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The Prevalence of Traumatic Brain Injury Among Young Offenders in Custody: A Systematic Review

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Abstract

Objectives: To examine the prevalence of traumatic brain injury among young people in custody and to compare this to estimates within the general youth population.

Design: Systematic review of research from various national contexts. Included studies were assessed for the relevance of the definition of traumatic brain injury and the research population, and the quality of the study design.

Results: Ten studies were identified for inclusion in the review. Four of these studies included control groups. No studies examining co-morbidity of TBI and other neurodevelopmental disorders among incarcerated young people were identified.

Conclusion: Reported prevalence rates of brain injury among incarcerated youth range from 16.5% to 72.1%, with a rate of 100% reported among a sample of young people sentenced to death. This suggests considerable levels of need among incarcerated young people. Where control groups or directly comparable studies within the general population exist, there is strong and consistent evidence of a prevalence of traumatic brain injury among incarcerated youth that is substantially greater than that in the general population. This disparity is seemingly more pronounced as the severity of the injury increases.

Keywords:

Traumatic brain injury; prevalence; young offenders; crime; antisocial behaviour; custody; incarceration.

Introduction

In recent years there have been numerous calls for improvements in the provision of support to address the mental and physical health needs of prison populations [1-3]. Addressing these needs is argued to be key to individual health and well-being, preventing reoffending, and reducing the costs of the criminal justice system [4]. Brain injury is a major cause of death and disability in children and working age adults [5]. Nonetheless insufficient attention is given to brain injury in addressing the needs of prison populations [4].

A traumatic brain injury (TBI) is a disruption to the normal function of the brain resulting from a direct blow to the head, penetration of the skull, or a force that causes the brain to move around inside the skull [6]. The Centers for Disease Control and Prevention report that the most common causes of TBI are falls (approximately 40% of reported instances), road traffic accidents (20%), 'being struck by/against' an object (19%), and assaults (11%)[7]. Falls are the primary causes of TBI for younger children, while traffic accidents becomes the primary cause for young people aged 15-19.

The severity of TBI can be measured in different ways. Most commonly, consideration is given to whether loss of consciousness (LOC) is experienced, and if so its duration and depth, based upon the extent to which a patient is able to respond to stimuli. A common classification of experiences of LOC is the Glasgow Coma Scale which provides a standardised means to score its severity as 'mild', 'moderate' or 'severe' [8]. Alternatively severity may be graded by the duration of 'Post-Traumatic Amnesia'; that is, the length of time after an injury that a person is alert but unable to take on new information [9].

Childhood TBI can result in a number of potential neurocognitive impairments and developmental difficulties that subsequently impact upon aspects of functioning and behaviour. These include deficits in: cognitive and socio-cognitive skills [10-13]; social or

pragmatic communication [14-17]; impulse control and regulation of aggressive responses to threat [10,18-23]; cognitive empathy [21], and therefore the ability to respond appropriately to other's emotions [10,13,24]. Such impairments have been frequently identified as 'risk factors' within criminological research [25-27]; that is, in population-based studies, the presence of these factors have been found to increase the risk of criminality. In particular, 'neurocognitive impairments' have been found to be strongly associated with 'early onset' and 'life course persistent' offending trajectories, and the number of times an individual has experienced LOC has been found to be significantly higher amongst persistent offenders [28]. A failure to address needs resulting from childhood TBI can lead to a range of poor social experiences and outcomes known to indirectly increase vulnerability to criminal behaviour. For example, TBI is associated with persistent problems in academic performance [29-32], including at the point of transition to secondary school [33-35] and susceptibility to negative peer influences [36,37]. In combination, this suggests young people may experience heightened vulnerability towards antisocial and criminal behaviour as a result of impairments caused by childhood TBI; an assertion that is supported by two population studies that establish a clear link between TBI and subsequent offending. A birth cohort study of 12,000 subjects in Finland identified a fourfold increased risk of adult offending with associated mental disorder following childhood TBI [38]. In Sweden, an analysis of hospital records across the entire population from 1973 to 2009 enabled comparison of outcomes for those who had experienced TBI in childhood to siblings who had not experienced such an injury, and suggested an association between TBI and subsequent violent crime [39].

It is equally apparent that TBI may result from certain forms of risk taking behaviours, including those associated with offending [4]. This demonstrates the complexity in interpreting the correlation or causal relationship between TBI and criminality. Thus brain

injury may result from behaviour associated with criminality, or the risk of future criminality, and may instead be indicative of a pre-existing trajectory towards offending behaviour.

In parallel to a heightened risk of offending behaviour, childhood TBI may also increase vulnerability to criminalisation through discrimination and disadvantage in experiences of the crimibal justice system. For example, impairments in executive functioning are known to affect capacity to engage in forensic police interviewing and presentation in court, potentially resulting in a young person being perceived as non-compliant [17, 40-43]. Subsequent interventions that fail to recognise and address needs may result in the potential for disengagement and possible breach of a court order [37].

