Exposure combinations are ordered by frequency of mutually exclusive categories.

Results omit exposure combinations in which <3 deaths occurred during follow-up.

Supplementary material accompanying Chapter 8

Contents:

(a) Study protocol

(b) Supplementary material accompanying published article

Study protocol

Published on OSF (https://osf.io/j8uzd/) and reproduced below:

Tobacco In Prisons study (TIPs): exploring changes in medication dispensing and hospital admissions following implementation of smokefree prisons in Scotland

PROTOCOL

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PLAIN LANGUAGE SUMMARY

To date, there has been little research on how smokefree prison policies affect health outcomes among people in prison. In particular, no previous studies appear to have explored changes in rates of hospital admissions or use of medications for smoking-related illnesses following the introduction of such policies. The implementation of a smokefree prisons policy in Scotland in November 2018 offers an opportunity to address this important gap in knowledge.

In order to address these questions, we propose using routinely collected data on the number of medications dispensed in prisons (from National Procurement, NHS National Services Scotland) and the number of hospital admissions from prisons (from Information Services Division, NHS National Services Scotland), combined with Scottish Prison Service (SPS) data on the prison population to account for changes in the number of people in prison during the study period. These data can be analysed using the statistical method ARIMA to investigate differences between the pre- and post-ban period in the rate of dispensed medications and hospital admissions for smoking-related illnesses. We also plan to look at rates of dispensing for conditions we would not expect to be affected by smoking, in order to give greater confidence that any changes observed are likely to be due to the ban.

1. Background

Smoking bans in public places have resulted in substantial reductions in smoking-related conditions, including hospitalisations for acute coronary syndromes and childhood asthma; and respiratory, irritant, and sensory symptoms (Ayres et al., 2009, Mackay et al., 2010a, Pell et al., 2008, Mackay et al., 2010b, Goodman et al., 2009). However, national smoking bans are heterogeneous and vary in whether they encompass smoking in custodial settings. In Scotland, prisons had partial exemption from the 2006 legislation on smokefree enclosed public places, in that people in prison were permitted to smoke in their cells, as well as during outdoor recreation. Staff have not been permitted to smoke on prison premises since 2008 in Scotland.

Smoking is common among people in prison, estimated at 64-88% across Europe and 68% in Scotland in 2017, with little evidence of a downward trend over time as observed in the general population (Carnie et al., 2017, Sweeting and Hunt, 2015). On 30th November 2018, a total smoke-free prison policy was implemented across the Scottish Prison Service estate. The implementation of the policy led to substantial decreases in levels of PM2.5, a marker of second-hand smoke, to a level comparable with outdoor concentrations (Semple et al., 2020): there are therefore strong grounds for expecting an impact on the health of people in prison.

Previous evaluations of smoke-free prison policies have suggested improvements in self-rated health and smoking-related symptoms (Sweeting and Hunt, 2015). However, fewer have investigated the occurrence of specific smoking-related illnesses or healthcare utilisation among people in prison (Spaulding et al., 2018, Frazer et al., 2016a). Several reviews cite a US PhD study finding lower rates of heart attack in a prison with a complete versus partial smoking ban (Sweeting and Hunt, 2015), whilst a modelling study from the US using smoking prevalence data and estimates of smoking attributable mortality from 2001-2011 estimated that prison smoking bans were associated with a 9% reduction in the incidence of smoking-related death (Binswanger et al., 2014).

No studies to date appear to have investigated impacts on healthcare or medication use as proxy measures of objective ill-health or as indicators of the economic burden associated with smoking in prison settings (Frazer et al., 2016b). A Cochrane review in 2016 identified a need for more robust studies assessing the health impact of smoking bans in institutional settings such as prisons, including both pre- and post-ban data and follow-up periods beyond six months.

Alongside the limited evidence of positive impacts, there are also concerns about potential negative unintended consequences of prison smoking bans (Sweeting and Hunt, 2015, Frazer et al., 2016b). These might include, for example, an increase in assaults due to greater aggression, hostility and violence within the prison environment, greater use of non-tobacco substances, or a worsening of mental health among some people in prison. There is limited evidence to date on these important outcomes.

Data on the impact of the smokefree Scottish prisons policy on medication dispensing and hospital admissions can help address these evidence gaps, enhancing our understanding of the impact of prison smoking bans on health and on healthcare costs and informing the development of an economic policy model for these outcomes.

This protocol describes plans for two sets of time-series analyses to model potential impacts on dispensing and hospital admissions to be conducted as part of the Tobacco In Prisons study (TIPs) (Hunt et al., 2019). TIPs is a 3.5 year study (2016-2020) which aims to evaluate the processes and outcomes of the November 2018 smokefree Scottish prisons policy, funded by the National Institute of Health Research. The data requested for this analysis will also contribute to the economic modelling element of the TIPS project, which is described separately (Tobacco In Prisons study team, 2019).

