Relationships between Abnormal Neurodevelopment and Traumatic Brain Injury early in life and Offending

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Foreword

As a result of the Covid-19 pandemic and associated restrictions on social interaction, it was not possible to carry out the original Major Research Project proposed. This project involved exploration of neurodevelopmental factors on offending and required face to face interview and assessment of participants. An alternative project was devised using secondary data also with an aim of investigating associations between neurodevelopment and offending. As the new study used existing data from an approved research database, no recruitment was required.

Chapter One: Systematic Review

The Relationship between Traumatic Brain Injury Early in Life and Offending:

A PRISMA Systematic Review

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Abstract

Background

Traumatic Brain Injury (TBI) early in life is common. Where recovery is poor, TBI can adversely impact typical brain development and function, and increase the risk of offending.

Aim

To systematically review the evidence for a relationship between TBI early in life and offending, with specific consideration of the effects of age at injury and injury severity.

Methods

To identify relevant papers, electronic database searches (CINIHAL, PsycInfo, MEDLINE, EMBASE) were carried out using relevant search terms. Reference lists from included articles were also hand searched. The papers were assessed for risk of bias using set criteria. Some papers were co-rated by an independent person.

Results

Twenty-one articles were included. Articles rated as low bias provided evidence to suggest that TBI before the age of 26 is associated with increased risk of offending, particularly violent offending, where TBI occurs after the age of 6 or 12 and is more severe. Potential mediators associated with executive function such as self-control and temperament, were identified.

Conclusions

Whilst there was some evidence to suggest TBI before age 26 increases offending risk, limitations and bias in studies indicates a need for further good quality research.

Keywords

Offending, Youth, Head Injury, Traumatic Brain Injury

Introduction

Traumatic brain injury (TBI), defined as an acute brain injury caused by some external force, is common early in life. The severity of a TBI is assessed through consideration of a number of variables, including duration of Loss of Consciousness (LOC) and Post Traumatic Amnesia (PTA) and the Glasgow Coma Scale (GCS) score. Longer durations and higher scores, indicate increased severity of TBI, ranging from mild to severe. Prevalence studies in western countries estimate that 691 per 100,000 young people (<18 years) attend Accident and Emergency following TBI (Thurman et al., 2016) and between 47 and 280 per 100,000 experience early TBI globally (Dewan et al., 2016). These wide ranging estimates might reflect problems in estimating TBI prevalence such as differences in methods, the use of hospital records in the context of significant TBI under-reporting. They might also represent the role individual factors play. Research indicates that being part of an ethnic minority group and experiencing disadvantage, such as lower socioeconomic status among other factors, may increase the likelihood of TBI occurring (McKinlay et al., 2008; Yates et al., 2006).

Early TBI can be associated with good recovery, particularly where injury is mild, which might reflect enhanced neuroplasticity and adaptability of the young brain (Anderson et al., 2011). However, it can also be associated with adverse outcomes, which can be more severe and persistent than those from adult injury, due to the vulnerability of the immature brain (Silver et al., 2020), particularly where the TBI is severe (Anderson et al., 2011).

It has been proposed that abnormal brain development increases the risk of offending behaviour after TBI early in life (Williams et al., 2018). This is thought to be of particular risk where abnormal development occurs in the prefrontal cortex, which is responsible for executive functions such as social behaviour, emotion regulation and cognition, and does not mature until adulthood (Zamani et al., 2020). Such functions are considered important to offending risk, particularly where deficits result in difficulties with impulse control, aggression, decision making and self-control, which can make rule breaking and acts of violence more likely (Williams et al., 2018). This perspective is consistent with

prevalence studies indicating that TBI is more prevalent in offending than in general populations (McMillan et al., 2019; Moynan & McMillan, 2018).

Individual studies suggest that the association between early TBI and offending can persist into adulthood and be more frequent and with higher risk of violence (Williams et al., 2018).

This systematic review explores the relationship between early TBI and offending. It defines early TBI as occurring ≤ age 25, as the brain, particularly the prefrontal cortex, continues to mature and develop until then (Arain et al., 2013; O'Rourke et al., 2020). This will build on previous reviews which consider 'early' TBI to occur at ≤ 19 years old (Kennedy et al., 2017; Li & Liu., 2013; Bellesi et al., 2019). It defines offending as behaviour warranting involvement with the Criminal Justice System (CJS) and conviction, rather than offence related behaviours considered in other reviews (Kennedy et al., 2017; Bellesi et al., 2019), which may not meet CJS criteria, such as aggression and conduct issues. Whilst there is evidence to suggest that TBI is associated with higher rates of violent offending specifically, it is also thought to be associated with offending more generally (Williams et al., 2018). Research indicates TBI can lead to poor self-control in a range of areas and an overall difficulty in adhering to social norms, including those not related to violence. As such, all offending meeting CJS criteria is included in this review.

A better understanding of the relationship between TBI early in life and offending behaviour might help to explain why some individuals with a history of early TBI become violent and anti-social (Williams et al., 2018; Zamani et al., 2020). Further, by focusing specifically on offending, this might inform service provision and intervention in an offender population and within the wider CJS.

Aim and Research Questions

Aim

To systematically review the evidence for a relationship between TBI early in life and offending, with specific consideration of age at injury and injury severity.

Research Questions

1. Does TBI ≤ age 25 increase the risk of offending compared to those without a TBI ≤ age 25?
2. Does TBI ≤ age 25 increase the risk of offending compared to TBI later in life?
3. Does the risk of offending following TBI ≤ age 25 vary with age at injury?
4. Does the risk of offending increase with TBI severity ≤ age 25?
5. Are there factors which mediate this relationship?

Methods

Registration

In accordance with PRISMA guidelines, this systematic review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) on the 14th of April 2021 (CRD42021246200).

Inclusion Criteria

1. Quantitative Design
2. Participants are assessed for early TBI (occurring ≤ age 25) either at the time of injury or retrospectively
3. Explores the relationship between early TBI and offending; which meets CJS criteria
4. Offending measured at least 1 year post injury
5. Published in a peer-reviewed journal

Exclusion Criteria

1. Studies not in the English Language
2. Unpublished articles / Articles without peer review
3. Qualitative Designs
4. Dissertations, theses, books or book chapters, conference presentations/abstracts, reviews or case studies
5. Studies published before 1990

Search Strategy

The following databases were searched on the 26th of February 2021; CINIHAL (EBSCO Host) which includes research from nursing and allied health professions from 1982 onwards, APA PsycInfo (EBSCO Host) which includes psychology and behavioural research from 1806 onwards, Ovid MEDLINE (R) which includes clinical research from 1946 onwards and EMBASE (Ovid) which includes biomedical research from 1947 onwards. Reference lists from included articles were hand searched to identify further suitable articles.

The main search algorithm was developed in consultation with the University of Glasgow library service, supervisors and consideration of relevant published systematic reviews (Kennedy et al., 2017; Bellesi et al., 2019). It was amended slightly for each database (see Appendix 1.2) but broadly included the following:

1. Key word searches related to main subject terms:

- **Head Injury**: "traumatic brain injur*" OR TBI OR "brain injur*" OR "head injur*" OR "head trauma" OR HI
- **Child or Young Person**: child* OR infant OR paediatric OR pediatric OR young* OR youth* OR juvenile OR teen* OR adolescen*
- **Offending Behaviour**: crimin* OR crime* OR offend* OR convict* OR "anti-socia*" OR antisocia* OR prison* OR inmate* OR incarcerat* OR delinquen*

2. The use of Subject Headings to map to articles relevant to main subject terms.

3. The use of the OR Boolean operator to combine search lines for main subjects.
4. The use of the AND Boolean operator to combine main subject searches.

Searches were restricted by date (1990 to present) because previous reviews suggest articles after 1990 are more consistent with current definitions, measures and outcomes (Li & Liu., 2013; Bellesi et al., 2019). Additional limiters were included for specific databases and hand searches, such as excluding animal studies (see Appendix 1.2).

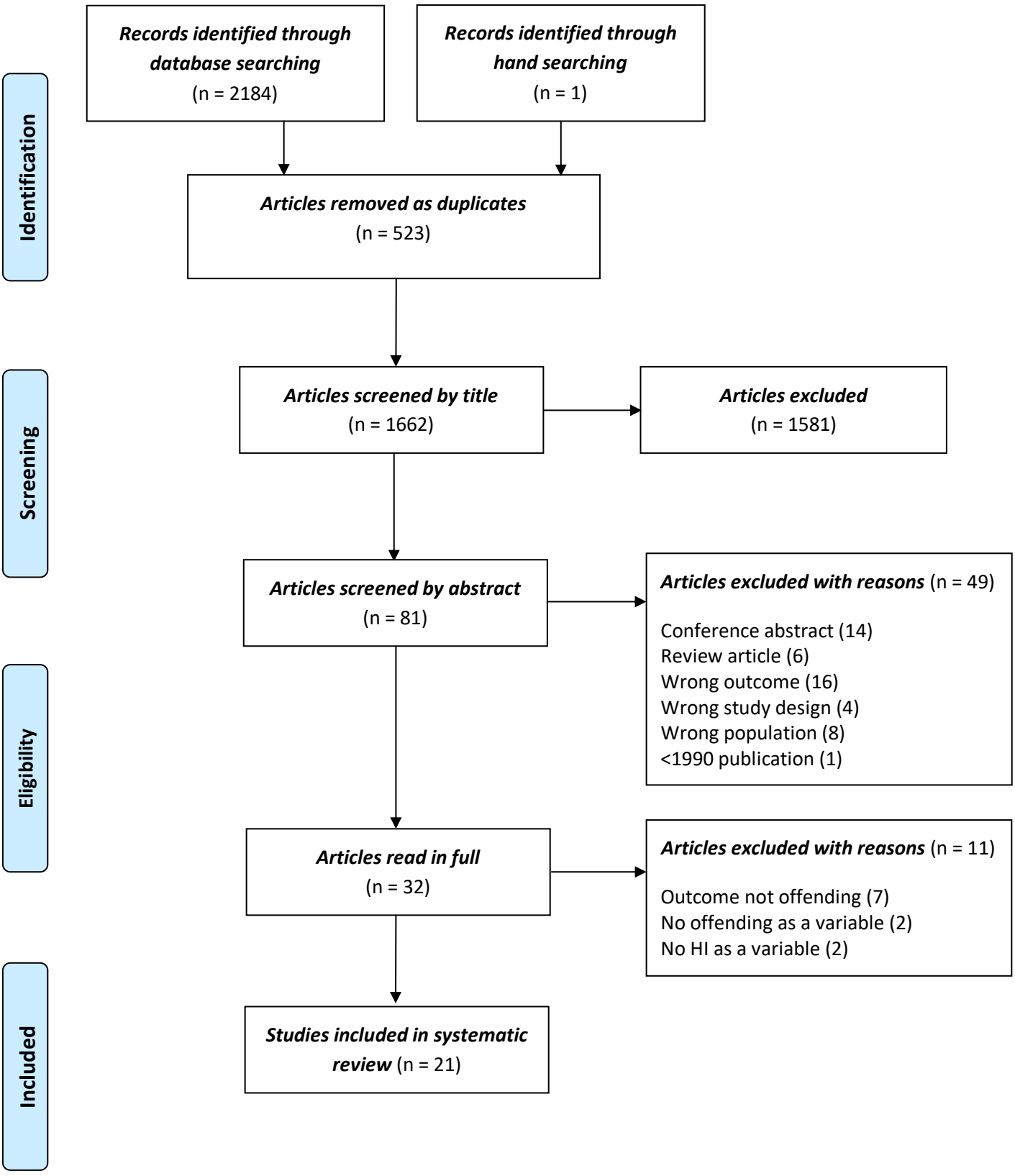

Figure 1: PRISMA Flow Diagram

After removal of duplicates, the final search returned 1662 articles. Following screening by title, 1581 articles were excluded and another 49 after screening by abstract. The remaining 32 articles were reviewed in full and 21 were identified as eligible for final inclusion.

Quality Rating

A version of the Sanderson, Tatt and Higgins (2007) criteria for assessing quality of observational studies in epidemiology, that had previously been adapted for HI studies (Moynan & McMillan, 2018; McGinley & McMillan, 2019) was used (Table 1.1). It should be noted, bias ratings are in association with the research questions in this review and do not necessarily reflect the overall quality of the study rated.

Domains and their definitions were further adapted through supervision and consideration of the variables in this review. Each study was rated as low or high bias on each of the seven domains using the criteria in Table 1.1. Where information was not recorded within the paper, 'Not Recorded' (N/R) was used in rating. The writer rated risk of bias for all papers and a second rater (a final year clinical psychology trainee) did so independently for 11 of the 21 papers (52%). There was inter-rater concordance for 73/77 ratings (95%). Disagreements were discussed and resolved.

Table 1.1 Domain and Criteria for assessing risk of bias

Domain	Criteria
Methods for selecting study participants	i) Inclusion and exclusion criteria are clearly stated ii) Sample is demographically similar to the larger population sampled
Methods for assessing traumatic brain injury	i) Use of internationally agreed definitions to define TBI (Carroll et. al., 2004) ii) Use of a validated HI tool

Methods for assessing offending	Clear definition of offending which might include (but not limited to): i) Age at first offence ii) Type of offending iii) Number of convictions iv) Number of arrests v) Sentence length If appropriate violent versus non-violent offending is clearly stated. The use of criminal records to corroborate self-report is desirable.
Methods to control confounding	Confounding factors are controlled. These might include (but are not limited to): i) Pre-injury factors ii) Substance misuse iii) Adverse Childhood Experiences iv) Parental factors v) Mental health difficulties vi) Socio Economic Status vii) Gender Corroboration of self-reported TBI and offending with objective sources e.g. medical or criminal records, is also desirable.
Comparison of outcomes	TBI sample outcomes are compared to a non-TBI sample
Statistical Methods	i) Appropriate statistical methods are used and reported to explore the TBI and offending relationship ii) Effect sizes are reported where appropriate
Conflict of Interest	Conflicts of interest are declared or funding sources identified.

Strategy for synthesising results of the systematic review

Study designs varied considerably meaning a narrative synthesis was used to summarise findings. When possible, outcomes were broadly compared as effect sizes.

Results

Risk of bias

Risk of bias was low on three domains, 'statistical methods,' 'conflict of interest' and 'comparison of outcomes' and high on two, 'methods to control for confounding variables' and 'methods for assessing traumatic brain injury' (see Table 1.2). Two domains were rated as mixed quality. No study was rated low bias across all domains. Individual studies were considered to be low bias overall, if they scored low on four or more of the seven domains. Overall, fifteen studies were rated low and six as high bias.

Inclusion and exclusion criteria were outlined in all but one paper (2). However, in around half of the studies, risk of bias for selecting participants was high, because the sample was not shown to be representative of the population or non-random sampling techniques were used.

Risk of bias was high for methods for assessing TBI. Only three papers used both an international definition and a validated measurement tool (1, 5 & 12). Seven studies used objective sources, such as medical records, to assess TBI. However, they often used diagnostic codes such as the International Classification of Diseases (ICD), which uses codes for head injury, rather than international definitions that indicate severity of TBI (Carroll et al., 2004).

Ratings for methods of assessing offending were mixed, with significant variability in the measures and definitions used. Seven studies which used official records, were rated low bias (4, 6, 8, 10, 13, 16 & 19). All others were rated as high bias because they used non-validated self-report and/or unclear offending definitions.

Two studies (12 & 13) corroborated self-report with official records, however not for both TBI and offending. Most studies (except 3, 4, 5 & 15) controlled for confounding factors in their analysis, and all but one (4) compared relevant outcomes to a non-TBI group. With the exception of four studies (3, 4, 5 & 15), effects sizes were reported.

Study Characteristics

The twenty-one included studies (Table 1.3) present data on 53,781 participants. Eight studies were carried out in the USA, four in Australia, three in the UK, two in Canada, two in Finland, one in Sweden and one in New Zealand. They were published between 2002 and 2020. Eleven employed a longitudinal design and ten a cross-sectional design. Amongst those with a longitudinal design, seven studies used birth cohorts and the others sampled from school and hospital settings. The cross-sectional studies recruited participants from juvenile and adult prison settings, with the exception of one which used an adolescent inpatient psychiatric hospital.

Table 1.2 Risk of bias ratings

Paper	Methods for selecting study participants	Methods for assessing traumatic brain injury	Methods for assessing offending	Methods to control for confounding variables	Comparison of outcomes	Statistical Methods	Conflict of interest	Overall Bias Rating
1. Brewer-Smyth et al., 2015	High	Low	High	High	Low	Low	Low	Low
2. Buckley & Chapman, 2017	High	High	High	High	Low	Low	Low	High
3. Davies et al., 2012	High	High	High	High	Low	High	Low	High
4. Fazel et al., 2011	Low	High	Low	Low	High*	High*	Low	Low
5. Gordon et al., 2017	High	Low	High	High	Low	High	Low	High
6. Guberman et al., 2019	Low	High	Low	Low	Low	Low	Low	Low
7. Ilie et al., 2017	Low*	High	High	High	Low	Low	Low	Low
8. Jackson et al., 2017	Low	High	Low	Low	Low	Low	Low	Low
9. Kennedy et al., 2017	Low	High	High	High	Low	Low	Low	Low
10. Luukkainen et al., 2012	High	High	Low	Low	Low	Low	N/R	Low
11. McKinlay et al., 2014[a]	Low	High	High	High	Low	Low	Low	Low
12. McKinlay et al., 2014[b]	Low	Low	High	High	Low	Low	Low	Low
13. Moore et al., 2014	Low	High	Low	Low	Low	Low	Low	Low
14. Perron & Howard, 2008	Low	High	High	High	Low	Low	Low	Low

15. Schofield et al., 2019	Low	High	Low	High	Low	High	Low	Low
16. Schwartz et al., 2017	Low	High	Low	High	Low*	Low	Low	Low
17. Silver & Nedelec., 2020	High	High	High	High	Low	Low	Low	High
18. Stoddart & Zimmerman,2011	Low	High	High	High	Low	Low	Low	Low
19. Timonen et al., 2002	Low	High	Low	Low	Low	Low	Low	Low
20. Veeh et al., 2018	High	High	High	High	Low	Low	Low	High
21. Williams et al., 2010	Low	High	High	High	Low	High	Low	High

*indicates where disagreements between raters on risk of bias were discussed and resolved

Table 1.3 Summary of Included Papers

Paper	Study Design & Sample	Measure and definition of TBI	Measure and definition of offending	TBI characteristics	Grouping Factor	TBI and offending relationship
1. Brewer-Smyth et al., 2015 USA	*Cross-sectional* State prison n=636 318 Male, 313 Female Mean age: 34 (violent), 37 (non-violent)	Measure: OSU-TBI ID Definition: from OSU-TBI ID	Measure: Self-report. Definition: Violent offending history	TBI: n=429 (67%) Mean age at injury: 16.9 (violent), 17 (non-violent)	<u>TBI status:</u> TBI vs no-TBI	No significant difference between TBI vs no TBI and offending. Significant difference between no TBI vs TBI (by age 15) and lifetime violent offending (OR=0.54, CI=0.30-0.97, p=0.0382) *Controls: age, gender, ACEs.*
2. Buckley and Chapman 2017 AUS	*Longitudinal* Queensland state education school students n=734 287 Male, 438 Female Mean age: 13.45 (range 13-14)	Measure: Self-report, Extended-Adolescent Injury Checklist Definition: Any TBI with or without LOC Measured at T1	Measure: Australian Self-Reported Delinquency Scale Definition: In a physical fight in past 3 months (Y/N) Measured at T2 (1 year later)	TBI: n=91 (13.7%) 53 Male, 38 Female Treated TBI: n=37 (40%)	<u>TBI status</u>: mTBI vs treated mTBI vs no TBI	Significant difference between TBI and no TBI on violence risk 12 months later (OR = 2.34 (1.07-5.16), p<0.05). No significant difference between treated mTBI vs no TBI and violence risk (OR=2.50, CI=0.85–7.39, p = 0.09) *Controls: sex, violence, risk taking.*
3. Davies et al., 2012 UK	*Cross-sectional* Male juvenile offenders n=61	Measure: Self-report Definition: TBI with LOC.	Measure: Self-report, IVO Definition: frequency and	TBI: n=44 (72.1%); 19 concussion no LOC; 14 mild, 6 complicated mild, 4 moderate/severe, 1 very severe	[a]TBI severity [b]TBI frequency	[ab]No significant difference between TBI severity or frequency vs no TBI and IVO score.

	Mean age: 16.87 (range 16-18)	Severity via LOC: Mild <10mins; Complicated mild 10-30mins; Moderate-severe 30-60 mins; Very severe >60 min Frequency: 1, 2-4, >4	severity of violent offending			[b]No significant difference between +4 TBIs vs ≤4 TBIs and IVO score ($F_{1,57}$ =3.02, p=.088, observed power =0.401). Effect size calculated d = 0.54, medium effect. [a]No significant difference between mild or moderate-severe TBI vs no TBI or TBI with no LOC, and age at first conviction ($F_{1,57}$=3.49, p=.067, observed power = 0.450). Effect size calculated d = 0.54, medium effect.
4. Fazel et al., 2011 SWEDEN	*Longitudinal* Swedish population birth cohort (0-35yrs;1973-2009) n=252,032 TBI: 179,083 male,72,949 female	Measure: ICD 8-10 from National Patient Register Definition: ICD 8-10 diagnostic codes.	Measure: Criminal Record Definition: violent offence per Swedish criminal code	TBI: n= 22,914 16,282 (71.1%) Male, 6632 (28.9%) Female Mean age at injury: 24.8yrs (SD 12.3) n= 5310 TBI < 16 n= 17,604 TBI ≥ age 16	TBI age: < age 16 vs ≥ age 16	Significant difference between TBI < age 16 vs ≥ 16 and violent crime age 35 (X^2 = 35.7, p=0.001). No effect sizes reported/computable.
5. Gordon et al., 2017 USA	*Cross-sectional* Young offenders State and County facilities n=4316 3838 male, 478 female State mean age: 15.8 (range 10-22)	Measure: BISQ Definition: Severity via LOC, mild = <30mins, moderate – severe = >30mins	Measure: Criminal Record Definition: any offence.	State sample: TBI: n=680 (22%); 383 (56.3%) mild, 297 (43.7%) moderate-severe County sample: TBI: n=302 (41.3%); 246 (81.5%) mild, 56 (18.5%) moderate-severe	[a]TBI status: TBI vs no-TBI [b]TBI order: TBI before vs in same year or after first offence	[a]No significant difference between TBI status and offence type in State or Community sample. [b]Significant difference between TBI before first offence vs. in the same year or after and violent offending ($\chi 2$ = 11.48, P < .01). No effect sizes reported/computable.

	County mean age: 15.2 (range 10-22)					
6. Guber-man et al., 2019 CANADA	*Longitudinal* Elementary school male pupil (6-24yrs) n=724 Mean age: 24	Measure: Digital Health Records Definition: ICD 9 diagnostic codes.	Measure: Criminal Record Definition: Criminal conviction per the Correctional Services of Canada classification.	TBI: n=296 (41%) 0-12 years: 61 13-17 years: 37 18-24 years: 56 0-24 years: 142 114 (15.7%) one TBI; 22 (3%) two TBIs, 6 (0.83%) three + TBIs	<u>TBI age:</u> 0-12; 13-17; 18-24; 0-24 vs no TBI	No significant difference between TBI status and offence type or risk of offending from age 18-24 years. *Controls: family social status (FSS), disruptive childhood behaviours.*
7. Ilie et al., 2017 CANADA	*Cross-sectional* Ontario public school students n=5189 2366 Male, 2931 Female Mean age: 14.57 (range 11-20)	Measure: Self-report Definition: HI with LOC ≥ 5 minutes or in hospital overnight	Measure: Self-report Definition: Frequency of specific offending behaviours	Lifetime TBI, 16.3% Recent TBI, 6%	<u>TBI status:</u> no TBI vs lifetime TBI vs recent TBI (in past 12 months)	Significant difference between lifetime and recent TBI groups respectively vs no TBI and: - carrying a weapon (OR=3.19, CI=1.99-5.12, p<0.001); (OR= 2.82, CI=1.38-5.80, p<0.001). - participating in a fight (OR=1.65, CI=1.05-2.59, p<0.05); (OR=3.69, CI=1.95-6.97, p<0.01). - beating up or hurting someone (OR=2.08, CI=1.22-3.54, p<0.01); (OR=2.59, CI=1.37-4.89, p<0.001). *Controls: sex, grade, alcohol/cannabis use, psychological distress.*
8. Jackson et al., 2017 USA	*Longitudinal* Collaborative Perinatal Project (CPP), 1959-1966	Measure: Medical records Definition:	Measure: Criminal record Definition:	TBI: n=121 (4.18%) 84 mild, 37 severe 49 Female, 72 Male	[a]<u>TBI status</u>: TBI age 0-7 vs. no TBI	[a]No significant difference between TBI before age 7 vs no TBI and risk of lifetime arrest (IRR=1.44, CI=0.88-2.37), juvenile arrest (IRR=1.67,

	n=726 377 Male, 349 Female	Severe TBI = skull fracture, haematoma/haemorrhage or bloody spinal fluid Mild TBI = any LOC and/or vomiting.	Juvenile arrest <age 18; Adult arrest > age 18		[b]TBI severity: severe, mild, no TBI	CI=0.87-3.32) or adult arrest (IRR=1.37, CI=0.82-2.30); p>0.05. [a]No significant difference between TBI before the age of 7 vs no TBI and risk of non-violent juvenile offences (IRR=1.67, CI=0.87-3.20, p>0.05). [b]Severe TBI before age 7 vs no TBI significantly increased the risk of juvenile arrests (IRR=2.44, CI=0.93-6.46, p<0.05). Mild TBI did not. *Controls: parental age/education, race, poverty, marital status, gender*
9. Kennedy et al., 2017 UK	*Longitudinal* Birth cohort age 0-17 n=11,412 5849 Male, 5563 Female	Measure: parent/self-report, non-validated questionnaire Definition: HI with any LOC and/or skull fracture	Measure: self-report Definition: frequency of offending and contact with police.	TBI: n=800 (9.6%) 457 male, 343 female	TBI status: TBI by age 16 vs orthopaedic injury vs no injury	Significant difference between TBI status and status and Significant difference between individuals with TBI vs no TBI/orthopaedic controls and risk of; committing an offence (OR=1.72, CI=1.32–2.23), and contact with the police (OR 1.62, CI=1.21–2.17); p<0.001. *Controls: pre-birth factors, ACEs.*
10. Luukk-ainen et al., 2012 FINLAND	*Cross-sectional* Inpatient adolescent psychiatric unit n=508 208 Male, 300 Female	Measure: Finnish Hospital Discharge Register Definition: ICD 9/10 diagnostic codes.	Measure: Criminal Record Definition: criminal conviction (Y/N)	TBI: n= 26 (5.1%) 18 Male, 8 Female	TBI status: TBI vs no-TBI	Significant difference between individuals with TBI (53.8%) vs no TBI (14.7%) and history of criminality; p<0.001.

	Mean age: 15.5 (range 12-17)					Significant difference between TBI status and risk of criminality (OR=4.89, CI=1.95–12.25, p=0.001). Significant difference between TBI vs no TBI and risk of violent (OR=5.9, CI=1.99-17.28, p<0.001) and non-violent crime (OR=3.9, CI=1.18-12.55, p=0.026). *Controls: age, gender, family type, parental employment.*
11. McKinlay et al., 2014[a] AUS	*Longitudinal* n=167 93 Male, 74 Female Mean age: 21.81-23.29 (range 18-30)	Measure: Audit of medical files Definition: Mild TBI = LOC < 20mins, PTA <1 hour and/or diagnosis; Moderate-Severe TBI = PTA >24 hours and/or diagnosis	Measure: self-report Definition: offending age 18-30	TBI: n=120 (75.9%) 62 moderate-severe, 62 mild Age at injury up to age 17	<u>TBI Status:</u> mild, moderate-severe, vs no TBI	Significant difference between mild vs no TBI (OR= 8.66 (1.0–72.1) p <0.05) and moderate-severe TBI vs no TBI (OR = 20.35 (2.5–162.8) p<0.01 and risk offending age 18-30. Significant difference between moderate-severe vs mild/no TBI and risk of; conviction (OR= 8.88, CI=1.1–73.3, p<0.05), arrest (OR=12.07, CI=1.8–98.4, p<0.05), motor/petty offences (OR = 8.88, CI=1.1–71.4, p<0.05). Significant difference between any TBI vs no TBI and risk of offending (OR=4.23, CI=1.33–13.48, p<0.02). *Controls: age, time post-injury, sex.*

12 McKinlay et al., 2014[b] NZ	*Longitudinal* Christchurch population birth cohort (0-25 yrs) n=1265	Measure: Parent/self-report corroborated by medical records Definition: Any TBI defined by LOC, PTA, GCS.	Measure: Self-report Delinquency Inventory Definition: frequency of offences and arrests age 16-25	TBI: n=266 (21%) 62% (n=164) outpatient (sent home post-TBI) 38% (n=102) inpatient (admitted to hospital post-TBI)	<u>TBI Status</u>: Outpatient TBI, Inpatient TBI vs no TBI <u>TBI age</u>: 0-5, 6-15, 16-21 years.	No significant difference between TBI age 0-5 vs no TBI and offending. Significant difference between TBI aged 6-15 vs no TBI and arrest (age 16-25), outpatient (IRR = 2.35, $p<0.01$) and inpatient (IRR = 2.46, $p<0.01$); and violent offending (age 18-25), outpatient (IRR = 0.52, $p<0.01$) and inpatient (IRR = 1.95, $p<0.01$). Significant difference between TBI aged 16-21 vs no TBI and arrest (age 21-25), outpatient (IRR = 2.39, $p<0.01$). Significant difference between TBI aged 16-21 vs no TBI and violent offending (age 21-25), outpatient (IRR = 2.33, $p<0.01$) and inpatient (IRR = 0.33, $p<0.01$). *Controls: gender, SES, early behaviour problems, parental substance misuse, offending, alcohol/drug dependence.*
13. Moore et al., 2014 AUS	*Cross-sectional* Young offenders juvenile detention centres n=316 278 Male, 38 Female	Measure: Self-report, Young People in Custody Health Survey (2009) Definition: Any HI with LOC; mild	Measure: Data linkage to the juvenile justice database Criminal History Questionnaire Definition:	TBI: n=102 (32%) 89 male, 13 female 91.8% mild, 8.2% moderate-severe	[a]<u>TBI status</u>: TBI vs no-TBI	[a]Significant difference between TBI vs no TBI and risk of incarceration for 12+ months (OR=2.61, CI=1.51-4.48, $p<0.05$). [a]No significant difference between TBI vs no TBI and most serious offence,

	Mean age: 17 (range 13-21)	TBI = < 30mins, moderate-severe >30 mins	Australian and New Zealand Standard Offence Classification. Re-incarceration = within18 months		[b]TBI frequency: No TBI, 1 TBI or 2 + TBIs	re-incarceration or multiple incarcerations. [b]Significant difference between 1 TBI vs no TBI and risk of re-incarceration (OR=1.81, CI=1.01-3.29), multiple incarcerations (OR=1.92, CI=1.02-3.56) and incarceration for 12+ months (OR=2.22, CI=1.18-4.17), p<0.05. No significant difference between 2 or TBIs vs no TBI and offending. *Controls: age, gender, aboriginality, school attendance, placement in care.*
14. Perron & Howard, 2008 USA	*Cross-sectional* Young people Missouri Division of Youth Services n=720 626 Male, 94 Female Mean age: 15.5 (range 11-20)	Measure: Self-report. Definition: Any HI with LOC ≥ 20 minutes	Measure: Self-Report of Delinquency (SRD) Definition: frequency of 7 violent and 10 non-violent crimes in year before incarceration	TBI: n=132 (18%) 123 Male, 9 Female	TBI Status: TBI vs no-TBI	Significant difference between TBI vs no TBI and offending (OR = 1.17, 95% CI = 1.03–1.33), p<0.001. *Controls: age, ethnicity, family residence, welfare, gender.*
15. Schofield et al., 2019 AUS	*Cross-sectional* Young people on a Juvenile Justice supervised community order n=788 672 Male, 116 Female	Measure: self-report. Definition: Any HI with LOC	Measure: New South Wales Department of Juvenile Justice Database Definition: Offence type defined as no,	TBI: n=308 (38%) 191 one TBI 116 ≥ two TBIs	TBI Status: no TBI, 1 TBI, multiple TBIs	No significant difference between TBI vs no TBI and offending. No effect sizes reported/computable.

	Mean age: 16.6 (SD 1.3, range 12-21)		low, medium and high, violence.			
16. Schwartz et al., 2017 USA	*Longitudinal* Pathways Cohort[1] Juvenile offenders n=1354 86.4% Male, 13.6% Female Mean age: 16.04 yrs (SD 1.14; range 14-24 yrs)	Measure: Self-report. Definition: Any HI with LOC and/or required medical attention.	Measure: Self-reported offending (SRO) measure. Definition: aggressive, income and overall offending frequency	TBI (%) 1 year intervals: T1=30.35% T2 = 3.17% T3 =2.36% T4 =2.76% T5 =3.05% T6 =3.41% T7 =2.29% T8 =2.74%	TBI Status: TBI vs no-TBI	Significant difference between TBI vs no TBI and; aggressive delinquency (b=0.07, $p < 0.05$) mediated by low self-control (b=-0.08, $p < 0.05$) and overall delinquency (b =0.04, $p < 0.05$) mediated by low self-control (b=-0.08, $p < 0.05$). Significant difference between TBI vs no TBI and aggressive offending at all-time points ranging from 1.37 ($p < 0.05$, T8) to 1.71 ($p < 0.05$, T2) times more. Significant difference between TBI vs no TBI and overall offending at T1-8 ranging from 1.32 ($p < 0.05$, T7) to 1.60 ($p < 0.05$, T3) times more. *Controls: self-control, psychopathy, exposure to violence, IQ, SES, baseline offending, age, sex, race.*
17. Silver, I. A., & Nedelec, J.L, 2020 USA	*Longitudinal* Pathways Cohort[1] Juvenile offenders n=416 345 Male, 71 Female	Measure: Self-report, non-validated questionnaire Definition: Any HI with LOC and/or need for medical treatment	Measure: Self-reported offending (SRO) measure. Definition: aggressive, income and overall offending frequency	TBI: 7.46% at least one; 2% at least two	TBI Status: TBI vs no-TBI	No significant difference between TBI vs no TBI and aggressive offending. Significant difference between TBI vs no TBI and aggressive offending, where the adverse psychological effects was a mediator (b = 0.106, SE = 0.045, $\beta = .032$; $p = .019$).

	Mean age range 15.94-19.47 (SD 1.10-1.12)					*Mediator: Adverse Psychological Effects; derived from Brief Symptom Inventory, Impulsivity questionnaire, Moral disengagement Questionnaire.* *Controls: street/community time*
18. Stoddart & Zimmer-man 2011 USA	*Longitudinal* High school pupils at risk via Grade Point Average n=850 50% Male/Female 2nd to 5th year (wave 5-8) after High School, approx.20-23 years	Measure: semi-structured interview Definition: Any HI with LOC	Measure: semi-structured interview Definition: Interpersonal and non-violent offending frequency	TBI Wave 5, n=88 (10.3%) TBI Wave 6, n=93 (10.9%) TBI Wave 7, n=14, (1.65%)	<u>TBI Status:</u> TBI vs no TBI	Significant difference between TBI vs no TBI and violent offending ($F_{4, 397}$ = 2.98; p = 0.02). Significant difference between TBI vs no TBI (wave 5/6) and violent offending (wave 8) (b=0.16, p<.01). Not significant when violence prior to head injury controlled. Significant difference between TBI vs no TBI (wave 7) and violent offending (wave 8) (b =1.07; p <0.001). *Controls: race, gender, previous violence, TBI, alcohol/marijuana use, violence witnessed, non-violent delinquency.*
19. Timonen et al., 2002 Finland	*Longitudinal* Finland Birth Cohort, 1966 Full sample n=10,934 Sub-sample n=272	Measure: Hospital Discharge Register Definition: ICD 7-10 diagnostic codes.	Measure: Criminal Record Definition: Frequency of crimes committed from age 15+ Age at first crime	TBI: n=152 (2.7%) males; n=104 (1.9%) females Mean age TBI 9 years (SD 3.7, range 2.4–14.9)	<u>TBI Status</u>: TBI by vs no TBI	Significant difference between TBI by age 15 vs no TBI and criminal offending from age 15 onwards (OR=1.6, CI=1.0–2.5, p<0.05); increased where co-morbid mental disorder (OR=4.3, CI=1.3–14.5, p<0.05). Significant difference in age at first offence between TBI before the age of

	152 Male TBI (2.7% full); 120 controls (2.5% full)					12 vs no TBI (log–rank = 6.67, d.f. = 1, P=0.0098). *Controls: maternal marital status and paternal at birth.*
20. Veeh et al., 2018 USA	*Cross-sectional* Young offenders in private residential facilities n=227 126 Male, 101 Female Mean age: 16.21 years (range 13-19)	Measure: Self-report using the Computer-Assisted Survey Interview (CASI) Definition: Any HI with LOC ≥ 2O minutes	Measure: Computer-Assisted Survey Interview; self-report of delinquency measure Definition: frequency of violent offending	TBI n=50 (22%)	TBI Status: TBI vs no-TBI	Significant difference between TBI vs no TBI and frequency of violence (R^2 = .14, $F_{8, 217}$=3.89, p = 0.00); mediated by temperament R^2 = 0.54. *Controls: gender, age, ethnicity, mental health, substance, education, childhood trauma.*
21. Williams et al., 2010 UK	*Cross-sectional* Young male offenders; YO Institute/YO Team and Special Needs School. n=186 Mean age: 16.67 years (range 11-19)	Measure: semi-structured interview Definition: Any HI with LOC or confusion. Mild TBI = <10 mins, Moderate TBI = >10 mins-6 hours, Severe TBI = > 6 hours	Measure: Self-report, IVO Definition: frequency and severity of violent offending	TBI: n=121 (65.1%) 46% LOC 55 (29.6%) mild 31 (16.6%) moderate-severe 60 (32%) multiple	[a]TBI Status: TBI vs no-TBI [b]TBI frequency: 0 - 5+	[a]Significant difference between TBI vs no TBI and IVO score ($F_{5, 180}$) = 3.364, p = 0.006) and conviction rate ($F_{1, 186}$) = 5.436, p=0.021). [b]Significant difference between 3+ TBIs and 2 or less TBIs and IVO score ($F_{1, 180}$) = 12.268, p =0 .001).

LOC: loss of consciousness; PTA: post-traumatic amnesia; OSU TBI-ID: Ohio State University Traumatic Brain Injury Identification Method; ICD-7-10: International Classification of Diseases (7^{th}-10^{th}); IVO: Index of Violent Offending; 1 indicates where samples may have overlapped; [a] and [b] indicates which grouping factors belong to results.

Research Questions

Does TBI ≤ age 25 increase the risk of offending compared to those without a TBI ≤ age 25?

There was evidence to suggest TBI ≤ age 25 increased offending risk in sixteen of twenty-one studies. Of these, twelve were rated as low and four as high bias and reported effects of TBI which occurred at 0-24 years.

Eight low bias studies (7, 9, 10, 11, 14, 16, 17 & 19) using multivariate analyses indicated TBI ≤ age 25 increased risk of offending in relation to all of their outcome measures, by between 1.6 and 20.35 times, compared to no TBI controls. Other low bias studies (8, 12, 13 & 18) found mixed results in multivariate analyses, reporting TBI increased (OR = 1.95-2.61) (8, 12, 13 & 18), reduced (OR = 0.33-0.52) (12), and had no effect, on offending risk (8, 12, 13 & 18), compared to no TBI samples. Two further low bias studies (1 & 4) found TBI ≤ age 25 decreased the risk of offending, compared to those with no TBI by 0.54 times, using univariate (4) and multivariate analyses (1). High bias studies provided support for TBI increasing offending risk (2, 5, 20 & 21) and two low (6 & 15) and two high bias studies found no association (3 & 5).

Fourteen studies examined the effects of TBI ≤ age 25, compared to no TBI, on violent offending specifically. Five out of eight low bias studies (7, 10, 12, 16 & 18) suggested that TBI increased the risk of violent offending by 1.37-5.9 times. These studies all controlled for confounds using multivariate analyses. This was further supported by six high bias studies (2, 3, 5, 17, 20 & 21). Three low bias studies, two of which used univariate analyses and did not control for confounds (4 & 15), found that TBI, reduced (1 & 4) and had no association with violent offending risk (15).

Twelve studies examined associations between TBI ≤ age 25 and any type of offending. Four of ten low bias studies (9, 11, 14 & 19) found that TBI increased offending risk compared to controls by 1.17-4.3 times, using multivariate analyses. Two other low bias studies using multivariate analyses, found that TBI increased some but not all types of offending (12 & 13). Other low bias studies found a positive effect that was mediated by low self-control (16) and no direct relationship (6, 8 & 15), between TBI and offending. Of the low bias studies which found no relationship, two employed longitudinal designs

and used multivariate statistical methods (6 & 8); the other cross-sectional study (15) did not. Two high bias studies provided mixed support (5 & 21).

One low bias study (10) directly compared the effects of TBI on offence type in their sample and estimated TBI increased the risk of violent offending by 5.9 and non-violent offending by 3.9 times, compared to no TBI, in the context of other factors.

The evidence seems to suggest that TBI before age 26 increases offending risk, particularly violent offending. However, whilst most of the studies in this review used multivariate analyses and controlled for confounds, the consideration of background factors which might influence offending risk after TBI was limited. These include pre-injury characteristics, family status and deprivation, which are considered relevant to recovery after TBI early in life (Zamani et al., 2020).

Does TBI ≤ age 25 increase the risk of offending compared to TBI later in life?

Only one, low bias study, compared the effects of TBI sustained before the age of 26 and later in life, on risk of offending (4). It indicated risk of violent crime was higher where injury occurred between ages 16-35 compared to before age 16. Notably, these comparison groups overlap the ≤ age 25 cut off used in this review.

Does the risk of offending following TBI ≤ age 25 vary with age at injury?

The studies included in this review all examined the impact of TBI ≤ age 25, however there was limited consistency across studies in the age bands used. In an effort to explore the effect of age in the TBI and offending relationship, across as many studies as possible, the studies were split into three broad age bands; 0-12, 0-17 and 15-25 years.

Four low bias studies explored the effects of TBI and no TBI between ages 0-12, on offending (6, 8, 12 & 19). They all employed longitudinal designs, measuring TBI prevalence and offending across multiple time points and controlling for a range of potential confounds, including background factors. Compared to no TBI, one study found TBI at ages 0-7 increased the risk of arrest as a juvenile by 2.44 times (before age 18), but not as an adult (between age 18 and 33) (8). Another (19) found that those

with a TBI before age 12 were convicted of their first offence earlier than those with a TBI after age 12. No other effects of TBI at ages 0-5 or 0-12 were found on offending up to age 25 (6 & 12).

Ten low and one high bias study explored relationships between TBI at ages 0-17 and offending. The low bias studies showed that risk of violent offending was 1.37-5.9 times higher (10, 12 & 16) and the risk of offending as a juvenile (9, 10, 16 & 19) or adult (11) was 1.37-4.89 times higher for those with TBI, compared to no TBI. Two studies found that arrest in adulthood was 2.35-2.46 times (8 & 12) more likely for those with TBI, than those without. Three other low bias studies (1, 4 & 12) found TBI before age 15 reduced the risk of lifetime offending at age 25-35, by almost half (OR=0.52-0.54) (1 & 12), compared to no TBI. One low bias study showed that TBI age 13-17 had no effect on offending by age 24 (6).

Three studies explored the effects of TBI between ages 15 and 25. One low bias study found that TBI at ages 16-21, increased the risk of violent offending by 2.33 times and arrest by 2.39 times, compared to no TBI, in an outpatient TBI population. However, in an inpatient TBI population violence risk was reduced (OR=0.33) and there was no effect on arrest (12). Another low bias study (18) found that TBI at age 22 was associated with slightly increased risk of violent offending one year later ($b = 1.07$; $p < 0.001$), however TBI at age 20 was not. One high bias study reported a 10% increased chance of violent offending at age 19, after TBI at ages 17 to 18, compared to no TBI, but only when this was mediated by adverse psychological effects (17).