2. Research questions

RQ1. What was the association between the smokefree prison policy and dispensing of medications for: smoking cessation; nicotine replacement; specific smoking-related health conditions; and potential unintended consequences among people in prisons in Scotland?

RQ2. What was the association between the smokefree prison policy and hospitalisations for: all causes; specific smoking-related health conditions; and potential unintended consequences among people in prisons in Scotland?

3. Methods

All data will be requested from January 2013 (4.5 years prior to the announcement of the smokefree policy in July 2017) to the end of November 2019 (one year post-implementation).

3.1. Data: medication dispensing

For RQ1, the data of interest will be dispensing rates for the relevant medications for all closed prisons in Scotland. This requires data on:

- Number of items dispensed in prisons (available from National Procurement, NHS National Services Scotland, based on individual named patient medication records)
- Prison population (based on SPS population and accommodation reports)

The items of interest are shown in Table 1 overleaf. As prescribing of anti-depressant medications may include indications other than mental health, and no data on indication are available, analysis of this category will include a subgroup analysis for selective serotonin reuptake inhibitors (SSRIs) only, the class most specific to mental health problems.

In addition to prescription on a named patient supply, nicotine replacement therapy (NRT) is also available by pharmacy stock supply and by purchase from the prison canteen[5], neither of which will be included in the dispensing data. This may affect the numbers included in the dispensing data, though as described below we may be able to incorporate data on canteen sales as a covariate in the models: these issues will be noted in the interpretation.

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[5] The 'canteen' is essentially the prison shop, a means by which people in prison can purchase items such as food, toiletries, phone cards etc

3.2. Data: hospitalisations

For RQ2, the data of interest for the primary analysis will be emergency hospital admission rates for the conditions of interest from closed prisons in Scotland; secondary analyses will cover all prisons, including the single open prison. This requires data on:

- Number of admissions as inpatients or day cases to hospitals in Scotland from Scottish prisons (available from Information Services Division, National Services Scotland)
- Prison population (based on SPS population and accommodation reports)

Emergency hospitalisations will be identified using the SMR01 and SMR04 dataset. Within these datasets, admissions can be considered synonymous with continuous inpatient stays (CIS): each of these represents a continuous spell of treatment which may be made up of multiple episodes of care (e.g., resulting from transfers between specialties, consultants, hospitals, or health boards). Episodes of care for the same individual are linked within SMR01 and SMR04 on a probabilistic basis to identify continuous inpatient stays.

Table 1. Medication items of interest to the evaluation (RQ1)

Level 1 grouping	**Level 2 grouping**	
	Category	**Comprising:**
Indicators of treatment for nicotine dependence	Smoking cessation	*Varenicline* *Buproprion*
	Nicotine replacement therapy (NRT)	*Nicotine and nicotine bitartrate*
Indicators of smoking-related illnesses or symptoms	Cardiovascular	*Glyceryl trinitrate*
	Respiratory	*Inhaled bronchodilators* *Inhaled steroids* *Antibiotics*
	Sensory	*Chloramphenicol eye drops/ointment*
	Gastrointestinal	*Proton pump inhibitors, H2 receptor antagonists & antacids*
Indicators of potential unintended consequences	Mental health: all antidepressants	*All anti-depressants*
	Mental health: SSRIs only	*Selective serotonin re-uptake inhibitors (SSRIs)*
Negative controls	-	*Anti-convulsants (excl. pregabalin and gabapentin)*

Table 2. Hospitalisations of interest to the evaluation, and ICD-10 codes (RQ2).

Level 1 grouping	**Level 2 grouping**	
	Category	**Comprising:**
All cause admissions	SMR01 (acute hospitals)	*N/A*
	SMR04 (psychiatric hospitals)	*N/A*
Conditions with potential acute effects related to smoking	Cardiovascular conditions: all ischaemic heart disease	*All Ischaemic heart disease (I20-I25)*
	Cardiovascular conditions: acute MI only	*Acute myocardial infarction (I21)*
	Respiratory conditions	*Asthma (J45-J46)*
		Chronic Obstructive Pulmonary Disease (J43-J44)
		Pneumonia and lower respiratory tract infection (J12-J18; J20-J22)
Indicators of potential unintended consequences	Intentional self-harm	*Intentional self-harm (X60-X84)*
	Assault	*Assault (X85-Y09)*
	Substance use	*Mental and behavioural disorders due to psychoactive substance use (F11-F16, F18, F19)*
		Poisoning by narcotics and psychodysleptics (T40.0, T40.1, T40.3, T40.5-T40.9)

Since there are no validated methods for identifying admissions to hospitals from prisons in routine healthcare data, we will use two different approaches for primary and secondary analyses.