Six low (4, 6, 7, 12, 18 & 19) bias studies compared age at injury and offending outcomes within their samples. This included articles with cross-sectional designs, and longitudinal studies exploring outcomes at multiple time points. Four low bias studies (4, 7, 12 & 18) found older compared to younger age at TBI, was associated with increased risk of offending. One (4) indicated that violent offending risk by age 35 was greater when TBI occurred between ages 16 and 35, compared to before age 16. Another (18) found that TBI at ages 18-20 increased violent offending risk by age 21, compared to those without, or with a TBI before age 18. Another (7) showed that those with a TBI in late adolescence were more likely to violently offend than those with an earlier or no TBI. The other (12) found that TBI

at age 6-15 and 16-21 increased the risk of arrest and violent offending up to age 25, at a similar rate, compared to uninjured controls, however TBI age 0-5 had no effect. Considering the other low bias studies, one indicated risk of lifetime offending was higher when TBI occurred before age 12 compared to after (19) and the other suggested TBI at 0-12, 13-17 or 18-24 years had no effect on offending compared to no TBI controls (6).

Overall, these studies seem to suggest that later, rather than earlier TBI (i.e. before age 6 or 12 years), is associated with greater offending risk. However, results do not indicate a clear temporal association, with the highest offending risk evidenced in the 0-17, rather than 15-25 age band. It might be that factors other than age, such as background factors relevant to recovery from TBI early in life and developmental factors, which were not always controlled for in the included studies, could help to explain these results.

Does the risk of offending increase with TBI severity ≤ age 25?

Seven studies explored variation in offending outcomes associated with severity or frequency of TBI. Three low bias studies suggested that greater TBI severity ≤ age 25, increases the risk of offending. One (8) indicated those with severe TBI before age 7 were 2.44 times more likely to be arrested as a juvenile, compared to those with mild or no TBI. Another (11) estimated that those with mild TBI by age 17 were 8.66 times more likely than no TBI controls, to have an offending history by age 30. Those with moderate-severe TBI were estimated to be 20.35 times more likely; however the confidence interval was very wide, indicating this may not be a reliable estimate (95% CI = 2.5-162.8). Another (12) found that TBI severity increased offending risk where TBI occurred at age 6-15, but not age 16-21, where severity appeared to reduce risk compared to no TBI. Another high bias study found offending risk increased with TBI severity (3).

Two low bias studies explored the effects of multiple TBIs on offending and found no effect. In one study (13), those with one TBI were significantly more likely to be re-incarcerated, to have more convictions and longer incarcerations, than no TBI controls, but those with two or more TBIs were not. In another (15), single or multiple TBI was not significantly associated with offending compared to no

TBI controls. There were two high bias studies however (3 & 21), which supported the role of multiple TBIs in increasing offending risk.

Are there factors which mediate this relationship?

Three papers reported a positive association between early TBI and offending, mediated by other factors. One was rated as low (16) and two as high bias (17 & 20). Poorer self-control mediated associations between early TBI and violent offending in the low bias longitudinal study (16). The high bias studies suggested that increased adverse psychological effects (17) and greater temperament difficulties (20), were mediators.

Discussion

Main Findings

This review of twenty-one studies indicates the risk of offending was higher in people who sustained a TBI before the age of 26, than those without a TBI. Publication dates ranged from 2002 to 2020. Notably, eighteen of the studies were published within the past 10 years and ten within the past 5 years; suggesting this is a growing field of research.

Does TBI ≤ age 25 increase the risk of offending compared to those without a TBI ≤ age 25?

Sixteen articles found that TBI age ≤ 25 increased offending risk compared to no TBI, including eight low bias studies. All but one of these low bias studies controlled for potential confounding factors. However, this did not always include background factors which are known to increase offending risk, but also considered relevant to recovery following early TBI, such family environment and deprivation (Zamani et al., 2020). Further, few studies considered pre-injury social or cognitive abilities. This seems important as any existing conduct and emotional problems, which have been shown to increase offending risk (Young et al., 2016), might be worsened by TBI. Research has found that where families have greater capacity to support young people following a TBI and where the young person already had good intellectual function and emotion regulation skills, recovery without long term deficits which might increase offending risk, is more likely (Anderson et al., 2012).

Four low bias studies reported that TBI reduced (1 &4) or had no effect on offending (6 &15); however, this seemed likely to be associated with inappropriate statistical methods and limited controls for confounding factors.

When considering if TBI ≤ age 25 was associated with specific types of offence, the low bias evidence did suggest that risk might be higher for violent offending. This is consistent with other research which suggests TBI early in life disrupts executive processes important for functions such as impulse control and empathy, associated with aggression and violence (Williams et al., 2010; 2018). However, as an association was still found for overall offending, and there was a wide variation in the definition of offending from paper to paper, to make strong conclusions here is difficult.

Does TBI ≤ age 25 increase the risk of offending compared to TBI later in life?

There was limited evidence about whether TBI ≤ age 25 or later in life, affects the risk of offending differently. The one low bias paper which explored this suggested offending risk was higher where TBI occurred later in life, but the design did not provide clear comparisons to answer this question, as the age groups used overlap this review's early/late TBI definition. Further, this paper was high in bias for statistical methods and comparison of outcomes domains, and no control group was used in the analysis relevant to this review, despite there being one in the study.

Does the risk of offending following TBI ≤ age 25 vary with age at injury?

Early theories of neuroplasticity indicate that the immature brain, is better able to recover from TBI, due to enhanced plasticity. Where recovery is possible, the brain is considered more likely to develop typically, and it is less likely that deficits, which might increase offending risk, will persist (Carlisi et al., 2020). However, this perspective has been challenged by recent research and advances in neuroimaging, which suggest the relationship between age at brain insult and recovery, is much more complex and might be explained by plasticity and vulnerability intermittently (Giza & Prins, 2006), as well as background factors thought to promote recovery, described above (Anderson et al., 2012).

Results in this review are somewhat consistent with neuroplasticity perspectives, as offending risk was shown to be higher where TBI occurred after age 6 or 12. However, this review did not find a linear increase in risk by age, expected in the context of a neuroplasticity framework. TBI at ages 0-17 was associated with higher offending risk than ages 15-25. This might reflect differential effects of TBI, dependent on developmental stage. It has been proposed that still developing skills, compared to those which have already been acquired, at the time of TBI, are most at risk of long term disruption (Zamani et al., 2020). So, it might be that as age increases e.g. in the 15-25 group, certain skills associated with desistance from offending, although maybe not those associated with violent offending specifically, are already developed and less likely to be adversely impacted and contribute to offending risk, as in the 0-17 group.

Notably, the use of age bands in this review did not result in an equal division of studies, with only three eligible for inclusion in the 0-12 and 15-25 bands, compared to eleven in the 0-17 band - where the strongest evidence was found. It seems possible therefore that conclusions here are biased by the number of studies available for each age group.

Whilst this review presents some evidence to support the role of neuroplasticity, when TBI occurs before age 6 or 12, the evidence is not consistent. This might suggest a more complex relationship between age at TBI and offending, which involves other background and developmental factors described above (Giza & Prins, 2006; Zamani et al., 2020). Notably, attempts to explore the effects of age (i.e. the use of age bands) in this review were imperfect, as age at injury was not easily comparable across studies. Future studies may benefit from using robust longitudinal designs, with repeat measures at a range of ages to compare the effects of age at injury on long term offending risk.

Does the risk of offending increase with TBI severity ≤ age 25?

The low bias papers within this review mostly indicated that more severe TBI increases the risk of offending, consistent with other reviews (Li & Liu, 2013; Bellesi et al., 2019). Although notably, one low bias study did indicate this relationship might be influenced by age at TBI (12), which may benefit from future research. Low bias studies showed that multiple TBIs did not increase offending risk. However, only 7/21 studies explored the effects of multiple TBIs, which is surprising because they are more common in offenders, than in the general population (McMillan et al., 2019; McMillan et al., 2021). High risk of bias on methods to assess TBI in 18/21 studies may in part explain this omission. More research regarding the role of multiple TBIs and effects of age on severe TBI outcomes, is needed to confidently answer this question.

Are there factors which mediate this relationship?

Poorer self-control (16) mediated the increased risk of offending after TBI; a factor supported by previous research (Hay et al., 2018). Two high bias studies indicated that temperament difficulties (20) and adverse psychological effects (derived from the Brief Symptom Inventory, Impulsivity

Questionnaire and Moral Disengagement Questionnaire) (17), mediated increased offending risk (17 & 20). The implication that poor executive functioning might increase offending risk is consistent with research highlighting greater vulnerability of the prefrontal cortex at an early age (Lenroot & Giedd, 2006; Williams et al., 2018) and the more complex alternative to a neuroplasticity framework to describe the impact of early TBI (Giza & Prins, 2006).

Notably, two low bias papers found that whilst TBI increased offending risk in univariate analyses, it did not when Family Social Status (variable including parental demographic factors), Childhood Disruptive Behaviours (6), and substance use (12) were included as covariates. Two other high bias papers had similar findings (2 & 18). Whilst sixteen of the twenty-one included papers informing this review did control for other potential confounding variables, using multivariate analyses, consideration of the factors noted here, as well as other background factors relevant to recovery from TBI early in life – such as developmental stage, deprivation, family function and environment and pre-injury functioning, was limited. This seems important when considering some of these factors, such as deprivation, may worsen following involvement in offending, via adverse impact on employment and resultant economic status. It is likely that circumstances such as this, may increase recidivism risk alongside TBI.

Future studies should examine associations between early TBI and offending in the context of potential mediating factors highlighted here, to better understand this potentially multifactorial relationship. Temporal sequencing may also help to better understand the potential role other factors such as pre-injury function and the consequences of offending following TBI, such as imprisonment, play in increasing recidivism across the lifespan (Meijers et al., 2015).

Limitations

A strength of this review is the inclusion of an independent second person to screen and assess risk of bias of a proportion of the included studies, to reduce overall bias. However, not all studies were co-rated. Bias was reduced further by registering this review and protocol on PROSPERO.

Limitations of this review exist in relation to the inclusion and exclusion criteria. Only articles exploring offending behaviour specifically were included, in an attempt to increase homogeneity across studies. However, this may have resulted in relevant articles which included offending behaviour not described using CJS criteria being missed in screening. Further, by choosing a cut off age of TBI, studies which included those injured under age 25 as well as over, indiscernibly, were excluded and relevant data may have been missed.

The use of a narrative, rather than more structured synthesis, may be considered a limitation as study outcomes were not able to be robustly or consistently compared; although this was attempted where possible through comparison of effect sizes. Finally, there were a significant number of papers included in this review (21). Whilst this may be a strength, as it allowed a large amount of evidence to be presented, it might also be a limitation as it allowed for less in-depth analysis of each paper.

Recommendations for Future Research

Few papers assessed TBI or offending using validated tools and internationally recognised definitions or corroborated self-report. Future research would benefit from using international definitions when measuring TBI (Carroll et al., 2004) and employing validated tools such as the Brain Injury Screening Index (BISI) (Pitman et al., 2015), Brain Injury Screening Questionnaire (BISQ) (Gordon et al., 1999) or Ohio State University Traumatic Brain Injury Identification Method (OSU-TBI-ID) (Bogner and Corrigan, 2009). These would be recommended over the use of the International Classification of Diseases (ICD), which uses codes for head injury, rather than international definitions which indicate severity of TBI (Carroll et al., 2004). Where medical records are used, consideration not just of diagnosis, but factors such as LOC and PTA, to align with recognised definitions would be

recommended. When measuring offending, employing similar methods across studies would allow for greater comparability and more confident conclusions in reviews such as this. Future research might also benefit from using more longitudinal designs and temporal sequencing methods to allow for clearer comparisons of offending outcomes dependent on age at injury.

This research might allow for recommendations to be made to forensic services in relation to screening for TBI and adaptations to treatment aimed at rehabilitation and the promotion of desistance from offending.

Conclusion

TBI before the age of 26, increases the risk of offending, particularly violent offending, compared to people with no history of TBI. This is especially the case when TBI occurs after the age of 6 or 12 and is more severe. These findings however are tentative, given the limited evidence on multiple mild TBI, difficulties comparing age at injury across studies and not all studies looking at offending outcomes into adulthood or with adequate control of confounds. Potential mediating factors were found, namely those associated with executive function such as self-control and temperament.

Future good quality research which considers other possible mediating and predictive factors, to better understand this relationship and infer causality, is needed. This may inform forensic services of potential prevention and intervention measures needed in relation to TBI ≤ age 25 and offending.

References

Papers included in the review are annotated with *

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Chapter Two: Major Research Project

The effects of neurodevelopmental factors on offending in a forensic mental health population.

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Plain Language Summary

Title

The effects of neurodevelopmental factors on offending in a forensic mental health population.

Background

Abnormal neurodevelopment (A-ND) occurs commonly in offenders, due to early life factors such as neurodevelopmental disorders (e.g. Autism Spectrum Disorder, Attention Deficit Hyperactivity Disorder, Learning Disability) and experiences such as neglect, abuse or head injury (Borschman et al., 2020). A-ND has been associated with cognitive, emotional and behavioural difficulties which can persist for a person's lifetime (Raine et al., 2018) and increase the likelihood they will offend (Hughes et al., 2020; Carlisi et al., 2020). The relationship between A-ND and offending has not been explored in a forensic mental health setting.

Aims and Questions

This study explores whether or not A-ND increases the risk of offending in a forensic mental health sample. Specifically, the research questions asked whether those with A-ND were more likely to; be repeat offenders, to offend more violently, to offend more often and to offend violently during their hospital admission. It also looked to see if A-ND had effects on offending when other factors known to predict offending were included.

Methods

Secondary data from 522 individuals within the Scottish Forensic Estate in 2013 was sourced from the Forensic Network Service-User Database and analysed. Data included information about neurodevelopment and offending as well as other factors known to predict offending such as education, employment, trauma, substance use, social status and health.

Main Findings and Conclusions

Those with A-ND were less likely than those without to have; more than one conviction, a violent conviction and more total convictions, but more likely to offend violently in hospital. Where other factors were considered, A-ND had no effect on offending. It seems that A-ND alone might not explain why individuals offend in a forensic mental health setting. It might also be that the way A-ND was

measured in this study was not detailed or accurate enough, contributing to the unexpected findings. Future research in a forensic mental health setting is needed to help professionals understand how to best look after those with A-ND in forensic hospital settings and reduce the likelihood they will re-offend.

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Abstract

Background: Abnormal neurodevelopment (A-ND) is estimated to be more prevalent in forensic than in general populations. There is evidence to suggest that A-ND is associated with offending; particularly violent and persistent offending.

Aims: To explore associations between A-ND and offending in a forensic mental health population, and the potential for A-ND to predict offending.

Methods: A between subjects, retrospective, cross-sectional design was utilised using secondary data from the 2013 Scottish Forensic Network Service-User Database. Data included demographic, health and offending information from 522 patients within the Scottish Forensic Estate. Variables used in analyses were measured from relevant census items.

Results: Univariate analyses showed that those with A-ND were significantly less likely than those without, to have; more than one conviction (X^2 (1)=5.447, p=0.02), more total convictions (U=3454, z=-2.485, p=0.013) and a violent conviction (X^2(1)=8.109, p=0.004), but more likely to have reports for violence during their hospital admission (X^2(1)=14.222, p<0.001). In multivariate analyses, A-ND was not associated with any offending outcomes. Other factors; substance misuse, older age, physical abuse, significant events in childhood and unemployment, were significant predictors of offending.

Conclusions: A-ND was not associated with offending in multivariate analyses. This might represent different outcomes of A-ND in forensic mental health, compared to non-mental health samples. However, it is more likely that limitations in the A-ND measure reduced its validity and contributed to unexpected results. Future research in a forensic mental health sample is needed.

Key Words: Forensic Mental Health, Abnormal Neurodevelopment, Offending

Introduction

The brain has been shown to develop rapidly and dynamically throughout early life. Some brain areas, such as the prefrontal cortex, are thought to only reach maturity in the mid 20's (Arain et al., 2013; O'Rourke et al., 2020). Typical neurodevelopment allows for the maturation of brain structures required for the acquisition of skills and adaptation to daily living and wider social norms as an adult (Hughes et al., 2020[a]). Where neurodevelopment early in life is abnormal, this can result in significant cognitive, communication, socio-emotional and behavioural impairments, which start in childhood and due to the vulnerability of the young brain, can persist into adulthood, (Raine et al., 2018; Zamani et al., 2020).

Abnormal neurodevelopment (A-ND) in infancy might result from neurodevelopmental disorders, such as Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD) and Learning Disability. Such conditions, which continue into adulthood, are often apparent before a child reaches school. Other potential causes of abnormal infant neurodevelopment include pre-natal genetic influence or post-natal early life trauma such as neglect, abuse or Traumatic Brain Injury (TBI) (Raine et al., 2019; Zamani et al., 2020).

Potential adverse effects of early A-ND include increased impulsivity, hostility (Lesch et al., 2012) and impaired attention, communication and responses to rewards and stimulation (Fishbein, 2006). Such difficulties can impact social learning and adversely affect engagement with normative social experiences such as the development of relationships, and engagement with education and employment (Raine et al., 2018). They might also increase the likelihood that individuals develop antisocial traits (Paradis et al., 2015), engage in offending, particularly acts of violence (Raine et al., 2019) and repeatedly enter the Criminal Justice System (Borschmann et al., 2020; Hughes et al., 2015). Studies have shown that such links can be found with persistent offending in adulthood, where neurodevelopmental deficits were evident before the age of 5 years old (Raine et al., 2019).

As a result, offending has been explored through a neurodevelopmental lens (Hughes et al., 2017). Offenders, particularly early and persistent offenders, (Moffit, 2015; Raine et al., 2005) have been shown to have altered brain structures, compared to non-offenders or offenders who desist in adulthood (Tiihonen et al., 2008; Carlisi et al., 2020). This might indicate that A-ND and its associated impairments increase the risk of offending behaviours.

This view is consistent with research suggesting that the prevalence of conditions which can lead to A-ND, is high in an adolescent forensic population (Hughes et al., 2012), with estimates of 2-65%, compared to 3-20% in the general population (Borschmann et al., 2020). Young people in prison were found to be three to four times as likely to have experienced a moderate-severe TBI, than peers in the community (Hughes et al., 2015). Rates of ADHD were found to be significantly higher in a youth (30%) and adult (26%) prison populations (Young et al., 2015) than in the general population (4%) (Mohammadi et al., 2019). Similarly, Borschmann and colleagues (2020) found 11-20% of young offenders met criteria for Foetal Alcohol Spectrum Disorders (FASD), compared to 2-5% of the general adolescent population. Learning disabilities were found to be overrepresented in a prison population at 10-32% compared to 2-4% in the general population (Hellenbach et al., 2017). Similarly, 60-65% of an adolescent prison population have been estimated to have communication impairments compared to 5-7% in the community (Borschmann et al., 2020).

Further, research in forensic samples suggests that specific neurodevelopmental disorders and processes are associated with offending. Delayed language development can be a significant predictor of future offending (Stattin & Klackenberg-Larsson, 1993; Petersen et al., 2013) and physical aggression (Dionne et al., 2003). Cognitive impairment can increase rates of violent offending and aggression (Winstanley et al., 2018), as can sensory impairments (Miller et al., 2005), complications at birth, foetal exposure to toxins and premature birth (Liu, 2011; Paradis et al., 2015). Childhood ADHD (Lundström et al., 2014), and emotional and behavioural difficulties (Young et al., 2016; Reef et al., 2011) have also been associated with early onset and repeat offending. There is less evidence about the potential associations between neurodevelopment and offending in forensic mental health samples, however Hilton and

colleagues (2018) did find that neurodevelopmental problems, were associated with violence in a male forensic inpatient sample.

However, other studies highlight the potential for neuroplasticity in the young brain, to facilitate adaptation to early life adversity, limiting long term impact on typical neurodevelopment (Anderson et al., 2011; Zamani et al., 2020). Where this is taken into account, the causal relationship between A-ND and offending becomes less clear (Anderson et al., 2011). As a result, recent research has started to re-examine whether A-ND is associated with offending. A range of factors, including social deprivation and inequalities (Anderson et al., 2011), substance misuse (Lundström et al., 2014), age (Zamani et al., 2020) and trauma (Hughes et al., 2020[b]) have been considered due to their co-morbidity in this vulnerable group (Borschmann et al., 2020) and there is tentative support for them predicting offending (Hughes et al., 2020[b]). More evidence is required in order to disentangle the potential role of infant A-ND in offending (Zamani et al., 2020), particularly in a forensic mental health population

Aim and Research Questions

Aim

To explore associations between A-ND in infancy and offending in a forensic mental health population, and the potential for A-ND to predict offending.

Research Questions

1.

i. Are adult patients in the forensic estate with A-ND in infancy more likely to be repeat offenders (as defined by more than one conviction), than patients without?

ii. Does A-ND predict repeat offending after adjustment for age, substance use, employment, educational attainment, history of abuse and significant events in childhood?

2.

i. Do adult patients in the forensic estate with A-ND in infancy have more total convictions than patients without?

ii. Does A-ND predict total convictions after adjustment for age, substance use, employment, educational attainment, history of abuse and significant events in childhood?

3.

i. Do adult patients in the forensic estate with A-ND in infancy have more violent convictions than patients without?

ii. Does A-ND predict violent convictions after adjustment for age, substance use, employment, educational attainment, history of abuse and significant events in childhood?

4.

i. Do adult patients in the forensic estate with A-ND in infancy receive more reports for violence during admission than those without?

ii. Does A-ND predict reports for violence during admission after adjustment for age, substance use, employment, educational attainment, history of abuse and significant events in childhood?

Methods

Design

This study used a between subjects, retrospective, cross-sectional design to examine differences in offending characteristics between those with and without neurodevelopmental difficulties.

Participants and Study Site

Relevant data were obtained from the Scottish Forensic Network Service-User Database. This contains anonymised information on 522 adults who were inpatients in one of 23 forensic mental health high, medium and low secure inpatient sites in 2013. These 23 sites (see Appendix 2.2, pp. 97) are part of Scotland's Forensic Mental Health Managed Care Network and provide inpatient care for the general adult forensic population, as well as a smaller specialist forensic learning disability provision. Individuals are supported by these forensic mental health and learning disability provisions where they have a mental disorder and are undergoing or have undergone, legal or court proceedings, or are deemed by civil legislation as at risk of harming themselves or others.

Individuals were included if their census record contained information on required variables at each stage of analysis. The process of including and excluding participants was carried out separately for each hypothesis (H1-4), as the required variables changed.

Procedure

The Forensic Network Service-User Database contains non-identifiable patient information, gathered during a census within the Scottish Forensic Mental Health Managed Care Network. The census used point prevalence methodology based on this population on the 26th of November 2013. Responsible Medical Officers/Senior Medical Trainees or Forensic Network staff completed the Forensic Network Inpatient Census Casenote Datasheet (Appendix 2.2) for each patient in their care at that time, who met the Scottish Government definition of a 'mentally disordered offender' and the census inclusion criteria (Appendix 2.3). Data were collected by reviewing routinely collected patient data, primarily via patient files. Data collected included lifespan information about demographics, physical and mental health, offending, trauma and substance use, as well as results from risk and other hospital-based assessments.

A research assistant from the Forensic Network was available to provide direct advice and support during the census and a nominated lead to liaise with the assistant was identified in each site. Datasheets were returned to the Forensic Network following set secure transfer protocols, and data were then collated centrally.

The researcher obtained approval to use the database from the State Hospital Research Ethics Committee. Following approval (Appendix 2.4), the non-identifiable data set was transferred to the researcher electronically by the Data Controller as an anonymised Excel Spreadsheet, which was password protected.

Research Approvals

The Forensic Network Service-User Database was granted ethical approval by the NHS Health Research Authority (18/SS/0099) on the 8th of August 2018 (Appendix 2.5). Ethical approval was granted for this study by the State Hospital Research Committee and NHS State Hospital Research and Development on the 18th November 2020 (Appendix 2.4). A Data Protection Impact Assessment (DPIA) screen was approved by the State Hospital Information Governance and Data Security Officer on the 11th December 2020 (Appendix 2.6).

Data Management

All variables were created using items held within the Forensic Network Service-User Database.

A number of items within the database allowed for 'unknown' to be selected. Where individuals were rated as 'unknown' on a required item, they were removed from the analysis. This was done separately for each research question, meaning sample size varied throughout the analyses.

For the purpose of regression analysis, both employment history and educational attainment were collapsed into binary variables due to the small frequency of ratings across additional categories.

Variables for Inclusion

Predictor Variables

Neurodevelopment (ND): ND was coded as a binary (Y/N) variable using item 11 *Abnormal Infant Development*. Participants rated as Y were considered to have experienced *A-ND* (Abnormal Neurodevelopment) and those rated as N were considered to have experienced *T-ND* (Typical Neurodevelopment).

Age: Age at the time of census completion was calculated using the date of birth for each participant, to create a continuous age variable.

Alcohol Problems: Problematic alcohol use was coded as a binary variable, using item 19 *Patient Alcohol Consumption Problems*. It refers to any past alcohol consumption problems rated as Y/N.

Drug Problems: Problematic drug use was coded as a binary variable, using item 20 *Patient Drug Misuse*. It refers to any past illicit drug misuse rated as Y/N.

Employment: Item 9 *Occupation Prior to Admission* has five rating options. Due to low frequency ratings across a number of categories, it was collapsed into a binary variable defined as Y/N employed prior to admission.

Education: Item 17 *Highest Academic Achievement* has eight rating options. Due to low frequency ratings across a number of categories, it was collapsed into a binary variable defined as Y/N qualifications.

Physical Abuse: Item 12 *History of Physical Abuse (<16 years)* is rated as a Y/N and was coded as a binary variable. Whether the individual was a witness or victim can also be specified.

Sexual Abuse: Item 13 *History of Sexual Abuse (<16 years)* is rated as a Y/N and was coded as a binary variable. Whether the individual was a witness or victim can also be specified.

Significant Events in Childhood: Item 14 *Significant Events in Childhood (<16 years)* is rated as Y/N and was coded as a binary variable. Event type can also be specified by selecting from 18 options. These types of event include; death of a sibling or caregiver, separation from parents, caregiver or sibling serious illness or accident, removal from the family home (e.g. taken in to kinship, foster or local authority care), parental unemployment or substance misuse and experience of bullying.

Outcome Variables

Offending Characteristics

Repeat Offending: History of repeat offending (more than one conviction versus none or one conviction only) was coded as a binary variable (Y/N), using item 37 *Previous Conviction(s).*

Offending History: To explore offending history, two variables were included. The *total number of previous convictions* in item 37a was coded as an ordinal variable; 1-4, 5-10 or 10+ convictions. From item 37b where all previous crime is rated by type, a history of *violent convictions* was identified and coded as Y/N.

Violence During Admission: This was coded as a binary Y/N variable from item 32, *Violent incidents during current admission*.

Sample Size Estimation

Paradis and colleagues (2015) found moderate to large effect sizes with a sample of n=2464, when comparing offence history; history of arrest and violent offending and ND. Power calculations (G*Power; Faul et al., 2009) based on Paradis and colleagues (2015) using the predictor variable A-ND and offending outcomes, indicated a sample of n=32 was required to detect a large (w=0.5) and n=88 for a medium effect (w=0.3), using Chi Squared analysis. Power calculations indicated n=128 was required to detect a medium effect (d=0.5) using Analysis of Variance. For multivariate analyses, with 80% power, $\alpha = 0.05$ and nine predictors, n=114 was required to detect a medium (f^2=0.15) effect size. As a result, n=114 was estimated to be required for this study, with recognition that using an existing database meant sample size could not be controlled.

Given that the census of the forensic mental health population was available, it was appropriate to use all individuals in the Forensic Network Service-User Database (n=522), to better represent the population. Sample size varied for each research question due to missing data. In the primary analyses sample size ranged from n=159 to n=380 across research questions, exceeding the estimate of n=114. For exploratory analyses that considered SIMD as a factor, the sample size did not reach the estimate, with the sample size ranging from n=84 to n=111.

Statistical Methods

SPSS Version 27 was used to analyse the data. Univariate analyses were used initially to explore associations between ND and offending behaviour for each research question. Univariate test assumptions regarding frequency of cases, normality and independence were checked and non-parametric tests used where indicated. Multivariate regression followed, to explore the relationships between ND and offending when age (continuous), alcohol problems (binary), drug problems (binary), employment (binary), education (binary), history of physical abuse (binary), history of sexual abuse (binary) and significant events in childhood (binary) were included as predictor variables. Logistic regression assumptions regarding independence of observations, linearity and proportional odds were checked; no assumptions were violated. Separate regression analyses were carried out adding SIMD as a predictor; this was deemed exploratory because of the large amount of missing data for the SIMD variable. This meant that where SIMD was included in analyses, sample size was reduced and the estimated sample size to provide adequate power was not reached.

1. **A-ND and Repeat Offending**

The Chi Square Test of Independence was used to investigate the relationship between ND (A-ND/T-ND) and repeat offending (yes/no). Binary logistic regression was used to explore the relationship between ND and repeat offending as the outcome, where other predictors (age, alcohol and drug problems, employment, education, history of physical and sexual abuse and significant events in childhood) were included in the model. A second binary logistic regression was carried out, adding SIMD as a predictor in the original model, to explore any additional or different effects on repeat offending.

2. **A-ND and Total Convictions**

The Mann Whitney U test was used to investigate the relationship between ND (A-ND/T-ND) and total convictions; an ordinal variable comprising 3 numerically ordered bands (1-4, 5-10, +10 convictions). Ordinal Logistic regression was used to explore the relationship between ND and total convictions as the outcome, where other predictors (age, alcohol and drug problems, employment, education, history

of physical and sexual abuse and significant events in childhood) were included in the model. A second ordinal logistic regression was carried out, adding SIMD as a predictor in the original model, to explore any additional or different effects on total convictions.

3. A-ND and Violent Convictions

The Chi Square Test of Independence was used to investigate the relationship between ND (A-ND/T-ND) and violent convictions (yes/no). Binary Logistic regression was used to explore the relationship between ND (A-ND/T-ND) and violent convictions as the outcome, where other predictors (age, alcohol and drug problems, employment, education, history of physical and sexual abuse and significant events in childhood) were included in the model. A second binary logistic regression was carried out, adding SIMD as a predictor in the original model, to explore any additional or different effects on violent convictions.

4. A-ND and Violence During Admission

The Chi Square Test of Independence was used to investigate the relationship between ND (A-ND/T-ND) and violence during admission (yes/no). Binary Logistic regression was used to explore the relationship between ND (A-ND/T-ND) and violence during admission as the outcome, where other predictors (age, alcohol and drug problems, employment, education, history of physical and sexual abuse and significant events in childhood) were included in the model. A second binary logistic regression was carried out, adding SIMD as a predictor in the original model, to explore any additional or different effects on violence during admission.

Results

Demographic Information

The Forensic Network Service-User Database contains information on 718 patients across Scotland's Forensic Mental Health Managed Care Network in 2013. Records were incomplete for 196 of these which gave a study sample of 522. The mean age of the full study sample was 41.21 (SD 11.98) years and age ranged from 17 to 79. In total, 465/522 (89%) participants identified as *White*. The majority of participants (80%) identified specifically as *White Scottish*. The remainder identified as *Any Mixed Background* (n=9, 2%); *Indian* (n=1, 0.2%); *Pakistani* (n=2, 0.4%); *Bangladeshi* (n=1, 0.2%), *Chinese* (n=1, 0.2%); *African* (n=5, 1%); *Any Other Asian Background* (n=2, 0.4%) and *Any Other Ethnic Background* (n=6, 1%). There was only data available to calculate SIMD for n=271 (52% of the sample). Of these, 36 postcodes could not be used as they were Northern Irish (10) or were recorded incorrectly (26). This left data to assign SIMD for n=235 (45% of the sample). Characteristics of the sub-samples with and without SIMD data available, are outlined in Table 2.12 (Appendix 2.7).

The most common primary International Classification of Diseases (ICD) diagnosis in the sample was Schizophrenia (n=304, 58%). Other diagnoses were learning disability (89, 17%), personality disorder (26, 5%), schizoaffective disorder (34, 7%), other psychotic disorder (11, 2%), bipolar affective disorder (25, 5%), problematic substance use (7, 1%), Autism Spectrum Disorder (ASD)/Attention Deficit Hyperactivity Disorder (ADHD) (3, 0.5%), depressive disorders (3, 0.5%), dementia (2, 0.4%), Acquired Brain Injury (ABI) (6, 1%), Post Traumatic Stress Disorder (PTSD (2, 0.4%) and mania (1, 0.2%).

Table 2.1 Demographic information for total sample and by ND group

	Total in Census (N=522)	**Missing Cases N (% Census)**	**A-ND (N=92)**	**T-ND (N=288)**
*Mean Age**	41.21	24 (5)	36.96	41.22
(SD, range)	(11.98, 17-79)		(12.89, 17-79)	(11.48, 18-76)
Gender		0 (0)		
N Male (%)	475 (91)		84 (91)	262 (91)
N Female (%)	47 (9)		8 (9)	26 (9)
Employment History		35 (7)		
Yes, N (%)	70 (13)		9 (11)	44 (16)
No, N (%)	417 (80)		72 (89)	235 (84)
*Educational Attainment***		101 (19)		
Yes, N (%)	149 (29)		15 (19)	101 (42)
No, N (%)	272 (52)		62 (81)	140 (58)
Scottish Index of Multiple Deprivation (SIMD) N (%)		287 (55)		
1 High	90 (17)		10 (28)	59 (41)
2	58 (11)		13 (36)	26 (18)
3	48 (9)		10 (28)	33 (23)
4	26 (5)		1 (3)	20 (14)
5 Low	13 (3)		2 (5)	6 (4)

Abnormal Neurodevelopment (A-ND); Typical Neurodevelopment (T-ND); Significant differences between the ND groups: *p<0.005; **p<0.001; SIMD (Scottish Index of Multiple Deprivation); SD (Standard Deviation)

Chi Square analyses indicated that those with A-ND were less likely to have educational qualifications at Standard Grade/GCSE or above ($X^2(1)=12.668$, $p<0.001$; $V=0.2$ small effect size). The A-ND group was significantly younger, compared to the T-ND group ($t(357)=2.947$, $p=0.03$).

Predictive Factors

The type of A-ND was specified for 86/92. These were Delayed Language Development (n=30), Delayed Walking (n=3), Cognitive Impairment or Developmental Delay (n=24), Emotional or behavioural difficulties (n=20) and Problems with Growth (n=9). For the other n=6 participants coded as having A-ND, the type was not specified on the census form. Overall, 24% (92/380) of participants were coded as A-ND. A further 50 patients were noted to have problems at birth; the nature of these varied and descriptions did not indicate the impact on early neurodevelopment. In addition, 158 participants were identified as having had a brain scan, with 34 rated as 'abnormal'. It could not be

determined whether the brain abnormality affected early neurodevelopment, as age at the time of the brain scan was not given and abnormalities were not described.

Table 2.2 Substance Use and Trauma History for total sample and by ND group

	Total in Census (N=522)	**Missing Cases N (% Census)**	**A-ND (N=92)**	**T-ND (N=288)**
*Alcohol Problems***		26 (5)		
Yes, N (%)	353 (68)		43 (50)	223 (79)
No, N (%)	143 (27)		43 (50)	59 (21)
*Drug Problems***		19 (4)		
Yes, N (%)	344 (66)		35 (39)	219 (78)
No, N (%)	159 (30)		54 (61)	60 (22)
History of Physical Abuse		89 (17)		
Yes, N (%)	179 (34)		33 (45)	93 (35)
No, N (%)	254 (49)		40 (55)	175 (65)
*History of Sexual Abuse***		99 (19)		
Yes, N (%)	106 (20)		28 (41)	46 (18)
No, N (%)	317 (61)		40 (59)	211 (82)
*Significant Events in Childhood**		56 (11)		
Yes, N (%)	385 (74)		77 (91)	211 (76)
No, N (%)	81 (15)		8 (9)	66 (24)

Abnormal Neurodevelopment (A-ND); Typical Neurodevelopment (T-ND); Significant differences between the ND groups: *p<0.005; **p<0.001

Chi-Square analysis indicated that significantly more participants in the A-ND compared to T-ND group had a history of sexual abuse ($X^2(1)=17.263$, $p<0.001$; *Cramer's V*=0.23) and significant adverse events in childhood ($X^2(1)=8.310$, $p<0.005$; *Cramer's V*=0.15). Effect sizes found were small-medium and small respectively. Fewer participants with A-ND had alcohol ($X^2(1)=27.813$, $p<0.001$; V=0.275) or drug problems ($X^2(1)=48.414$, $p<0.001$; V=0.363), with medium effect sizes.

Offending Information

Table 2.3 Offending characteristics for sample and by ND group

	Total in Census (N=522)	**Missing Cases N (% Census)**	**A-ND (N=92)**	**T-ND (N=288)**
More than one Conviction		38 (7)		
Yes, N (%)	335 (64)		51 (65)	198 (78)
No, N (%)	149 (29)		28 (35)	57 (22)
Total convictions, N (%)		200 (38)		
1-4	121 (23)		23 (50)	64 (33)
5-10	70 (14)		12 (26)	47 (24)
>10	131 (25)		11 (24)	82 (43)
Violent convictions		0 (0)		
Yes, N (%)	169 (32)		18 (20)	102 (35)
No, N (%)	353 (68)		74 (80)	186 (65)
Violence during admission		19 (3)		
Yes, N (%)	248 (48)		59 (65)	117 (42)
No, N (%)	255 (49)		32 (35)	161 (58)
Index Offence		159 (30)		
Non-sexual violence	203 (39)		26 (45)	132 (65)
Crimes of indecency	66 (13)		17 (29)	27 (13)
Crimes of Dishonesty	7 (1)		2 (4)	3 (2)
Other Crimes	14 (3)		3 (5)	8 (4)
Fire-raising, vandalism etc	24 (5)		4 (7)	9 (5)
Miscellaneous Offences	49 (9)		6 (10)	23 (11)

Abnormal Neurodevelopment (A-ND); Typical Neurodevelopment (T-ND)

As indicated in Table 2.3, the majority of the total sample had more than one conviction (64%). Most often participants had committed crimes of violence (39%) in their index offence and almost half had been involved in violence during their hospital admission (48%).

Missing data across individual domains did not appear to be systematic, with the exception of one hospital which did not record the age or previous post code for any of their patients on the census forms (n=23) and one additional hospital, where the previous post code was not recorded (n=60).

Research Questions

The A-ND group was significantly younger, than the T-ND group (t(357)=2.947, p=0.03) and for this reason age was included in regression analyses.

1. i) Are adult patients in the forensic estate with A-ND in infancy more likely to be repeat offenders (as defined by more than one conviction), than patients without?

In relation to this research question, those who were rated as a 'sentenced prisoner transfer' and had <5 total convictions were excluded. This was because as per the instructions on the census form, those transferred from prison had their index and previous convictions combined, meaning it was not possible to determine if they had more than one conviction.

Table 2.4 ND and More than one Conviction, N (%)

More than one conviction	*A-ND*	*T-ND*
Yes	51 (65)	198 (78)
No	28 (35)	57 (22)

Chi-square analysis with n=334 indicated the A-ND sample were significantly less likely to have more than one conviction, than the T-ND sample ($X^2(1)=5.447$, p=0.02; V= 0.128, small effect).

1. ii) Does A-ND predict repeat offending after adjustment for age, substance use, employment, educational attainment, history of abuse and significant events in childhood?

Binary logistic regression was used to explore the relationship between ND and more than one conviction as the outcome, where other predictors (age, alcohol and drug problems, employment, education, history of physical and sexual abuse and significant events in childhood) were included in the model.

Table 2.5 Binary Logistic Regression with More than one Conviction as the outcome (n=211)

	B	S.E.	Wald	df	*p*	OR	95% Confidence Interval	
							Lower	Upper
Age	0.009	0.018	.242	1	.623	1.009	.974	1.045
A-ND	.244	.493	.245	1	.621	1.276	.486	3.354
Employment	.219	.590	.138	1	.711	1.245	.392	3.955
Education	-.974	.407	5.731	1	.017	.378	.170	.838
Alcohol Problems	.947	.460	4.237	1	.040	2.578	1.046	6.349
Drug Problems	1.146	.501	5.236	1	.022	3.146	1.176	8.395
Physical Abuse	.079	.508	.025	1	.876	1.083	.400	2.929
Sexual Abuse	-.758	.530	2.048	1	.152	.468	.166	1.323
Significant Events in Childhood	.669	.470	2.023	1	.155	1.952	.777	4.907

Odds Ratio (OR) taken from Exp(B).

The model explained 21.9% of the variance (*Nagelkerke* R^2) and the Hosmer-Lemeshow test indicated the model was a good fit (Chi-square=9.722, df=8, p=0.285). Significant predictors of more than one conviction were, no educational qualifications and drug and alcohol problems.

When SIMD was added to the model as a predictor, resulting in a smaller sample (n=99) because of missing data, 40.6% of the variance (*Nagelkerke* R^2) was explained and only alcohol problems significantly predicted having more than one previous conviction (Wald=4.477, df=1, p=0.034, Exp (B)=4.4360, CI=1.115-17.053). The Hosmer-Lemeshow test indicated this model was a good fit (Chi-square=10.708, df=8, p=0.219).

2. i) Do adult patients in the forensic estate with A-ND in infancy have more total convictions than patients without?

Table 2.6 ND and Total Convictions, N (%)

Total Convictions	*A-ND*	*T-ND*
1-4	23 (50)	64 (33)
5-10	12 (26)	47 (24)
>10	11 (24)	82 (43)

Univariate analyses (n=239) indicated that the A-ND sample had significantly fewer convictions than the T-ND sample (U=3454, z=-2.485, p=0.013; r=0.16, small effect size).

2. ii) Does A-ND predict total convictions after adjustment for age, substance use, employment, educational attainment, history of abuse and significant events in childhood?

Ordinal logistic regression was used to explore the relationship between ND and total convictions as the outcome, where other predictors (age, alcohol and drug problems, employment, education, history of physical and sexual abuse and significant events in childhood) were included in the model.

Table 2.7 Ordinal Logistic Regression with Total Convictions as the outcome **(**n=159)

	B	S.E.	Wald	df	*p*	Confidence Interval Lower	Upper
Age	.028	.015	3.416	1	.065	-.002	.058
A-ND	-1.172	.432	7.355	1	.007	-2.019	-.325
Employment	-1.236	.467	6.996	1	.008	-2.152	-.320
Education	-.637	.345	3.405	1	.065	-1.314	0.40
Alcohol Problems	.641	.446	2.062	1	.151	-.234	1.516
Drug Problems	1.511	.538	7.886	1	.005	.456	2.565
Physical Abuse	1.162	.392	8.801	1	.003	.394	1.930
Sexual Abuse	.175	.449	.151	1	.697	-1.054	0.705
Significant Events	.282	.446	.401	1	.527	-.592	1.157

The model explained 29.8% of the variance (*Nagelkerke* R^2) and the model fitting information indicated that the final model (Chi-square=48.721, df=9, p <0.001), improved the baseline intercept only model. The Hosmer-Lemeshow test indicated the final model was a good fit (*Pearson*) (Chi Square = 304.667, df=287, p=0.226). Significantly more total convictions were predicted by unemployment, T-ND, a history of physical abuse and drug problems.

When SIMD was added to the model as a predictor, resulting in a smaller sample (n=84) because of missing data, 36.2% of the variance (*Nagelkerke* R^2) was explained. The model fitting information indicated that the final model (Chi-square=32.322, df=13, p=0.002) improved the baseline intercept only model and that the final model was a good fit (*Pearson*) (Chi Square = 178.904, df=151, p=0.06). Drug problems (Wald=4.084, df=1, p=0.043, B=1.864, CI=0.056-3.672), a history of physical abuse (Wald=9.123, df=1, p=0.003, B=1.766, CI=0.620-2.911) and older age (Wald=4.022, df=1, p=0.045, B=0.050 CI=0.001-0.099), significantly predicted more total convictions.