In the primary analysis, we will use the person's postcode of residence recorded in SMR01 and SMR04 to identify people admitted from any one of the 14 closed Scottish prisons. This approach will identify all people with a continuous inpatient stay as an inpatient or day case where at least one episode of care during that stay contains a postcode of residence associated with one of those prisons. Analysis of prison postcodes indicates that 13 of these 14 establishments have a unique postcode, while one shares its postcode with two residential and two commercial addresses. This suggests that incorrect misclassification of admissions as originating from prisons is likely to be minimal, but this approach is likely to under-ascertain the total number of admissions. A similar project in England using this approach estimated that it identified approximately 70% of admissions[6]. This approach is therefore likely to have high specificity, but only moderate sensitivity for detecting hospital admissions originating from prisons. However, the study team are not aware of any reason why either the sensitivity or specificity of this method may have changed during the study period or in concert with the intervention, so this under-ascertainment is unlikely to result in significant bias.

In the secondary analysis, we will use an additional two methods to complement postcode of residence in identifying hospital admissions originating from prisons: GP registration as recorded in SMR01 or SMR04 as the single general practice code applicable to all Scottish prison GPs, or the "admission/transfer from" location recorded in SMR01 or SMR04 as "legal establishment, including prison". Hospital admissions will be included in the analysis if they meet any one of these criteria. This approach is likely to identify more of the hospital admissions originating from prisons (i.e., is more sensitive) but may also include people admitted from locations other than prison (i.e., is less specific): for instance, the "legal establishment, including prison" category also applies to police custody suites, and both methods may also include admissions originating from the Castle Huntly open prison, which is excluded from the main analysis. There also remain limitations in the sensitivity of this method, as it will under-ascertain people on remand or short-term sentences who are not registered with the prison GP practice. Again, there is no reason to believe that either the sensitivity or specificity of this method may have changed during the study period or in concert with the intervention, so this under-ascertainment is unlikely to result in significant bias.

The conditions of interest, and the associated ICD-10 codes, are shown in Table 2 (preceding page). All episodes of care within the continuous inpatient stay will be evaluated for the diagnoses of interest. Only the principal diagnostic position for each hospital episode will be used to identify relevant cases, except for intentional self-harm, assault, and substance use: on the advice of ISD, all diagnostic positions will be considered for these codes, as they are generally recorded as secondary diagnostic codes.

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[6] Personal communication, Miranda Davies, Nuffield Trust.

3.3. Analysis

3.3.1. Overall analytical approach

The data series for both dispensing and admission rates will be analysed using Autoregressive Integrated Moving Average (ARIMA) time series methods.

Included in the models will be two pre-specified breakpoints based on the official dates of announcement and implementation of smokefree prisons:

- First breakpoint on date of announcement (17/07/2017)
- Second breakpoint on date of implementation (30/11/2018)

Two analytical approaches will be tested:

1. Testing for the presence of structural breaks and outliers in the data using Wald test applied to the white noise residuals of the (S)ARIMA errors model.
2. Testing for the presence of structural breaks and outliers in the data using indicator saturation applied to the white noise residuals of the (S)ARIMA errors model.

In each approach, the estimated breakpoints will then be incorporated into the final intervention model ensuring efficient effect estimates and standard errors.

Measures of overcrowding (such as population counts relative to capacity) will be included in all models as potential confounding factors. Interpretation will also be informed by the results of the TIPs qualitative workstreams, which may give insights into confounding factors less amenable to measurement. For instance, insights from this may be helpful in understanding any potential impact of new psychoactive substance use following the ban or the influence of e-cigarette use.

The primary analysis for both research questions will comprise only the 14 closed prisons (i.e., excluding Castle Huntly). This is because findings from work package 3 of the TIPs study have demonstrated that the nature, implementation, and effectiveness of the smokefree policy is likely to differ substantially in open versus closed establishments; for example, those in the open prison may continue to smoke on periods of home leave, or potentially whilst undertaking jobs away from the prison. Secondary analyses including all prisons in Scotland, whether open or closed, will also be undertaken.

3.3.2. Analysis: medication dispensing

Medications will be analysed according to each of the two levels of grouping shown in Table 1. Although the Scotland-wide implementation of the policy means that control prisons are not available for comparison, negative control medications (i.e., those that are not expected to change as a result of the policy) will be used to supplement the results of time series analysis. A list of items which were considered as negative controls and the reasons they were deemed unsuitable is available on request.