3. i) Do adult patients in the forensic estate with A-ND in infancy have more violent convictions than patients without?

Chi-square analysis with n=380 indicated that the A-ND sample were significantly less likely to have violent convictions than the T-ND sample ($X^2(1)=8.109$, p=0.004; V= 0.146, small effect).

Table 2.8 ND and Violent Convictions, N (%)

Violent Convictions	*A-ND*	*T-ND*
Yes	18 (20)	102 (35)
No	74 (80)	186 (65)

3. ii) Does A-ND predict violent convictions after adjustment for age, substance use, employment, educational attainment, history of abuse and significant events in childhood?

Binary logistic regression was used to explore the relationship between ND and violent convictions as the outcome, where other predictors (age, alcohol and drug problems, employment, education, history of physical and sexual abuse and significant events in childhood) were included in the model.

Table 2.9 Binary Logistic Regression with Violent Convictions as the outcome (n=232)

	B	S.E.	Wald	df	*p*	OR	Confidence Interval	
							Lower	Upper
Age	.008	.015	.269	1	.604	1.008	.979	1.037
A-ND	-.674	.437	2.383	1	.123	.509	.216	1.199
Employment	.088	.432	.042	1	.838	1.092	.468	2.545
Education	-.623	.325	3.688	1	.055	.536	.284	1.013
Alcohol Problems	.233	.434	.288	1	.592	1.262	.539	2.955
Drug Problems	1.456	.516	7.947	1	.005	4.289	1.558	11.803
Physical Abuse	.752	.357	4.443	1	.035	2.121	1.054	4.267
Sexual Abuse	-.388	.405	.916	1	.338	.678	.307	1.501
Significant Events	.435	.426	1.041	1	.308	1.545	.670	3.564

Odds Ratio (OR) taken from Exp(B).

The model explained 18.7% of the variance (*Nagelkerke* R^2). Violent convictions were predicted by drug problems and a history of physical abuse. However, the Hosmer-Lemeshow Test indicated the model *was not* a good fit (Chi-square=19.002, df=8, p=0.015).

When SIMD was added to the model as a predictor, resulting in a smaller sample (n=111) because of missing data, 25.7% of the variance (*Nagelkerke* R^2) was explained and only a history of physical abuse significantly predicted having violent convictions (Wald=9.953, df=1, p=0.002, Exp(B)=6.126, CI=1.987-18.891). The Hosmer-Lemeshow Test indicated that the model was now a good fit (Chi-square=8.370, df=8, p=0.398)

4. i) Do adult patients in the forensic estate with A-ND in infancy receive more reports for violence during admission than those without?

Chi-square analysis with n=369 indicated that the A-ND sample were significantly more likely to have reports for violence, including actual or potential physical harm to a victim, during their inpatient admission, than the T-ND sample ($X^2(1)=14.222$, $p<0.001$; $V=0.196$, small effect).

Table 2.10 ND and Violence During Admission, N (%)

Violence During Admission	*A-ND*	*T-ND*
Yes	59 (65)	117 (42)
No	32 (35)	161 (58)

4. ii) Does A-ND predict reports for violence during admission after adjustment for age, substance use, employment, educational attainment, history of abuse and significant events in childhood?

Binary logistic regression was used to explore the relationship between ND and violence during admission as the outcome, where other predictors (age, alcohol and drug problems, employment, education, history of physical and sexual abuse and significant events in childhood) were included in the model.

Table 2.11 Binary Logistic Regression with Violence During Admission as the outcome (n=226)

	B	S.E.	Wald	df	*p*	OR	Confidence Interval	
							Lower	Upper
Age	-.016	.014	1.308	1	.253	.984	.958	1.011
A-ND	.474	.378	1.572	1	.210	1.606	.766	3.368
Employment	-1.288	.497	6.724	1	.010	.276	.104	0.730
Education	-.422	.311	1.850	1	.174	.655	.357	1.205
Alcohol Problems	-.438	.403	1.183	1	.277	.645	.293	1.421
Drug Problems	-.439	.433	1.026	1	.311	.645	.276	1.507
Physical Abuse	-.180	.356	.257	1	.612	.835	.416	1.677
Sexual Abuse	-.428	.422	1.029	1	.310	.652	.285	1.490
Significant Events	0.935	.855	0.426	1	.023	2.548	1.139	5.703

Odds Ratio (OR) taken from Exp(B).

The model explained 15.8% of the variance (*Nagelkerke* R^2) and the Hosmer-Lemeshow test indicated the model was a good fit (Chi-square=5.291, df=8, p=0.726). Reports of violence during admission were predicted by unemployment and significant events in childhood.

When SIMD was added to the model as a predictor, resulting in a smaller sample (n=107), because of missing data, 24.9% of the variance (*Nagelkerke* R^2) was explained and only significant events in childhood significantly predicted reports for violence during admission (Wald=5.339, df=1, p=0.021, Exp (B)=7.862, CI=1.367-45.199). The Hosmer-Lemeshow Test indicated that the model was a good fit (Chi-square=3.533, df=8, p=0.897).

Discussion

Main Findings

This study explored associations between A-ND and offending in a forensic mental health sample. Results show that those with A-ND had fewer violent convictions, total convictions and were less likely to have more than one conviction, than those with T-ND. Those with A-ND however were found to have more reports for violence during admission than those with T-ND. When other potential predictors of offending were included in multivariate analyses, ND was not associated with any offending outcome.

These findings largely contradict other studies in forensic settings which report that cognitive impairment (Winstanley et al., 2018), delayed language (Peterson et al., 2013) and emotional and behavioural difficulties (Young et al., 2016), increase offending risk. They also differ from studies indicating neurodevelopmental abnormality continues to increase offending risk, when socioeconomic status and other background factors are controlled for (Paradis et al., 2015). More consistent with this study, Christensen and Baker (2020) found that youths with intellectual disabilities were less likely to offend than peers who experienced typical development. However, they outlined limitations in their study which put into doubt the generalizability of these results.

Results in this study might be explained by moderating factors. It was considered that the younger age of the A-ND group moderated the association with lower rates of offending in univariate analyses, because of reduced time to offend. However, age was not a significant covariate in multivariate analyses. Psychosis was also considered as a possible moderating factor, due to its association with increased inpatient violence risk (Lopez-Garcia, 2019). However, diagnosis of schizophrenia or other psychotic illness was actually more prevalent in the T-ND than the A-ND group.

It is notable that A-ND was associated with fewer violent and total convictions, but more violence during admission, when compared to T-ND. Studies by Lovell and Skellern (2019) indicate that where individuals have intellectual or other neurodevelopmental difficulties, staff and carers supporting them often underreport acts of violence or other offences, due to beliefs around violence being more

'acceptable' or unintentional. It might therefore be that convictions in this sample, in which staff or carers were victims, were underreported, making convictions an unreliable indicator of offending. In turn, the expected results found in relation to the violence during admission outcome, might represent outcomes from a more valid measure, as it was recorded within a forensic inpatient setting with highly trained staff. These staff might be less likely to hold such beliefs, and be less hesitant in reporting inpatient violence particularly, as it is less likely to result in the pursuit of conviction, than violence reported in the community.

It might also be that the type of A-ND associated with community and inpatient violence is different, as studies comparing community and inpatient violence have found that they were predicted by different factors. Krakowski and colleagues (1998) found that whilst community offenders performed poorly on tests of frontal lobe function, those committing inpatient violence did not. Another study showed that whilst neurodevelopmental problems and antisocial traits predicted community offending, this model did not fit inpatient offending outcomes (Hilton et al., 2018). As such, it may be that using one brief and broad measure of A-ND to explore both inpatient and community offending outcomes here, was not sensitive enough to produce results comparable to those in the studies described above, which used neuropsychological tests and a wider range of variables, to define A-ND.

Within the study sample, 92/380 (24%) participants were identified as having A-ND, including delayed language development, cognitive impairment, emotional and behavioural difficulties and problems with growth. This is within the ranges of A-ND prevalence in forensic settings, although these are broad (2-65%), and slightly above the range reported for the general population (3-20%) (Borschman et al., 2020). Comparison to estimates in forensic mental health populations is difficult as no studies have explored this, however some studies have suggested that A-ND is more common where there is a co-morbid mental health condition. McCarthy and colleagues (2019) found that in an adult forensic sample, 5.8-63.8% of individuals with A-ND had a co-morbid mental health condition, compared to 1.4-23.2% with T-ND. In particular, A-ND has been shown to commonly occur alongside Schizophrenia and other psychotic disorders; the primary diagnoses for two thirds of this study sample (Rapoport et al., 2012).

This might suggest that the prevalence A-ND in this study is potentially an underestimate, although this should be considered tentative due to a lack of strong evidence.

Any potential under-reporting of A-ND in this study may relate to the use of file review alone to define it. Other studies have found that where screening for A-ND has been used in addition to file review, more individuals with A-ND have been identified. McCarthy and colleagues (2015) screened for A-ND in an adult prison sample and 51% of those identified, were identified through screening and interview alone, as A-ND was not recorded in their file. Further, it seems likely that the records used to rate census items were limited, and for example, did not always include third party reports or reports from other sources such as General Practitioners. This may have meant evidence of existing A-ND was unavailable at the time of census, unless the patient was aware of their diagnosis and had disclosed it or it was contained in their referral on admission to hospital.

It may also be that a broad binary measure for A-ND was not adequate to replicate results from other studies which report differences in offending between specific diagnoses. For example, Lundström and colleagues (2014) found that ADHD but not ASD was associated with violent offending. The small number of participants diagnosed with a specific neurodevelopmental condition and lack of detailed information or dates of diagnosis, made more detailed investigation of A-ND impossible in this study. Another study showed A-ND predicted offending where early abuse and neglect were considered markers for A-ND, which this study did not consider in its A-ND definition (Kavanaugh et al., 2017). Other factors from the census which might have enhanced the categorisation of A-ND, such as problems at birth, head injury and brain scans, could not be used. Problems at birth was only defined as a binary measure, meaning any impact on neurodevelopment could not be determined and head injury and brain scans were also binary and did not have dates. Further, whilst the item used to define A-ND; *Abnormal Infant Development,* did provide a binary indicator of some developmental difficulty, there was no indication of the impact on functioning or of persisting disability. More generally, it is notable that there were no details provided to indicate what file information would be adequate for raters of the census to confirm A-ND was present.

As such, the validity of an A-ND diagnosis, as defined by the census, is unclear and it seems likely the ND measure used may at least in part contribute to unexpected findings in this study.

However, it may be that A-ND is not a strong predictor of offending. The systematic review in Chapter 1 of this portfolio, explored the impact of early TBI and associated neurological effects on offending, and found that TBI might increase risk, but was likely to be part of a wider, multifactorial model. Another recent review by Kerr (2021) found that history of TBI did not increase the risk of offending in adolescence, suggesting that early head injury which often impacts neurodevelopment, was not significant. As such, this study might support suggestions that offending is better explained by other factors.

When other predictors were examined using multivariate analyses, A-ND was not significantly associated with any offending outcome, although other factors were. Unexpectedly T-ND, was associated with more convictions, but only where SIMD was not included as a predictor in the model. When SIMD was added to the multivariate model ND was not significantly associated with any offending outcome and the overall fit of the model was improved for each research question. Although SIMD itself was not significant, its inclusion seemed to improve the sensitivity of the results, as fewer predictors were identified when SIMD was included. SIMD is a measure of multiple deprivation, based on an individual's post code prior to admission. It describes deprivation across seven domains; income, employment, education, health, access to services, crime and housing (Fraser, 2020). It is likely that it was better able to explain offending in the sample, than some other single factors, including ND and highlights the likelihood that offending risk is influenced by multiple factors.

Other factors which were significantly associated with offending outcomes in multivariate analyses included problematic substance use, older age, history of physical abuse, significant events in childhood and unemployment. This is consistent with predictors of offending found in other studies (Anderson et al., 2011; Craig et al., 2017; Hughes et al., 2020[b]; Lundström et al., 2014, Kavanaugh et al., 2017; McVean, 2019). It is not however consistent with recent studies suggesting A-ND may still be associated with offending where other factors such as socioeconomic status (Paradis et al., 2015), are

controlled for in analyses and reviews indicating that the association persists where background and environmental factors are considered (Zamani et al., 2020). This may suggest that the present findings are better explained by problems with the validity of the ND rating, rather than the absence of a true relationship between A-ND and offending.

The results in this study, whilst unexpected, are nonetheless important to consider, particularly as this study was novel in exploring A-ND and offending in a forensic mental health context and utilised a whole population sample. It might be that findings here represent some moderation in the A-ND and offending relationship, resulting from co-morbid mental disorder or differential effects of forensic mental health care, compared to that in other CJS institutions, such as prisons.

Limitations

The scope of this study was likely limited by the secondary data available from the Forensic Network Service-User Database. The data were gathered via a census form which included 'unknown' as a potential rating for all of the variables used in this study. As a result, a number of participants had missing data on one or more variables and were not included in some analyses. The prevalence of missing data also meant that two predictor variables; employment and education, had to be collapsed into binary variables due to the small number of ratings across categories, likely reducing sensitivity. SIMD – a variable which seemed to improve the fit of the regression models in this study – was missing for 55% of the sample. In relation to the offending outcomes, some sensitivity may also have been lost through the use categorical rather than continuous ratings.

The census form was completed by hospital staff and corroboration from individual self-report was not included. Staff reviewed case files in order to complete the form, and it is likely the quality and presence of relevant data from offence and medical records varied for each participant. Further, there was no measure of inter-rater reliability, despite the ratings taking place across a range of hospitals and professional disciplines. Staff who completed the census were not provided with training. They were able to contact the project's research assistant directly for support, however it is unlikely they all sought this where required and may instead have opted for the 'unknown' variable mentioned above.

These limitations may reduce the ability for this study to generalise the findings from the data used.

Clinical Implications

This study did not provide evidence to suggest that A-ND predicts offending outcomes in a forensic mental health sample, when other predictive factors were considered. It is likely that limitations in the measurement of A-ND in the census contributed to these unexpected findings. It might be that if a more robust and sensitive measure of A-ND was developed, to improve the validity of the census data in this domain, this could better inform clinical practice with this group in a forensic mental health setting.

However, it might also be that these results provide evidence for different associations between A-ND and offending in a forensic mental health population, compared to non-mental health samples. If these results were to be replicated it may suggest that the forensic mental health population have protective factors, which help them desist from offending in the context of A-ND, which are as of yet unrecognised. Identification and promotion of these may be possible through clinical intervention and strengths-based approaches (Ward & Brown, 2004). More research in this area would help to support or contradict this and inform clinical practice.

Recommendations for Future Research

More good quality research in forensic mental health settings to build upon these findings is needed.

Future research should consider in more detail how A-ND is defined, and where possible include screening and neuropsychological assessment tools.

With reference to the census data, it might be useful to capture in more detail items relevant to A-ND, already contained in the census in future years. This includes head injury and problems at birth and incorporating an indication of the impact A-ND has on functioning or persisting disability. The use of corroboratory self or third-party report where possible, in addition to file review, may also increase the accuracy and sensitivity of this measure.

It is recommended more generally, that the census data continue to be accessed and explored, as the availability of a full population sample is of significant value in research.

Conclusion

Whilst univariate analyses found some significant associations between A-ND and offending which were expected, others were not. In multivariate analyses alcohol and drug use, older age, a history of physical abuse, significant events in childhood and unemployment, were found to be significant predictors of convictions and violence during admission; A-ND was not. As such, this study did not provide evidence for A-ND as a predictor of offending, which is inconsistent with other research in this area. It is likely that the measure of A-ND used in this study was not valid and that a more robust assessment of A-ND in the census may have resulted in different and more expected findings. Nonetheless, it is also possible that results here represent some differences in the A-ND and offending relationship in a forensic mental health sample. Future research to unpick these relationships, particularly in a forensic mental health sample where research is limited, will help to inform assessment, intervention, and rehabilitation for those with A-ND.

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Appendices

Appendix 1.1: Author Guidelines for the Journal of Brain Injury

Submitting Your Paper

This journal uses ScholarOne Manuscripts to manage the peer-review process. If you haven't submitted a paper to this journal before, you will need to create an account in ScholarOne. Please read the guidelines above and then submit your paper in the relevant Author Centre, where you will find user guides and a helpdesk.

Please note that Brain Injury uses Crossref™ to screen papers for unoriginal material. By submitting your paper to Brain Injury you are agreeing to originality checks during the peer-review and production processes.

Preparing Your Paper

All authors submitting to medicine, biomedicine, health sciences, and allied and public health journals should conform to the Uniform Requirements for Manuscripts Submitted to Biomedical Journals, prepared by the International Committee of Medical Journal Editors (ICMJE).

Structure

Your paper should be compiled in the following order: title page; abstract; keywords; main text introduction, materials and methods, results, discussion; acknowledgments; declaration of interest statement; references; appendices (as appropriate); table(s) with caption(s) (on individual pages); figures; figure captions (as a list).

Word Limits

Some journals set a maximum length for submissions. Though Brain Injury does not have a specific limit, we prefer that manuscripts not exceed 5,000 words excluding abstract, references, tables, and figure legends. If articles are greater than 5,000 words, authors may be asked to shorten their manuscript.

Structure

Your paper should be compiled in the following order: title page; abstract; keywords; main text; acknowledgments; declaration of interest statement; references; appendices (as appropriate); table(s) with caption(s) (on individual pages); figures; figure captions (as a list).

Formatting and Templates

Papers may be submitted in Word or LaTeX formats. Figures should be saved separately from the text. To assist you in preparing your paper, we provide formatting template(s).

Word templates are available for this journal. Please save the template to your hard drive, ready for use.

References

Please use this reference guide when preparing your paper (https://www.tandf.co.uk//journals/authors/style/reference/tf_USVancouver.pdf).

What to Include

Author details

Please ensure everyone meeting the International Committee of Medical Journal Editors (ICMJE) requirements for authorship is included as an author of your paper. All authors of a manuscript should include their full name and affiliation on the cover page of the manuscript. Where available, please also include ORCiDs and social media handles (Facebook, Twitter or LinkedIn). One author will need to be identified as the corresponding author, with their email address normally displayed in the article PDF (depending on the journal) and the online article. Authors' affiliations are the affiliations where the research was conducted. If any of the named co-authors moves affiliation during the peer-review process, the new affiliation can be given as a footnote. Please note that no changes to affiliation can be made after your paper is accepted.

Abstract

The manuscript should contain a structured abstract of 200 words. For papers reporting original research, state the primary objective and any hypothesis tested; describe the research design and your reasons for adopting that methodology; state the methods and procedures employed, including where appropriate tools, hardware, software, the selection and number of study areas/subjects, and the central experimental interventions; state the main outcomes and results, including relevant data; and state the conclusions that might be drawn from these data and results, including their implications for further research or application/practice.

For review essays, state the primary objective of the review; the reasoning behind your literature selection; and the way you critically analyse the literature; state the main outcomes and results of your review; and state the conclusions that might be drawn, including their implications for further research or application/practice.

Include between 3 and 5 keywords.

Funding details

Please supply all details required by your funding and grant-awarding bodies as follows:

Disclosure statement

This is to acknowledge any financial interest or benefit that has arisen from the direct applications of your research. Further guidance on what is a conflict of interest and how to disclose it.

Biographical note

Please supply a short biographical note for each author and should be relatively brief (e.g., no more than 200 words).

Data availability statement

If there is a data set associated with the paper, please provide information about where the data supporting the results or analyses presented in the paper can be found. Where applicable, this should include the hyperlink, DOI or other persistent identifier associated with the data set(s). Templates are also available to support authors.

Figures

Figures should be high quality (1200 dpi for line art, 600 dpi for grayscale and 300 dpi for color, at the correct size). Figures should be supplied in one of our preferred file formats: EPS, PDF, PS, JPEG, TIFF, or Microsoft Word (DOC or DOCX) files are acceptable for figures that have been drawn in Word. For information relating to other file types, please consult our Submission of electronic artwork document.

Tables

Tables should present new information rather than duplicating what is in the text. Readers should be able to interpret the table without reference to the text. Please supply editable files.

Equations

If you are submitting your manuscript as a Word document, please ensure that equations are editable. More information about mathematical symbols and equations.

Units

Please use SI units (non-italicized).

Disclosure Statement

Please include a disclosure statement, using the subheading “Disclosure of interest.” If you have no interests to declare, please state this (suggested wording: The authors report no conflict of interest). For all NIH/Wellcome-funded papers, the grant number(s) must be included in the declaration of interest statement. Read more on declaring conflicts of interest.

Complying With Ethics of Experimentation

Please ensure that all research reported in submitted papers has been conducted in an ethical and responsible manner, and is in full compliance with all relevant codes of experimentation and legislation. All papers which report in vivo experiments or clinical trials on humans or animals must include a written statement in the Methods section. This should explain that all work was conducted with the formal approval of the local human subject or animal care committees (institutional and national), and that clinical trials have been registered as legislation requires. Authors who do not have formal ethics review committees should include a statement that their study follows the principles of the Declaration of Helsinki.

Consent

All authors are required to follow the ICMJE requirements on privacy and informed consent from patients and study participants. Please confirm that any patient, service user, or participant (or that person's parent or legal guardian) in any research, experiment, or clinical trial described in your paper has given written consent to the inclusion of material pertaining to themselves, that they acknowledge that they cannot be identified via the paper; and that you have fully anonymized them. Where someone is deceased, please ensure you have written consent from the family or estate. Authors may use this Patient Consent Form, which should be completed, saved, and sent to the journal if requested.

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At the point of submission, you will be asked if there is a data set associated with the paper. If you reply yes, you will be asked to provide the DOI, pre-registered DOI, hyperlink, or other persistent identifier associated with the data set(s). If you have selected to provide a pre-registered DOI, please be prepared to share the reviewer URL associated with your data deposit, upon request by reviewers.

Where one or multiple data sets are associated with a manuscript, these are not formally peer reviewed as a part of the journal submission process. It is the author's responsibility to ensure the soundness of data. Any errors in the data rest solely with the producers of the data set(s).

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This journal gives authors the option to publish open access via our Open Select publishing program, making it free to access online immediately on publication. Many funders mandate publishing your research open access; you can check open access funder policies and mandates here.

Appendix 1.2: Search Terms for Database Searches

APA PsycInfo (EBSCO Host)	1. TI (“traumatic brain injur*” OR TBI OR “brain injur*” OR “head injur*” OR “head trauma” OR HI) AND AB (“traumatic brain injur*” OR TBI OR “brain injur*” OR “head injur*” OR “head trauma” OR HI) 2. DE “Head injury” OR DE “Traumatic Brain Injury” OR DE “Brain Injuries” 3. S1 OR S2 4. TI (child* OR infant OR paediatric OR pediatric OR young* OR youth* OR juvenile OR teen* OR adolescen*) AND AB (child* OR infant OR paediatric OR pediatric OR young* OR youth* OR juvenile OR teen* OR adolescen*) 5. TI (crimin* OR crime* OR offend* OR convict* OR “anti-socia*” OR antisocia* OR prison* OR inmate* OR incarcerat* OR delinquen*) AND AB (crimin* OR crime* OR offend* OR convict* OR “anti-socia*” OR antisocia* OR prison* OR inmate* OR incarcerat* OR delinquen*) 6. DE "Criminal Offenders +" 7. S5 OR S6 8. S3 AND S4 AND S7
CINIHAL (EBSCO Host)	1. TI (“traumatic brain injur*” OR TBI OR “brain injur*” OR “head injur*” OR “head trauma” OR HI) AND AB (“traumatic brain injur*” OR TBI OR “brain injur*” OR “head injur*” OR “head trauma” OR HI) 2. (MH “Head injuries+”) 3. S1 OR S2

	4. TI (child* OR infant OR paediatric OR pediatric OR young* OR youth* OR juvenile OR teen* OR adolescen*) AND AB (child* OR infant OR paediatric OR pediatric OR young* OR youth* OR juvenile OR teen* OR adolescen*) 5. TI (crimin* OR crime* OR offend* OR convict* OR "anti-socia*" OR antisocia* OR prison* OR inmate* OR incarcerat* OR delinquen*) AND AB (crimin* OR crime* OR offend* OR convict* OR "anti-socia*" OR antisocia* OR prison* OR inmate* OR incarcerat* OR delinquen*) 6. (MH "Crime+") 7. (MM "Juvenile Delinquency") 8. S5 OR S6 OR S7 9. S3 AND S4 AND S8
Ovid MEDLINE (R)	1. (((head or brain) adj4 (injur* or trauma)) or TBI).tw. 2. brain injuries/ or brain injuries, traumatic/ 3. 1 or 2 4. (child* or infant or paediatric or pediatric or young* or youth* or juvenile or teen* or adolescen*).tw. 5. (crimin* or crime* or offend* or convict* or (anti-socia*) or antisocia* OR prison* or inmate* or incarcerat* or delinquen*).tw. 6. Exp Crime/ 7. Juvenile Delinquency/ 8. Criminals/ 9. 5 or 6 or 7 or 8 10. 3 and 4 and 9
EMBASE (Ovid)	1. (((head or brain) adj4 (injur* or trauma)) or TBI).tw. 2. traumatic brain injury/ or brain injury/ 3. 1 or 2

	4. (child* or infant or paediatric or pediatric or young* or youth* or juvenile or teen* or adolescen*).tw. 5. (crimin* or crime* or offend* or convict* or (anti-socia*) or antisocia* OR prison* or inmate* or incarcerat* or delinquen*).tw. 6. Exp offender/ 7. Exp crime/ 8. Exp criminal behaviour/ 9. Exp juvenile delinquency/ 10. 5 or 6 or 7 or 8 or 9 11. 3 and 4 and 10

Appendix 2.1: Author Guidelines for the Journal of Health and Justice

Submission to this journal is completed online.

Preparing main manuscript text

Use double line spacing*;* Include line and page numbering*;* Use SI units: Please ensure that all special characters used are embedded in the text, otherwise they will be lost during conversion to PDF*;* Do not use page breaks in your manuscript

File formats
The following word processor file formats are acceptable for the main manuscript document: Microsoft word (DOC, DOCX)*;* Rich text format (RTF)**.**

Style and language
For editors and reviewers to accurately assess the work presented in your manuscript you need to ensure the English language is of sufficient quality to be understood.

Preparing Figures
Figures should be numbered in the order they are first mentioned in the text, and uploaded in this order.

Multi-panel figures (those with parts a, b, c, d etc.) should be submitted as a single composite file that contains all parts of the figure.

Figures should be uploaded in the correct orientation.

Figure titles (max 15 words) and legends (max 300 words) should be provided in the main manuscript, not in the graphic file.

Figure keys should be incorporated into the graphic, not into the legend of the figure.

Each figure should be closely cropped to minimize the amount of white space surrounding the illustration.

Individual figure files should not exceed 10 MB. If a suitable format is chosen, this file size is adequate for extremely high quality figures.

Preparing tables
Tables should be numbered and cited in the text in sequence using Arabic numerals (i.e. Table 1, Table 2 etc.).

Tables less than one A4 or Letter page in length can be placed in the appropriate location within the manuscript.

Tables larger than one A4 or Letter page in length can be placed at the end of the document text file. Please cite and indicate where the table should appear at the relevant location in the text file so that the table can be added in the correct place during production.

Larger datasets, or tables too wide for A4 or Letter landscape page can be uploaded as additional files. Please see [below] for more information.

Tabular data provided as additional files can be uploaded as an Excel spreadsheet (.xls) or comma separated values (.csv). Please use the standard file extensions.

Table titles (max 15 words) should be included above the table, and legends (max 300 words) should be included underneath the table.

Tables should not be embedded as figures or spreadsheet files, but should be formatted using 'Table object' function in your word processing program.

Color and shading may not be used. Parts of the table can be highlighted using superscript, numbering, lettering, symbols or bold text, the meaning of which should be explained in a table legend.
Commas should not be used to indicate numerical values.

Please note that your manuscript must include a 'Declarations' section including all of the subheadings (please see below for more information).

Footnotes
Footnotes can be used to give additional information, which may include the citation of a reference included in the reference list. They should not consist solely of a reference citation, and they should never include the bibliographic details of a reference. They should also not contain any figures or tables.

Footnotes to the text are numbered consecutively; those to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data). Footnotes to the title or the authors of the article are not given reference symbols.

Always use footnotes instead of endnotes.

Article Structure

Title page
The title page should present a title that includes, if appropriate, the study design list the full names and institutional addresses for all authors if a collaboration group should be listed as an author, please list the Group name as an author. If you would like the names of the individual members of the Group to be searchable through their individual PubMed records, please include this information in the "Acknowledgements" section in accordance with the instructions below indicate the corresponding author.

Abstract
The Abstract should not exceed 350 words. Please minimize the use of abbreviations and do not cite references in the abstract. The abstract must include the following separate sections: Background: the context and purpose of the study; Results: the main findings; Conclusions: a brief summary and potential implications; Keywords: Three to ten keywords representing the main content of the article.

Background
The Background section should explain the background to the study, its aims, a summary of the existing literature and why this study was necessary.

Methods
The methods section should include: the aim, design and setting of the study; the characteristics of participants or description of materials; a clear description of all processes, interventions and comparisons. Generic names should generally be used. When proprietary brands are used in research, include the brand names in parentheses the type of statistical analysis used, including a power calculation if appropriate

Results
This should include the findings of the study including, if appropriate, results of statistical analysis which must be included either in the text or as tables and figures.

Discussion
For research articles this section should discuss the implications of the findings in context of existing research and highlight limitations of the study. For study protocols and methodology manuscripts this section should include a discussion of any practical or operational issues involved in performing the study and any issues not covered in other sections.

Conclusions
This should state clearly the main conclusions and provide an explanation of the importance and relevance of the study to the field.

List of abbreviations
If abbreviations are used in the text they should be defined in the text at first use, and a list of abbreviations can be provided.

References
References should follow the American Psychological Association (APA) reference style. For further guidance, see the Publication Manual of the American Psychological Association and the respective web site of the Association (http://www.apastyle.org/).

Web links and URLs: All web links and URLs should be given a reference number and included in the reference list rather than within the text of the manuscript. They should be provided in full, including both the title of the site and the URL, as well as the date the site was accessed.

Declarations
All manuscripts must contain the following sections under the heading 'Declarations': Ethics approval and consent to participate; Consent for publication; Availability of data and materials; Competing interests; Funding; Authors' contributions; Acknowledgements; Authors' information (optional); Please see below for details on the information to be included in these sections.

Ethics approval and consent to participate
Manuscripts reporting studies involving human participants, human data or human tissue must: include a statement on ethics approval and consent (even where the need for approval was waived) include the name of the ethics committee that approved the study and the committee's reference number if appropriate.

Consent for publication
If your manuscript contains any individual person's data in any form (including any individual details, images or videos), consent for publication must be obtained from that person, or in the case of children, their parent or legal guardian. All presentations of case reports must have consent for publication.

You can use your institutional consent form or our consent form if you prefer. You should not send the form to us on submission, but we may request to see a copy at any stage (including after publication).

Availability of data and materials
All manuscripts must include an 'Availability of data and materials' statement. Data availability statements should include information on where data supporting the results reported in the article can be found including, where applicable, hyperlinks to publicly archived datasets analysed or generated

during the study. By data we mean the minimal dataset that would be necessary to interpret, replicate and build upon the findings reported in the article. We recognise it is not always possible to share research data publicly, for instance when individual privacy could be compromised, and in such instances data availability should still be stated in the manuscript along with any conditions for access.

Competing interests
All financial and non-financial competing interests must be declared in this section.

See our editorial policies for a full explanation of competing interests. If you are unsure whether you or any of your co-authors have a competing interest please contact the editorial office.

Please use the authors initials to refer to each authors' competing interests in this section.

If you do not have any competing interests, please state "The authors declare that they have no competing interests" in this section.

Funding
All sources of funding for the research reported should be declared. The role of the funding body in the design of the study and collection, analysis, and interpretation of data and in writing the manuscript should be declared.

Authors' contributions
The individual contributions of authors to the manuscript should be specified in this section. Guidance and criteria for authorship can be found in our editorial policies. Please use initials to refer to each author's contribution in this section.

Acknowledgements
Please acknowledge anyone who contributed towards the article who does not meet the criteria for authorship including anyone who provided professional writing services or materials. Authors should obtain permission to acknowledge from all those mentioned in the Acknowledgements section.

Group authorship (for manuscripts involving a collaboration group): if you would like the names of the individual members of a collaboration Group to be searchable through their individual PubMed records, please ensure that the title of the collaboration Group is included on the title page and in the submission system and also include collaborating author names as the last paragraph of the “Acknowledgements” section. Please add authors in the format First Name, Middle initial(s) (optional), Last Name. You can add institution or country information for each author if you wish, but this should be consistent across all authors.

If any of the sections are not relevant to your manuscript, please include the heading and write 'Not applicable' for that section.

Appendix 2.2: Forensic Network Inpatient Census – Patient Casenote Datasheet

FORENSIC NETWORK INPATIENT CENSUS
Patient Casenote Datasheet

Completed by (In CAPITALS): .....

Date Completed (dd/mm/yyyy): ..... | ..... | .....

1) Hospital/Clinic (please select by placing a "X" or "✓" in the relevant box):

Mental Hospitals/Clinics			
ID	**HOSPITAL**	**WARD/UNIT**	
01	Ailsa Hospital	Elgin Ward (Open Rehab)	☐
		IPCU	☐
02	Argyll & Bute Hospital	Lochgilphead IPCU	☐
03	Beckford Lodge	LSU	☐
04	Bellsdyke Hospital	Trystpark Ward	☐
05	Leverndale/Dykebar	Ward 5 – Balloch/South Ward	☐
		Ward 6 – Boulevard	☐
06	Midpark Hospital	Balcary (IPCU)	☐
		Dalveen (Rehab)	☐
07	Murray Royal Hospital	Rohallion – LSU	☐
		Rohallion – MSU	☐
08	New Craigs Hospital	Affric (LSU)	☐
		Bruar Ward (IPCU)	☐
09	Rowanbank Clinic	Cedar (MSU)	☐
		Elder (MSU)	☐
		Elm (MSU)	☐
		Larch (MSU)	☐
		Pine (MSU)	☐
		Sycamore (MSU)	☐
10	Royal Cornhill Hospital	Blair Unit (IPCU)	☐
		Great Western Lodge	☐
11	Royal Edinburgh Hospital	Orchard Clinic – Cedar	☐
		Orchard Clinic – Hawthorn	☐
		Orchard Clinic – Redwood	☐
12	Stratheden Hospital	Ward 4 (IPCU)	☐
		Radernie (LSU)	☐
13	Surehaven	Campsie (LSU)	☐
		Kelvin (LSU)	☐
14	The Ayr Clinic	Arran (LSU)	☐
		Bellisle (LSU)	☐
		Longreen (LSU)	☐
15	The State Hospital	Arran	☐
		Iona	☐
		Lewis	☐
		Mull	☐

Learning Disability Hospitals/Clinics			
ID	**HOSPITAL**	**WARD/UNIT**	
16	Kirklands	Kylepark (LSU)	☐
17	Leverndale	Boulevard	☐
		Bute	☐
		Campsie	☐
18	Lynebank	Daleview	☐
		Levendale	☐
19	Rowanbank Clinic	Holly (MSU)	☐
20	Royal Cornhill	Elmwood	☐
21	Royal Edinburgh	William Fraser	☐
		Glen Lomond	☐
22	Strathmartine	Craigowl	☐
		Bridgefoot	☐
23	The State Hospital	Iona 2 (HSU)	☐

1

PATIENT DEMOGRAPHIC INFORMATION

2) Previous post-code:

(01) Unknown ☐
(02) Known ☐ Specify: ..... (2a)
(03) Homeless ☐
(04) Other ☐ Specify: ..... (2b)

3) Gender: (01) Male ☐ (02) Female ☐ (03) Transgendered Male ☐ (04) Transgendered Female ☐

4) If known please specify the most recent measurements for:

(4a) Height (CM): ..... Unknown ☐
(4b) Weight (KG): ..... Date (dd/mm/yyyy): ..... Unknown ☐
(4c) BMI: ..... Date (dd/mm/yyyy): ..... Unknown ☐

5) Nationality: ..... Unknown ☐

6) Ethnic Origin: (tick below)

1A- White Scottish	☐	3D- Chinese	☐
1B- White British	☐	3E- Any Other Asian Background	☐
1C- White Irish	☐	4A – Caribbean	☐
1D - Any other White Background	☐	4B – African	☐
2A- Any Mixed Background	☐	4C - Any Other Black Background	☐
3A- Indian	☐	5A - Any Other Ethnic	☐
3B- Pakistani	☐	98 - Refused or not provided	☐
3C- Bangladeshi	☐	99 - Not Known	☐

7) Current Marital Status:

(01) Unknown ☐
(02) Single ☐
(03) Married ☐
(04) Divorced ☐
(05) Separated ☐
(06) Widowed ☐
(07) Cohabitation Heterosexual ☐
(08) Cohabitation Homosexual ☐

8) Children:

(01) Unknown ☐
(02) No ☐
(03) Yes – natural children ☐ If known, specify **number**: ..... (8a)
(04) Yes – step-children/partner's children ☐ If known, specify **number**: ..... (8b)
(05) Yes – unknown if natural/step-children ☐ If known, specify **number**: ..... (8c)

9) Occupation prior to admission:

(01) Unknown ☐
(02) Employed ☐ If known, specify (CAPITALS): .....
..... (9a)
(03) Unemployed ☐
(04) Unemployed – voluntary work ☐
(05) Retired ☐
(06) Sickness benefit ☐

PERSONAL HISTORY

10) Birth Problem or Incident

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ (10a) If known, specify (CAPITALS): .....

.....

.....

11) Abnormal Infant Development

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ (11a) If known, specify below (tick all applicable boxes):

(a) delayed language development ☐
(b) delayed walking (>18mths) ☐
(c) problems with vision ☐
(d) neurosensory or conductive deafness ☐
(e) cognitive impairment/developmental delay ☐
(f) emotional and behavioural difficulties ☐
(g) attention deficits ☐
(h) problems with growth ☐
(i) Other (Please Specify below IN CAPITALS) ☐

.....
..... (11b)

12) History of Physical Abuse (<16yrs)

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ (12a) If known, specify below (tick all applicable boxes):

(a) Victim of abuse ☐
(b) Witnessed abuse ☐
(c) Victim and Witness of abuse ☐
(d) Unknown ☐

13) History of Sexual Abuse (<16yrs)

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ (13a) If known, specify below (tick all applicable boxes):

(a) Victim of abuse ☐
(b) Witnessed abuse ☐
(c) Victim and Witness of abuse ☐
(d) Unknown ☐

14) Significant Events in Childhood (<16yrs)

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ (14a) If known, specify below (Tick applicable boxes):

(a) Arrival of new baby in household ☐
(b) Death of parent ☐
(c) Death of a sibling ☐
(d) Death of grand-parent (or other close relative) ☐
(e) Either parent away from child 3 weeks 2 or more at a time ☐
(f) Parent has stopped living in household (Divorce/Separation) ☐
(g) New adult/parent has entered the household ☐
(h) Parent has had a serious illness of accident ☐

Specify (In CAPITALS): ..... (14b)

(i) Sibling has had a serious illness or accident ☐
(j) Another child has stopped living in household ☐
(k) Another child has come to live in household ☐
(l) Lived in temporary accommodation ☐
(m) Moved into care ☐
(n) Moved house ☐
(o) Changed school ☐
(p) Bullied ☐
(q) Parental unemployment ☐
(r) Parental alcohol or drug misuse ☐
(s) Other (Specify Below IN CAPITALS) ☐

..... (14c)

15) Schooling:

(01) Unknown ☐
(02) None ☐
(03) Mainstream School ☐
(04) Special School – learning disability ☐
(05) Special School – behavioural problems ☐
(06) Other ☐ Specify (CAPITALS): ..... (15a)

16) Further/Higher Education:

(01) Unknown ☐
(02) None ☐
(03) College ☐
(04) University ☐
(05) Other ☐ Specify (CAPITALS): ..... (16a)

17) Highest Level of Academic Achievement:

(01) Unknown ☐
(02) No Qualifications ☐
(03) Standard Grades/GCSE's ☐
(04) Highers/A-Levels/Advanced Highers ☐
(05) Diploma ☐
(06) Undergraduate Degree (e.g. BSc, BA) ☐
(07) Postgraduate Degree (e.g. MSc, PhD) ☐
(08) Other ☐ Specify (CAPITALS):
..... (17a)
(09) Completed an Apprenticeship ☐ If profession known, Specify (CAPITALS):
..... (17b)

18) Family Psychiatric History

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ If known, specify below – (tick all applicable boxes):

	1st degree relative (18a) (parents, sibling, children)	**2nd degree relative (18b)** (grandparents, grandchildren, aunts, uncles, nephews, nieces or half-siblings)	**3rd degree relative (18c)** (1st cousins, great-grandparents or great grandchildren)	**Relative – degree unknown (18d)**
(1) Schizophrenia	☐	☐	☐	☐
(2) Affective Illness	☐	☐	☐	☐
(3) Learning Disability	☐	☐	☐	☐
(4) Drug misuse	☐	☐	☐	☐
(5) Alcohol misuse	☐	☐	☐	☐
(6) Other (specify IN CAPITALS):	☐	☐	☐	☐

(18e)

19) Patient Alcohol Consumption Problems

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ Specify below – tick all applicable boxes:

	On Current Admission (19a)	**Historical (19b)**
(1) Harmful (Recreational) use	☐	☐
(2) Dependence	☐	☐
(3) Secondary Diagnosis	☐	☐
(4) Other (Specify IN CAPITALS)	☐	☐

(19c)

20) Patient Illicit Drug Misuse

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ Specify below – tick all applicable boxes:

	On Current Admission (20a)	**Historical (20b)**
(1) Harmful (Recreational) use	☐	☐
(2) Dependence	☐	☐
(3) Secondary Diagnosis	☐	☐
(4) Other (Specify IN CAPITALS)	☐	☐

(20c)

21) Patient Use of Drugs/Substances (Please tick all that apply)

(01) Unknown/Not Applicable	☐	(08) Hallucinogens (e.g., LSD, magic mushrooms, acid)	☐
(02) No drugs	☐	(09) Barbiturates	☐
(03) Morphine or Heroine	☐	(10) Benzodiazepines (e.g., diazepam (valium), lorazepam)	☐
(04) Cocaine	☐	(11) Solvents/Vapours/Sprays	☐
(05) Opiates or derivatives	☐	(12) Ecstasy	☐
(06) Amphetamines (e.g., speed)	☐	(13) Legal Highs	☐
(07) Cannabis	☐	(14) Others/Unsure of category (Specify in CAPITALS):	☐
		.....	(21a)

22) Patient History of Intravenous Drug Use

(01) Unknown ☐
(02) No ☐
(03) Yes ☐

23) Prior History of Perpetrating Animal Abuse

(01) Unknown ☐
(02) No ☐
(03) Yes ☐

CURRENT INPATIENT INFORMATION

24) Date of Current Admission (dd/mm/yyyy): ..... | ..... | .....

25) Responsible Medical Officer (RMO): .....