In addition to measures of overcrowding, we will also explore the feasibility of including available canteen data on sales of e-cigarette devices and SPS data on the free provision of e-cigarette devices, as a potential confounding factor for the dispensing of NRT and smoking cessation medications (Brown et al., 2019b).

As described above, two alternative analytical approaches will be tested:

1. Wald test applied to the white noise residuals of the (S)ARIMA errors model

2. Indicator saturation applied to the white noise residuals of the (S)ARIMA errors model

3.3.3. Analysis: hospital admissions

Based on power calculations, it is unlikely that there will be sufficient statistical power to detect an impact on hospital admissions, unless it is very large (Appendix 1). Therefore, the hospital admission analyses should be considered exploratory rather than conclusive.

Admissions will be analysed according to each of the two levels of grouping shown in Table 2.

It was not feasible to identify a set of negative controls for hospital admissions (i.e., causes of admission that are not expected to change as a result of the policy), given the challenge of identifying health conditions unrelated to smoking likely to result in a sufficient number of inpatient admissions. A list of items which were considered as negative controls and the reasons they were deemed unsuitable is available on request.

As described above, primary and secondary analyses for hospital admissions data will use different methods for identifying admissions from prisons.

The primary analyses will include the 14 closed prisons in Scotland and will exclude Castle Huntly (the only open prison), for the reasons given above. Secondary analyses will include all 15 prisons in Scotland, whether open or closed, identified either on the basis of postcode alone (A) or a combination of postcode, GP practice location code, or ‘admission/transfer from’ field (B), as described above. Note that neither the “Admission/transfer from” field and prison GP practice code are prison-specific, hence admissions from Castle Huntly cannot be excluded from these data, hence the decision to include all prisons in secondary analysis B.

Clustered within these analyses will be sub-analyses using the two alternative statistical approaches described in Section 3.3.1.

This approach can be summarised as follows:

Primary analysis: all continuous inpatient stays with a postcode of residence as any one of the 14 closed Scottish prisons

1) Wald test applied to the white noise residuals of the (S)ARIMA errors model
2) Indicator saturation applied to the white noise residuals of the (S)ARIMA errors model

Secondary analysis A: all continuous inpatient stays with a postcode of residence as any one of the 15 total Scottish prisons

1) Wald test applied to the white noise residuals of the (S)ARIMA errors model
2) Indicator saturation applied to the white noise residuals of the (S)ARIMA errors model

Secondary analysis B: all continuous inpatient stays with postcode of residence as any one of the 15 total Scottish prisons OR practice location code of 31391 (i.e., registration with prison GP), OR admission/transfer from “Legal establishment, incl. prison” (code = 33)

1) Wald test applied to the white noise residuals of the (S)ARIMA errors model
2) Indicator saturation applied to the white noise residuals of the (S)ARIMA errors model

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[Protocol Appendix] Appendix 1. Power calculation for dispensing of indicative medications

Two-sided step intervention model for time-series analysis calculated using fisher.stats.uwo.ca/faculty/aim/2007/OnlinePower/

Based on preliminary data shared by National Prisoner Healthcare Network, appears feasible to use weeks as time points.

Total number of observations = n = 360 weeks

Number of observations in pre-intervention series (setting breakpoint as beginning of lead-in period for primary analysis, 17th July 2017) = T = 236 weeks

Auto-correlation coefficient = ø = no baseline data on which to base this so range of assumptions trialled, as below

Autocorrelation	**Power to detect 0.25 SD change**	**Power to detect 0.5 SD change**	**Power to detect 1 SD change**
0.25	42%	95%	100%
0.5	26%	75%	100%
0.75	15%	45%	96%

[Protocol Appendix] Appendix 2. Power calculation for hospital admissions.

Two-sided step intervention model for time-series analysis calculated using fisher.stats.uwo.ca/faculty/aim/2007/OnlinePower/

Based on previous research into all-cause hospital admissions among people in prison[7], analyses will need to use months as time points.

Total number of observations = n = 82 months (January 2013 – November 2019 inclusive)

Number of observations in pre-intervention series (setting breakpoint as beginning of lead-in period for primary analysis, 17th July 2017) = T = 54 months

Auto-correlation coefficient = ø = no baseline data on which to base this so range of assumptions trialled, as below

Autocorrelation	**Power to detect 0.5 SD change**	**Power to detect 1 SD change**
0.25	40%	94%
0.5	26%	75%
0.75	19%	56%

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[7] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1731884/pdf/v055p00364.pdf

Supplementary material for published article

Supplement to Tweed et al (2021), Lancet Public Health