26) Responsible Health Board:

(01) Ayrshire & Arran	☐	(11) Orkney	☐
(02) Borders	☐	(12) Shetland	☐
(03) Dumfries & Galloway	☐	(13) Tayside	☐
(04) Fife	☐	(14) Western Isles	☐
(05) Forth Valley	☐	(15) N. Ireland – East	☐
(06) Grampian	☐	(16) N. Ireland – North	☐
(07) Greater Glasgow & Clyde	☐	(17) N. Ireland – South	☐
(08) Highland	☐	(18) N. Ireland – West	☐
(09) Lanarkshire	☐	(19) Other – Specify (IN CAPITALS):	☐
(10) Lothian	☐	.....	(26a)

27) Source of Current Admission:

(01) Court	☐	(06) Hospital – Intensive Psychiatric Care Unit (IPCU)	☐
(02) Prison - Adult remand	☐	(07) Hospital – Low Secure Ward M.I.	☐
(03) Prison - Adult sentenced	☐	(08) Hospital – Low Secure Ward L.D.	☐
(04) Young Offenders Institute - Remand	☐	(09) Hospital – Open Ward M.I.	☐
(05) Young Offenders Institute – Sentenced	☐	(10) Hospital – Open Ward L.D.	☐
	☐	(11) Hospital – Medium Secure Unit M.I	☐
	☐	(12) Hospital – Medium Secure Unit LD	☐
	☐	(13) Hospital – High Secure Unit M.I	☐
		(14) Hospital – High Secure Unit LD	☐
		(15) Hospital – General	☐
		(16) Hospital – Security level unknown (specify hospital if known):	☐
		.....	(27a)
		(17) Other (Specify below IN CAPITALS)	☐
		.....	(27b)

28) Reason(s) for Current Admission:

(01) Offence(s) or Alleged Offence(s) ☐
(02) Sentenced Prisoner Transfer ☐
(03) Behavioural Problems (no offence) ☐ (28a) Specify behavioural problems below:
(04) Behavioural Problems (+ offence) ☐ (28a) Specify behavioural problems below:

(a) Physical Violence	☐
(b) Inappropriate sexual behaviour	☐
(c) Absconding	☐
(d) Self-Harm	☐
(e) Menace	☐
(f) Other - Specify (CAPITALS):	☐

(28b)

(05) Other - Specify (CAPITALS): ☐

(28c)

29) Offence(s) or Alleged Offence(s) leading to Current Admission (please tick)

(01) Not applicable/no offence(s) /Sentenced Prisoner Transfer ☐
(02) Unknown ☐
(03) Alleged Offence(s)/Offence(s) ☐ Specify below (29a) (please tick all applicable):

All Crimes

Non-sexual crimes of violence		**Crimes of dishonesty**	
(02) Serious assault	☐	(13) Housebreaking	☐
(03) Attempted murder	☐	(14) Theft by opening a lockfast place	☐
(04) Culpable Homicide	☐	(15) Theft from a motor vehicle	☐
(05) Murder	☐	(16) Theft of a motor vehicle	☐
(06) Robbery	☐	(17) Shoplifting	☐
(07) Other violence (specify IN CAPITALS)	☐	(18) Other theft (specify IN CAPITALS)	☐
(29b)		(29e)	
		(19) Fraud	☐
		(20) Other dishonesty (specify IN CAPITALS)	☐
		(29f)	
Crimes of indecency			
(08) Attempted rape	☐	**Other crimes**	
(09) Rape	☐	(21) Crimes against public justice	☐
(10) Sexual assault	☐	(22) Handling an offensive weapon	☐
(11) Offences associated with prostitution	☐	(23) Drugs	☐
(12) Other indecency (specify IN CAPITALS)	☐	(24) Other crime (specify IN CAPITALS)	☐
(29c)		(29g)	
		Fire-raising, Vandalism etc.	
		(25) Fire-raising	☐
		(26) Vandalism	☐

All Offences

Miscellaneous offences		**Motor vehicle offences**	
(27) Common assault	☐	(31) Dangerous and careless driving	☐
(28) Breach of the peace, etc.	☐	(32) Drink/drug driving	☐
(29) Drunkenness	☐	(33) Speeding	☐
(30) Other offences (Specify IN CAPITALS)	☐	(34) Unlawful use of vehicle	☐
(29d)		(35) Vehicle defect offences	☐
		(36) Other vehicle (specify IN CAPITALS)	☐
		(29h)	

30) Victim(s) from the event(s) leading to current admission:

(01) Unknown/Not Applicable/Sentenced Prisoner Transfer ☐
(02) No ☐
(03) Yes ☐ If known, specify below:

30(a) Number of victims _____

30(b) Relationship to victim(s) at time of event:

(01) Not Specified ☐
(02) Stranger(s) ☐
(03) Known ☐ (30c) – If known, specify below:

a) Spouse/partner ☐	b) ex-spouse/partner ☐	c)Son/Daughter ☐
d) Step-son/daughter ☐	e) Mother/Father ☐	f) Grandparent ☐
g)Uncle/Aunt ☐	h)friend ☐	i) work colleague ☐
j) fellow prisoner ☐	k) fellow patient ☐	
l) Other ☐	Specify below (CAPITALS):	

---------- (30d)

31) Weapon(s) used in the event(s) leading to current admission:

(01) Unknown/Not Applicable/Sentenced Prisoner Transfer ☐
(02) No ☐
(03) Yes ☐ (31a) If known, specify below:

(a) Unknown ☐
(b) Kitchen knife ☐
(c) Other/Unknown type of knife ☐
(d) Sharp Instrument ☐
(e) Gun ☐
(f) Other weapon ☐ (31b) Specify below (CAPITALS):

---

32) Violent incidents during current admission:

(e.g., events involving physical contact with a victim, any sexual event (including exposure and touching) and any episode of physical aggression towards property (including fire setting). This includes 'near miss' incidents – events which may not result in actual harm but have potential to do so)

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ Specify below:

(32a) **Violence directed at** (tick all applicable):

(a) Nursing Staff ☐
(b) RMO ☐
(c) Other health professionals ☐
(d) Visitors ☐
(e) Self ☐
(f) Patients ☐
(g) Other ☐
(h) Unknown ☐

(32b) **Violence resulted in**(tick all applicable):

(a) Injury to victim(s) ☐
(b) Injury to self ☐
(c) Death to victim(s) ☐
(d) No injuries (to self or victim(s)) ☐
(e) Unknown ☐

33) Legislation for current and/or past detention (Please tick):

	Current Detention (33)	Detentions during Current Admission (33a)	Past Detention(s) (33b)
(1) Unknown/not applicable	☐	☐	☐
Mental Health Care and Treatment (Scotland) Act 2003 (Civil)			
(2) Section 36 (1) – Emergency detention	☐	☐	☐
(3) Section 44 (1) – Short-term detention	☐	☐	☐
(4) Section 47 (1) – Short-term detention: extension certificate	☐	☐	☐
(5) Section 64 (4) – Compulsory Treatment Order	☐	☐	☐
(6) Section 65 – Interim Compulsory Treatment Order	☐	☐	☐
(7) Section 68 – Extension of short-term detention pending tribunal	☐	☐	☐
Sentenced Prisoners			
(8) Transfer for treatment direction (TTD) Restricted Patient status	☐	☐	☐
Criminal Procedure (Scotland) Act 1995			
(9) Section 52D – Assessment Order	☐	☐	☐
(10) Section 52M – Treatment Order	☐	☐	☐
(11) Section 200 – Pre-sentence enquiry into mental/physical condition	☐	☐	☐
(12) Section 54 - Temporary Compulsion Order	☐	☐	☐
(13) Section 53 – Interim Compulsion Order	☐	☐	☐
(14) Section 57A – Compulsion Order	☐	☐	☐
(15) Section 57 (2) (a) – Compulsion Order	☐	☐	☐
(16) Section 57 (2) (b) – Restriction Order	☐	☐	☐
(17) Section 59 + 57 – Restriction Order + Compulsion Order	☐	☐	☐
(18) Section 59A – Hospital Direction	☐	☐	☐
(19)Other - Specify Below (IN CAPITALS):	☐	☐	☐
..... (33c)			

34) Case has been notified/referred to Multi Agency Public Protection Arrangements (MAPPA)

(01) Unknown ☐
(02) No ☐
(03) Yes ☐

35) Current conviction status:

(01) Unknown ☐
(02) Not convicted – Unknown/unclear reason ☐
(03) Not convicted – Not guilty by reason of insanity/acquittal involving mental disorder ☐
(04) Not convicted – Insane and unfit to plead/unfit for trial ☐
(05) Convicted ☐ Specify below:

(35a) Date of most recent conviction (dd/mm/yyyy)	.....	.....	.....	Unknown ☐

36) Date Current Order Began (dd/mm/yyyy) .... Unknown ☐

37) Previous conviction(s) - *for Sentenced Prisoner Transfer this includes their current conviction*

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ If known, specify below:

37(a) Total number of previous convictions (including current convictions)**:**

(01)Unknown ☐
(02) < 5 ☐
(03) 5-10 ☐
(04) 10+ ☐

37(b) Previous offences committed. (tick all applicable) - If known, specify number of times each committed

(01) Unknown ☐

All Crimes

Non-sexual crimes of violence		**No.**	**Crimes of dishonesty**		**No.**
(02) Serious assault	☐		(13) Housebreaking	☐	
(03) Attempted murder	☐		(14) Theft by opening a lockfast place	☐	
(04) Culpable Homicide	☐		(15) Theft from a motor vehicle	☐	
(05) Murder	☐		(16) Theft of a motor vehicle	☐	
(06) Robbery	☐		(17) Shoplifting	☐	
(07) Other violence (specify IN CAPITALS)	☐		(18) Other theft (specify IN CAPITALS)	☐	
(i)			(iv)		
			(19) Fraud	☐	
			(20) Other dishonesty (specify IN CAPITALS)	☐	
			(v)		
Crimes of indecency					
(08) Attempted rape	☐		**Other crimes**		
(09) Rape	☐		(21) Crimes against public justice	☐	
(10) Sexual assault	☐		(22) Handling an offensive weapon	☐	
(11) Offences associated with prostitution	☐		(23) Drugs	☐	
(12) Other indecency (specify IN CAPITALS)	☐		(24) Other crime (specify IN CAPITALS)	☐	
(ii)			(vi)		
			Fire-raising, Vandalism etc.		
			(25) Fire-raising	☐	
			(26) Vandalism	☐	

All Offences

Miscellaneous offences			**Motor vehicle offences**		
(27) Common assault	☐		(31) Dangerous and careless driving	☐	
(28) Breach of the peace, etc.	☐		(32) Drink/drug driving	☐	
(29) Drunkenness	☐		(33) Speeding	☐	
(30) Other offences	☐		(34) Unlawful use of vehicle	☐	
(iii)			(35) Vehicle defect offences	☐	
			(36) Other vehicle (specify IN CAPITALS)	☐	
			(vii)		

38) If the patient has previous convictions, were weapon(s) used?:

(01) Not relevant ☐
(02) Unknown ☐
(03) No ☐
(04) Yes ☐ (38a) If known, specify below:

(a) Unknown	☐	(d) Sharp Instrument	☐
(b) Kitchen knife	☐	(e) Gun	☐
(c) Other/Unknown type of knife	☐	(f) Other weapon (Specify):	☐
		(38b)	

39) If the patient has previous convictions, was a Scottish Criminal Record Office (SCRO) Notice of Convictions used to obtain this information?

(01) Not relevant ☐
(02) Unknown ☐
(03) No ☐
(04) Yes ☐

PSYCHIATRIC HISTORY:

40) Year of FIRST Psychiatric Contact (yyyy) ..... Unknown ☐

41) This is the FIRST Psychiatric Admission:

(01) Unknown ☐
(02) Yes ☐
(03) No ☐ If known, specify below:

41(a) Total number of Admissions (including current) ..... Unknown ☐
41(b) Year of FIRST Admission (yyyy) ..... Unknown ☐

42) Previous treatment (tick all applicable)**:**

(01) Unknown ☐
(02) None ☐
(03) Out-patient only ☐
(04) Prison ☐
(05) In-patient ☐ (42a) If known, specify the levels of security employed (tick all applicable):

(a) High Security	☐	(d) Open ward	☐
(b) Medium Security	☐	(e) NHS Hostel	☐
(c) Low Security/IPCU	☐	(f) Unknown (Specify):	☐
		.....	(42b)

43) Episodes of self-harm/suicide:

	Unknown (01)	No (02)	Yes (03)
a) Current Admission	☐	☐	☐
b) Previous History	☐	☐	☐

MEDICAL HISTORY

44) History of any of the following (Please tick all that apply):

	Current (<1yr) (44)	Historical (>1yr) (44a)
(1) None/Not Applicable	☐	☐
(2) Asthma	☐	☐
(3) High Blood Pressure	☐	☐
(4) Diabetes: Type I ( ), Type II ( ), Unknown ( )	☐	☐
(5) Dyspepsia	☐	☐
(6) Epilepsy	☐	☐
(7) Head Injury	☐	☐
(8) Hepatitis B	☐	☐
(9) Hepatitis C	☐	☐
(10) HIV Positive	☐	☐
(11) Any operations (Specify IN CAPITALS): ..... (44b)	☐	☐
(12) Other (Specify IN CAPITALS): ..... (44c)	☐	☐

45) Any longstanding treatment for physical complaints:

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ If known, specify below (IN CAPITALS):

..... (45a)

46) Any history of brain scans?

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ Specify below:

(46a) If known, specify scan type:

(a) CT Scan ☐
(b) MRI Scan ☐
(c) fMRI Scan ☐
(d) SPECT ☐
(e) Other ☐ Specify (In CAPITALS):
..... (46ai)
(f) Unknown ☐

(46b) Any abnormalities:

(01) Unknown ☐
(02) No ☐
(03) Yes ☐ Specify (In CAPITALS):

..... (46c)

48) ICD-10 Diagnosis– Please tick all applicable:

	Current Diagnosis (a)		
Diagnosis	Main diagnosis (i)	All other Current diagnoses (ii)	**Past Diagnosis Previous Admission (b)**
(1) Unknown/not applicable	☐	☐	☐
(2) Acquired brain injury	☐	☐	☐
(3) Dementia	☐	☐	☐
(4) F10.2 Alcohol Dependence	☐	☐	☐
(5) F10.1 Alcohol Harmful use	☐	☐	☐
(6) F10.3 Alcohol Withdrawal	☐	☐	☐
(7) F19.2 Drug Dependence	☐	☐	☐
(8) F19.1 Drug Harmful use	☐	☐	☐
(9) F15.3/F19.3 Drug Withdrawal	☐	☐	☐
(10) F20 Schizophrenia	☐	☐	☐
(11) F21 Schizotypal disorder	☐	☐	☐
(12) F22 Persistent delusional disorders	☐	☐	☐
(13) F23 Acute and transient psychotic disorders	☐	☐	☐
(14) F24 Drug Induced psychosis	☐	☐	☐
(15) F25 Schizoaffective disorder	☐	☐	☐
(16) F29 Unspecified non-organic psychosis	☐	☐	☐
(17) F30 Manic episode	☐	☐	☐
(18) F31 Bipolar affective disorder	☐	☐	☐
(19) F32 Depressive episode	☐	☐	☐
(20) F33 Recurrent depressive disorder	☐	☐	☐
(21) F41 Anxiety Disorder	☐	☐	☐
(22) F43.1 Post-Traumatic Stress Disorder	☐	☐	☐
(23) F43.2 Adjustment Disorder	☐	☐	☐
(24) F60.0 Paranoid Personality Disorder	☐	☐	☐
(25) F60.1 Schizoid Personality Disorder	☐	☐	☐
(26) F60.2 Dissocial Personality Disorder	☐	☐	☐
(27) F60.3 Emotionally Unstable Personality Disorder	☐	☐	☐
(28)F60.4 Histrionic Personality Disorder	☐	☐	☐
(29) F60.5 Anankastic Personality Disorder/Obsessive Compulsive Disorder	☐	☐	☐
(30) F60.6 Anxious (avoidant) Personality Disorder	☐	☐	☐
(31) F60.7 Dependent Personality Disorder	☐	☐	☐
(32) F61.0 Mixed Personality Disorder	☐	☐	☐
(33) Narcissistic Personality Disorder	☐	☐	☐
(34) F70-F79 Mental Retardation / Learning Disability	☐	☐	☐
(35) F84.5 Asperger's Syndrome	☐	☐	☐
(36) F84 Autistic Spectrum Disorder	☐	☐	☐
(37) F90 Attention Deficit Hyperactivity Disorder	☐	☐	☐
(38) F91 Conduct Disorder in childhood	☐	☐	☐
(39) Other (specify IN CAPITALS)	☐	☐	☐
----------			(48c)

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Mental Health

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Note to Rehabs/IPCU's/Low Secure Units

Definition of Mentally Disordered Offenders

The Forensic Network Inpatient census will include **all** patients from high and medium security establishments. For other establishments which employ lower levels of security provision, the following definition has been provided in order for clinicians to identify which of their patients are defined as mentally disordered offenders and will therefore be included in the census.

The Scottish Office policy on *Health, Social Work and Related Services for Mentally Disordered Offenders in Scotland* describes mentally disordered offenders as those who are:

"Considered to suffer from a mental disorder as defined in the Mental Health (Care and Treatment) (Scotland) Act 2003, whether or not they are, of may be, managed under its provisions and come to the attention of the criminal justice system or whose behaviour poses a risk of such contact" (Scottish Office, 1999 – with update for 2003 Act)

This includes **everyone** currently being treated and detained under a criminal section of mental health legislation, namely:

- Assessment Orders
- Treatment Orders
- Compulsion Orders
- Interim-Compulsion Orders
- Restriction Orders
- Hospital Directions
- Transferred Prisoners
- Temporary Hospital Orders

Patients should also be included in the census if they:

a) have been directly transferred from high or medium security services,
b) are detained under compulsory treatment orders and were previously subject to criminal section under the mental health legislation.
c) have an identified bed in inpatients, regardless of suspension of detention

Appendix 2.4: The State Hospital Research Ethics Committee confirmation of Ethical Approval

Wednesday the 18th of November 2020

Dear Kirstin,

Re: The effects of early neurodevelopmental factors on offending characteristics.

Many thanks for your revised research proposal and covering letter that was reviewed by the TSH Research Committee on 12th of November 2020. The committee have reviewed the changes you have made to the original proposal (and helpfully highlighted) in line with the feedback from the research committee and am satisfied that the amended proposal has addressed the areas of concern to the committee. Subsequently I am happy to approve the study.

One condition of the research committees' approval is that you provide the committee with regular 6-monthly progress reports and a final report focused on the study findings appropriate to implementation into current practice. This is an important mechanism by which the committee track progress, and is also a key component of our research governance processes.

If you require any further assistance, or have any feedback on the Research approval process then please do not hesitate to contact me.

Yours sincerely

JAMIE PITCAIRN

Research & Development Manager

The State Hospital

Appendix 2.5: NHS Health Research Authority approval for The Forensic Network Service-User Database

Forensic Network Service-User Database

- **Research type**

Research Database

- **IRAS ID**

250580

- **Contact name**

J Pitcairn

- **Contact email**

Jamie.Pitcairn@nhs.net

- **Research summary**

Forensic Mental Health Services Managed Care Network Service-User Database

- **REC name**

Scotland A REC

- **REC reference**

18/SS/0099

- **Date of REC Opinion**

8 Aug 2018

- **REC opinion**

Favourable Opinion

- **Data collection arrangements**

Routinely collected patient data at forensic hospitals/clinics across Scotland will be reviewed and recorded by local Responsible Medical Officers/Senior Medical Trainees or forensic network staff. The information collected will form the Forensic Mental Health Services Managed Care Network Service-User Database. Non-identifiable patient information will be made available to approved researchers/health professionals for service evaluation/audit/research purposes. The database will be managed and administered by the Forensic Network on the National Services Scotland (NSS) secure network (SWANN/N3) and secure servers. It will be governed by the Database Governance Body, Data Custodian and Data Controller.

- **Research programme**

The database will support health professionals and researchers who are interested in exploring the field of forensic mental health and inpatient security. The database will also be useful for service planning both locally or across the whole Forensic Mental Health Services Managed Care Network.

- **Research database title**

Forensic Mental Health Services Managed Care Network Service-User Database

- **Establishment organisation**

Forensic Mental Health Managed Care Network

- **Establishment organisation address**

The State Hospital, Carstairs, Lanark, ML11 8RP

Appendix 2.6: Data Protection Impact Questionnaire

Data Protection Impact Assessment (DPIA) Questionnaire

Name of Project/system or title of the processing analysed	The effects of early neurodevelopmental factors on offending characteristics.
Date of Assessment	11/12/20

DOCUMENT CONTROL SHEET

Key Information

Title	The effects of early neurodevelopmental factors on offending characteristics.
Date Published/ Issued	11/12/2020
Date Effective From	11/12/2020
Version/ Issue Number	V1
Document Type	Data Protection Impact Assessment (DPIA) Screening
Document Status	Approved
Author	Kirstin Ferguson, Trainee Clinical Psychologist
Owner	
Approvers	Ken Lawton, Information Governance and Data Security Officer
Contact	
File Name	

Revision History

Version	Date	Summary of Changes
1	11/12/20	Initial draft

Approvals

Version	Date	Name	Designation
1	11/12/20	Ken Lawton	Information Governance and Data Security Officer

Appendix 2.7: SIMD Group Characteristics

Table 2.12 Characteristics of SIMD samples defined as with and without SIMD data

	SIMD Present (N=235)	**SIMD Missing (N=287)**
*Mean Age**	39.72	42.54
(SD, range)	(12.21, 18-76)	(11.63, 17-79)
Gender		
N Male (%)	221 (94.5%)	254 (88%)
N Female (%)	13 (5.5%)	34 (12%)
Employment History		
Yes, N (%)	40 (18.4%)	30 (11%)
No, N (%)	177 (81.6%)	240 (89%)
Educational Attainment		
Yes, N (%)	75 (39%)	74 (32%)
No, N (%)	116 (61%)	156 (68%)
Alcohol Problems		
Yes, N (%)	163 (72%)	190 (70%)
No, N (%)	63 (28%)	80 (30%)
Drug Problems		
Yes, N (%)	161 (71%)	183 (66%)
No, N (%)	66 (29%)	93 (34%)
*Abnormal Neurodevelopment**		
Yes, N (%)	35 (19.5%)	57 (27.5%)
No, N (%)	144 (80.5%)	144 (72.5%)
*History of Physical Abuse**		
Yes, N (%)	88 (43%)	91 (40%)
No, N (%)	117 (57%)	137 (60%)
History of Sexual Abuse		
Yes, N (%)	43 (22%)	63 (27.5%)
No, N (%)	151 (78%)	166 (72.5%)
*Significant Events in Childhood**		
Yes, N (%)	184 (84%)	201 (79%)
No, N (%)	34 (16%)	47 (21%)

SIMD (Scottish Index of Multiple Deprivation); Significant differences between the SIMD groups: *$p<0.005$; SD (Standard Deviation)

Appendix 3.1: Major Research Project Proposal

Kirstin Ferguson

University Supervisor: Professor Tom McMillan

Field Supervisor: Dr Fiona Mair

Date: 19th June 2020

Word count = 3143

Major Research Project Proposal

The effects of early neurodevelopmental factors on offending characteristics.

Abstract

Background: The prevalence of abnormal neurodevelopment (AN-D) is higher in a forensic population than in the general population (Borschmann et al., 2020). There is some evidence to suggest that AN-D is associated with offending; particularly early, violent and persistent offending (Moffit, 2015; Raine et al., 2019). It is proposed that effects of AN-D, including increased traits of impulsivity, hostility (Lesch et al., 2012) impaired attention, communication (Fishbein, 2006) might be associated with the development of offending behaviour and vulnerability to antisocial traits (Paradis et al., 2015).

Aims: This study will examine the relationship between early AN-D and offending in a Scottish forensic sample, while controlling for other factors thought to mediate offending behaviour including age, substance use, unemployment and education.

Methods: Data will be sourced from the 2013 Forensic Network Inpatient Census database (FNCD) which contains anonymised information on individuals across the Scottish Forensic Estate. Multivariate analyses will be used to compare offending characteristics in individuals with and without AN-D.

Applications: Results may help services better understand the prevalence and effects of AN-D in the Scottish Forensic Estate, particularly in relation to offending behaviour. This might highlight opportunities for bespoke interventions (Borschmann et al., 2020) and contribute to discussions around the placement of individuals with AN-D in the criminal justice system (CJS) (Hughes et al., 2020).

Introduction

Neurodevelopment is the development of the central nervous system (CNS), which is comprised of the brain and spinal cord, and controls bodily function. When CNS development is abnormal this can result in abnormal brain structure and functional development. This might be as a result of some neurodevelopmental disorder such as Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), Learning Disability or disruption caused by other pre-natal influence or post-natal trauma such as neglect, abuse or Traumatic Brain Injury (TBI). Neurodevelopmental disorders are highly co-morbid (Hellenbach et al., 2017) and can result in significant cognitive, communicative, socio-emotional and behavioural impairments, amongst others, which start in childhood and persist in to adulthood (Raine et al., 2018).

EFFECTS OF ABNORMAL NEURODEVELOPMENT (AN-D)

The effects of AN-D are present across the lifespan, including traits such as increased impulsivity, hostility (Lesch et al., 2012), and impaired attention, communication and responses to rewards and stimulation (Fishbein, 2006). Such difficulties can adversely affect engagement with normative social experiences such as the development of relationships, and engagement with education and employment (Raine et al., 2018). The might also increase the likelihood that individuals develop antisocial traits (Paradis et al., 2015), engage in offending, particularly acts of violence (Raine et al., 2019) and enter the Criminal Justice System (Borschmann et al., 2020; Hughes et al., 2015).

As a result offending has been explored through a neurodevelopmental lens (Hughes et al., 2017), particularly early and persistent offending (Moffit, 2015; Raine et al., 2005). These individuals have been shown to have uniquely altered brain structures compared to non-offenders or offenders who desist in adulthood (Tiihonen et al., 2008; Carlisi et al., 2020).

PREVALENCE IN A FORENSIC CONTEXT

The prevalence of AN-D is high in a forensic population (Hughes et al., 2012; Borschmann et al., 2020). Young people in prison were found to be three to four times as likely to have experienced a moderate to severe TBI, than peers in the community (Hughes et al., 2015). Rates of ADHD were found to be significantly higher in a youth (30%) and adult (26%) prison population (Young et al., 2015) than in the general population (4%) (Mohammadi et al., 2019). Learning disabilities are also found to be overrepresented in a prison population at 10-32% compared to 2-4% in the general population (Hellenbach et al., 2017; Borschmann et al., 2020). Similarly, a recent review estimated 60-65% of an adolescent prison population had communication impairments compared to 5-7% for peers in the community (Borschmann et al., 2020).

CAUSALITY IN A FORENSIC CONTEXT

There is some evidence to suggest specific neurodevelopmental disorders are associated with offending, particularly violent and repeat offending. Delayed language development has been found to be a significant predictor of future offending (Stattin and Klackenberg-Larsson, 1993) and associated with higher levels of physical aggression (Dionne et al., 2003). Cognitive impairment has been shown to increase rates of violent offending and aggression (Winstanley et al., 2018), as have sensory impairments (Miller et al., 2005) and complications at birth, foetal exposure to toxins and premature birth (Liu, 2011; Paradis et al., 2015). Childhood ADHD (Lundstrom et al., 2014), emotional and behavioural difficulties (Reef et al., 2011) have been associated with an early onset and repeat offending

However, much of this research is limited by a lack of exploration of independence or causality in the context of other predictive factors such as substance misuse, educational attainment, age (Lundstrom et al., 2014; Reef et al., 2011; Wakeling et al., 2011) and employment. Further, the overall body of research is limited by a lack of consistent measurement of predictor and outcome variables, making results hard to generalise (Murray and Farrington, 2010).

Aims

This study will use data from the Forensic Network Inpatient 2013 Census database (FNCD) to highlight the prevalence of AN-D in the Scottish Forensic Estate and to explore the relationship between AN-D and offending characteristics. This will be done in the context of possible mediating factors; age, substance use, unemployment and education.

Hypotheses

H1: Adult patients in the forensic estate with AN-D are more likely to be repeat offenders (as defined by 1+ reconviction), than patients without.

H2: AN-D predicts repeat offending after adjustment for age, substance use, unemployment and education.

H3: Adult patients in the forensic estate with AN-D have i) more convictions and (ii) more violent convictions, compared to patients without.

H4: AN-D predicts offending history after adjustment for age, substance use, unemployment and education.

H5. Adult patients in the forensic estate with AN-D are involved in more violent incidents during admission than those without.

H6. AN-D predicts violence during admission after adjustment for age, substance use, unemployment and education.

Plan of Investigation

Participants

Data will be sourced from the FNCD, which contains anonymised information on 522 individuals who were inpatients across the Scotland's Forensic Mental Health Managed Care Network, in 2013. This includes data from the 23 forensic mental health inpatient sites in Scotland, including high, medium and low secure settings and both general adult and learning disability populations.

Inclusion & Exclusion Criteria

Participants will be included if their census record contains information on all required variables. Participants will be excluded if they are recorded on item 29 Offence(s) or Alleged Offence(s) leading to Current Admission as (01) Not applicable/no offence(s) /Sentenced Prisoner Transfer as it will be impossible to identify if they have been reconvicted or not.

Predictor Variables

AN-D will be identified using item 11 Abnormal Infant Development, coded as; Yes (Y), No (N), or Do Not Know (DK). If an individual is rated as 'Y' on this item, they will be considered to have experienced *AN-D*.

Age is not a variable contained in the standard Census data entry form. However, age at the time of Census entry will be obtained by request from the database data controller.

Substance misuse will be defined by items 19 Patient Alcohol Consumption Problems and 20 Patient Drug Misuse. These are both rates as historic i) Yes (Y), No (N), or Do Not Know (DK) and at the time of admission Yes (Y), No (N), or Do Not Know (DK).

Employment history will be captured using item 9 Occupation Prior to Admission. This will be rated as (1) Unknown, (2) Employed (specify if known), (3) Unemployed, (4) Unemployed – voluntary work, (5) Retired, (6) Sickness benefit for each respondent.

Education history will be identified using item 15 Schooling, item 16 Further/Higher Education and item 17 Highest Academic Achievement. This categorical data will be used to explore the relationships in H1-4.

Outcome Variables

Offending Characteristics

Repeat Offending

A history of recidivism will be conceptualised as *reconviction* using item 37 Previous Conviction(s), coded as (1) Unknown, (2) No or (3) Yes, with (3) Yes indicating *reconviction*.

Offending History

Recidivism risk will be quantified via i) the number of previous convictions; as per item 37a as a categorical rating (0, <5, 5-10, 10+) and ii) the number of previous convictions involving violence; as per item 37b as a continuous variable.

Violence in Hospital

A record of involvement in violent incidents in custody during current admission will be obtained from item 32 and rated as 1) Unknown, (2) No or (3) Yes.

Descriptive Measures

Demographics Information including: Scottish Index of Multiple Deprivation (via item 2), Gender (item 3), Ethnic Origin (item 6), Current Marital Status (item 7) and Children (item 8).
Medical History information including: Physical Health (item 44) and ICD-10 diagnoses (item 48)

Design/Data Analysis

Initially, descriptive statistics will be used to check the assumptions for parametric tests; normality, linearity, independence and homogeneity of variance.

H1: Chi Squared analysis will investigate the relationship between AN-D and repeat offending by comparing subgroups classified by item 11 of the Census; AN-D (Y/N) and reconviction (Y/N).

H2. Multiple logistic regression will explore the relationship between AN-D and repeat offending including age (continuous), substance use (binary), unemployment (categorical), and education (categorical) as predictor variables.

H3. T-tests or non-parametric equivalent between groups analysis, will investigate relationships between AN-D and number of convictions by comparing subgroups classified by item 11 of the Census as AN-D (Y/N) and i) the number of previous convictions and ii) the number of previous convictions involving violence.

H4. Multiple linear regression will explore whether i) the number of previous convictions, ii) the number of previous violent convictions are predicted by AN-D including age, substance use (binary), unemployment (categorical) and education (categorical) as predictor variables.

H5. A t-test or non-parametric equivalent between groups analysis, will investigate the relationship between AN-D and violent incidents in hospital by comparing subgroups classified by item 11 of the Census as AN-D (Y/N) and the number of incidents.

H6. Multiple linear regression will explore whether the number of violent incidents in hospital are predicted by AN-D including age (continuous), substance use (binary), unemployment (categorical) and education (categorical) as predictor variables.

Justification of Sample Size

Investigating the relationship between ADHD diagnosis and recidivism, Mannuzza and colleagues (2008) found moderate to large effect sizes with a sample of n=186. Paradis and colleagues (2015) found moderate to large effect sizes with a sample of n=2464 comparing offence history and AN-D.

G*Power analyses (Faul et al. 2009), indicate a sample of N=32 is required to detect a large effect (w=0.5) and N=88 for a medium effect (w=0.3) in planned Chi Squared analysis. Planned t-tests require N=128 for a medium effect (d=0.5) to be detected. For planned multiple regression analyses, with 80% power and $\alpha = 0.05$ and four predictors, N=85 is required to detect medium ($f^{2=}0.15$) effect sizes. This is consistent with an estimated sample for this study of N=380; estimated by those who answered item 11 (AN-D) in the FNCD.

Health and Safety/ Ethical Issues

This data has already been collected and has acquired ethical approval for its use in research. Therefore there are no foreseen health and safety issues.

The following submissions for approval will be made for this study:

- Proposal review by the State Hospital Research Committee
- Approval from the data controller Jamie Pitcairn, Research and Development Manager at the Forensic Network, for the release of data

Financial Issues

There will be no financial costs associated with gathering or analysing the data in this study.

Timetable

Final Proposal – 29th May 2020 (3000 words)

Application to the State Hospital Research Committee – early July 2020

Data analysis and write up – May to July 2021

Final Project submitted – July 2021

Practical Applications

Results may help services better understand the prevalence and effects of AN-D in the Scottish Forensic Estate, particularly in relation to offending behaviour. This might highlight a window

of opportunity for positive change through bespoke interventions and support in criminal justice settings (Borschmann et al., 2020), which might meet the needs of many, as a recent review suggests that neurodevelopment and brain development may be ongoing until around age 25-30 in an offender population (O'Rourke et al., 2020). At a service development and policy level, this study may also help to start discussions around whether or not individuals who have experienced AN-D are best placed within the CJS (Hughes et al., 2020).

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Appendix 3.2: Major Research Project Proposal (abandoned due to Covid-19)

Kirstin Ferguson

University Supervisor: Professor Tom McMillan

Field Supervisor: Dr Abi McGinley

Date: 13th March 2020

Word count = 3282

Major Research Project Proposal

The effects of head injury early in life on engagement with mental health services in prison and on risk of recidivism.

Abstract

Background: In a prison population, the prevalence of head injury (HI) is estimated to be 25% to 86%, greater than in the general population (Moynan and McMillan, 2018) and is associated with negative outcomes, including recidivism (Fishbein et al., 2009). HI before age 15 is associated with effects on cognitive and emotional development including increased impulsivity and higher levels of reactive aggression (Fullerton et al. 2019) as well as antisocial behaviour (Williams et al., 2018) and offending behaviour and recidivism (Ryan et al., 2014). There is recognition that increased engagement with mental health interventions might help individuals at risk of reoffending prepare for the community and reduce recidivism risk; however the impact early head injury has on engagement and recidivism remains unclear (Kennedy, et al., 2017).

Aims: This study will examine relationships between head injury before the age of 15 and recidivism in a prison mental health sample.

Methods: Males from an adult prison mental health sample will take part in an interview and consent to file review to measure a number of variables related to engagement and recidivism including demographics, head injury and substance use.

Applications: If results suggest that early HI is associated with recidivism, this will support the use of routine screening for head injury in a forensic mental health population and inform on-going service development and future provision (NPHN, 2016).

Introduction

Individuals who suffer a head injury before age 15 are more likely to experience developmental delays. Head Injury (HI) early in life is associated with increased prevalence of mental illness and substance misuse (McKinlay et al. 2014), increased impulsivity and reactive aggression (Fullerton et al. 2019) and poorer self-regulation and social functioning (Anderson et al., 2011). As such, early HI has been proposed to increase the risk that a child might grow up to display antisocial behaviours, including offending (Fullerton et al., 2019). Further, early HI has been associated with earlier and more persistent offending behaviour than if a HI is sustained in adulthood (Moffitt et al., 2002; Ryan et al., 2014). This is in the context of and HI estimated prevalence in a prison population of 25-86% (Moynan and McMillan, 2018) compared to <1% and 12% (Dewan et al., 2018) in the general population.

HI has also been shown to increase the chance that someone will engage in recidivism (repeat offending) as a result of associated cognitive, behavioural and social deficits (NPHN, 2016; Williams et al., 2018). The definition of recidivism includes an initial release from prison and subsequent rearrest, reconviction or reimprisonment within a follow up period ranging from 6 months to 9 years (Alper et al., 2018); with 2 years most often used in research (Fazel et al., 2015). When measuring recidivism risk, offence history is often used as a predictor (Wakeling et al., 2011).

Nonetheless, other research has indicated that the link between early HI and offending is unclear, when factors such as neuroplasticity and the ability to engage in treatment and rehabilitation are considered. It is suggested that traits including aggression and impulsivity can reduce capacity to engage with and complete treatment in prison (Williams et al., 2018), as well as increasing challenging behaviour more generally. As it might be that the effects of head injury on treatment moderate any relationships here (Fishbein et al., 2009).

A better understanding of the effects of early HI on recidivism therefore seems important, especially as 19-55% of HI attendances at A&E in the UK in 2014 were under 15 years of age (NICE, 2014), a peak time period for the onset of offending (Loeber et al., 2012). Whilst a recent and novel review suggested that the brain could be considered as still developing, in an offender population, until as late as age 25-30 (O'Rourke et al., 2020), this study will define early HI as under age 15, to complement the use of the OSU TBI-ID; a validated HI screening tool.

Other factors associated with recidivism including problematic drug use (Caudy et al., 2015), unemployment (Makarios et al., 2010) and age, where younger ages is associated with increased recidivism (Wakeling et al., 2011), will also be taken in to account to better understand any unique role of early HI.

Aims

This study will examine the relationship between early HI (as defined by OSU-TBI) and recidivism in a forensic mental health sample. This will help inform whether routine screening and/or adaptations for HI are required in a forensic mental health setting, to increase engagement with psychological interventions offered and reduce recidivism risk.

Hypotheses

H1: Adult male prisoners referred to MH services who report early head injury (as defined by the OSU-TBI) with persisting disability will be less likely to engage with mental health services in prison than prisoners without early HI.

H2. Early head injury (as defined by the OSU-TBI) in prisoners referred to MH services is associated with increased frequency of recidivism compared to those without early HI.

H3. Adult male prisoners referred to MH who report early head injury (as defined by the OSU-TBI) will have (i) more previous convictions and (ii) more often have a history of violent convictions, compared to prisoners without early HI.

H4. Adult male prisoners referred to MH services who report early head injury (as defined by the OSU-TBI) and have persisting disability will have more recorded incidents in prison than prisoners without early HI.

Plan of Investigation

Participants/Recruitment

Participants will have been referred to the NHS Mental Health Team in HMP Shotts for psychological intervention from Clinical Psychology or nursing colleagues. Currently there is a caseload of around 90 with 40 referred per month; this gives an estimate of around 130 adults currently referred to the service. Prisoners referred in the past year who remain in the prison but did not engage will also be included in the recruitment sample, although it is possible they will be less willing to engage.

Inclusion & Exclusion Criteria

Participant should i) be fluent in English, ii) demonstrate capacity to consent, iii) not have significant communication difficulties which would impair their ability to complete the assessments, iv) not considered to pose a risk to researcher safety by prison staff.

Recruitment Procedures

Participants will be recruited through the prison mental health team. Staff will provide an information sheets and pass potential names to the researcher. Posters will be displayed in HMP Shotts, advertising the project as an exploration of engagement with mental health interventions and asking those interested to use the NHS self-referral box.

Predictor Variables

To identify moderate to severe early head injury, the *Ohio State University - Traumatic Brain Injury Identification Method (OSU TBI-ID; Corrigan and Bogner, 2007) - Short Version,* a validated HI screening tool, previously used successfully in a Scottish prison sample (Walker, 2017), will be administered. It defines early HI as occurring before age 15 and significant (moderate/severe) injury is associated with a loss of consciousness (LOC) of 30 minutes or more.

Current problematic drug use will be recorded using the *Drug Abuse Screening Test (DAST-10) (Skinner, 1982), a* brief self-report tool previously used in prison and HI samples.

Age and Employment history will be obtained through self-report using a *data capture form* used in previous studies (McVean, 2019). Employment will be measured as a Y/N in relation to the year prior to imprisonment.

Outcome Variables

Recidivism

An *SPS File Review* will be undertaken to:

1. Determine engagement in past recidivism or not, defined as reconviction for any offence within a 2 year period of release from custody. This will include time periods where the individual was on probation.
2. Quantify recidivism risk via i) the number of previous convictions and ii) the number of previous convictions involving violence.

Engagement

A *Mental Health Service File Review* will be undertaken to identify whether individuals have engaged or not engaged in psychological intervention with the prison mental health team following referral.

Compliance

An SPS *File Review* will be undertaken to quantify the number of recorded incidents in prison.

Descriptive Measures

The *Dysexecutive Questionnaire (DEX; Wilson, Evans, Alderman, Burgess and Emslie, 1998)* will be completed by the individual and their personal officer to examine deficits in executive function.

The *Clinical Outcomes in Routine Evaluation-Outcome Measure (CORE-10; Barkham et al., 2013)* will be used to assess psychological distress.

The *Traumatic Life Events Questionnaire (TLEQ; Kubany et al., 2000)* will measure the self-reported frequency and severity of any traumatic adulthood events.

The assessment process will take approximately 45 minutes. The researcher will also be required to complete the file reviews indicated outside of this time.

Research Procedures

Following recruitment through NHS and SPS staff, and obtaining informed consent, the researcher will meet with each participant to complete the assessment and complete the file reviews.

Design and Data Analysis

This study will use cross sectional measurement and follow a retrospective, quantitative design.

Data Analysis

H1: Chi Squared analysis will investigate the relationship between early head injury and recidivism by comparing subgroups classified by the OSU-TBI as having early head injury or not and having been reconvicted within 2 years of any release from custody or not (ascertained from file review and/or self-report).

Multiple logistic regression will look at the relationship between early head injury and recidivism where drug use (continuous score 0-10), age (continuous) and employment (categorical, Y/N) are also included as predictor variables.

H2. Multiple linear regression will explore whether i) the number of previous convictions, ii) the number of previous violent convictions are predicted by early head injury where drug use (continuous score 0-10), age (continuous variable) and employment (categorical, Y/N) are also entered as predictor variables.

H3. Chi Squared analysis will investigate the relationship between early head injury and engagement by comparing two subgroups classified by the OSU-TBI and having engaged or not engaged with mental health services in prison (Y/N; ascertained from NHS file review).

H4. A t-test will investigate relationships between early head injury and in-prison incidents by comparing the two subgroups classified by the OSU-TBI and the number of recorded incidents per group.

Justification of sample size

There are no comparable studies published where the relationship between early head injury and recidivism or engagement is addressed independently. In relation to multiple regression in H1 and 2, a medium effect (0.15) for engagement/recidivism with 80% power and $\alpha = 0.05$ with four predictors, n= 85 was required according to G*Power analysis (Faul et al. 2009). A sample of 85 will be aimed for in this study.

Settings and Equipment

- This study will require the researcher to access a room at HMP Shotts, which in sight of HMP Shotts staff, with exits identified and access to a personal alarm.
- Equipment will include pens, paper forms/stimuli for informed consent and for each of the proposed measures.

Health and Safety Issues

Researcher Safety Issues: The researcher will complete mandatory training for access to prison, including violence and aggression training. Additional risk management strategies will be put in place eg. personal alarms, checking in with prison staff prior to assessment.

Participant Safety Issues: Detailed consideration should consistently be given to any risk participation may have eg. reactions from other inmates, location of testing and proximity of enemies. Adherence to SPS procedures should enable appropriate monitoring and safety.

Ethical Issues

In accordance with recognised ethical guidelines good research practice should be followed ie. consent, monitoring of risk and safeguarding of information. Specific consideration will be given to capacity to take part in research.

The following submissions for approval will be made:

- NHS Lanarkshire R&D Approval
- NHS Research Ethics Committee Submission – including completion of Integrated Research Application System (IRAS) form and attendance at Ethics Panel
- SPS Ethics Committee

Financial Issues

Costs will include the printing/purchase of measures to be used and return travel to HMP Shotts.

Timetable

Proposal Submission for Blind Review – 13th March 2020

Final Proposal – 27th May 2020

Applications to NHS and SPS ethics – early July 2020

Recruitment – September/October 2020 to April2021

Data analysis and write up – May to July 2021

Final Project submitted – July 2021

Practical Applications

Results may help the forensic mental health service better understand the role of head injury in relation to on-going service development, future provision and the role head injury screening might play (NPHN, 2016).

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