Articles 37 and 40 of the United Nations Convention on the Rights of the Child [44] establish the rights of young people within the criminal justice system to be dealt with in ways that take account of their specific, individual developmental needs, providing interventions that promote care, guidance and support. Given the apparent heightened vulnerability to criminality and criminalisation, it is therefore imperative that criminal justice systems recognise and respond to needs resulting from childhood TBI, particularly amongst serious and persistent offenders. To this end, a growing number of studies have examined the prevalence of TBI amongst incarcerated young people in various populations and contexts. This article reports on a systematic review of this body of research in order to answer the primary research question: ‘What is the prevalence of traumatic brain injury amongst incarcerated young people?’ This in turn supports an answer to a secondary question: ‘Is the prevalence amongst incarcerated young people greater than the rate amongst the general youth population?’ Consideration is also given to sociodemographic variation in prevalence rates of TBI among young people in custody, including in relation to gender and ethnicity, as well as to the co-occurrence of TBI and other neurodevelopmental or mental health difficulties.

Methods

The review was completed in two distinct phases. The initial phase was undertaken as part of a broader examination of the prevalence of neurodevelopmental disorders amongst incarcerated young people, commissioned by the Office of the Children's Commissioner for England in 2009 [45]. This was subsequently updated through a second phase of searches and analysis undertaken in 2014.

Both phases followed the same search strategy. A systematic review of academic journal articles was undertaken through a structured search of key bibliographical databases, chosen so as to provide extensive coverage of a variety of relevant academic disciplines. These included PubMed, PsychINFO and Applied Social Sciences Index and Abstracts. Search terms were developed through consideration to the synonyms of a number of key concepts, including 'youth', 'crime', 'custody' and 'traumatic brain injury', which were combined using Boolean terms. Consideration was given to variations in terminology over time and in different cultural contexts.

The review of academic journal articles was supplemented by a purposive search for relevant evidence published by key health, criminal justice and social policy organisations. However, no such sources were identified in relation to TBI. The bibliographies of included sources were also searched for further relevant evidence. In addition, the initial phase of the research was supported by an expert advisory group, drawn from a range of relevant academic and professional disciplines and able to provide insight into emerging and published research. The membership of the group is listed elsewhere [45]. Specific searches identified the work of key authors, as identified by the expert advisory group.

The senior research team was multidisciplinary, including expertise in neuroscience, psychiatry, psychology, social policy and criminology. Searches were undertaken by two

research assistants in the first phase and one research assistant in the second phase. Each research assistant had undertaken formal methods training regarding literature-based research prior to their employment, and received weekly mentoring and supervision from a senior member of the team throughout their involvement in the study.

The research protocol determined that studies were included if they provided a prevalence rate for one or more neurodevelopmental disorder amongst a sample of young people in custody. A broad definition of youth was applied so as to reflect the varying classifications within different nation states, though all studies had to include young people under 18 within their sample with a maximum upper age range of 21. The review was inclusive of a wide range of definitions of particular neurodevelopmental disorders. In the case of TBI, definitions used by particular studies needed, as an absolute minimum, to satisfy that of the Centers for Disease Control and Prevention [5], which defines TBI as 'a bump, blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain.'

Studies were excluded if no clear definition of the nature of the neurodevelopmental disorder was provided, or specific prevalence rates for young people could not be extracted from the data. No specific exclusion criteria were set regarding the year of publication or the geographical location of the research, though the review was necessarily restricted to publications in the English language. Three studies were rejected despite a focus on incarcerated young people. Two studies reported on youth justice populations that also include young people within community services and do not readily distinguish between these distinct populations in the data provided [46,47]. A further study was rejected due to the conflation of TBI and epilepsy in the construction of the sample [48].

All decisions regarding inclusion were made by at least two researchers, including one senior researcher. It was determined that, where there was disagreement between two researchers that could not be resolved, a senior researcher would further review the source

and determine inclusion or exclusion. Titles and abstracts were initially considered for relevance. Full papers were reviewed when the abstract was deemed relevant or where relevance was unclear.

The majority of sources identified were published in peer-reviewed academic journals and therefore deemed to be of high quality. When it was unclear whether a source was peer reviewed, specific frameworks for assessing research quality were utilised according to the type of research study under consideration. These included the Maryland Scientific Methods Scale [49] and the Global Assessment and Evaluation of Quality framework [50].

All sources selected for inclusion were read by at least two researchers, including at least one senior researcher. Key information was routinely extracted and recorded in a spreadsheet, including the national context, research population, sampling frame, data collection method, and definition of the neurodevelopmental disorder. All reported prevalence rates were recorded, including of any control groups and subsamples.

Results

The first phase of the review identified 156 sources for inclusion, of which 8 related to TBI. The second phase of the review subsequently identified a further 2 sources. A total of 10 sources are therefore included, as listed in Table 1. No studies examining co-morbidity of TBI and other neurodevelopmental disorders amongst incarcerated young people were identified for inclusion. All of the studies are based on populations in the US, UK or Australia. This may be a result of restriction in the review to sources written in English, or may reflect a lack of emphasis on TBI in other national contexts. In all three national contexts the age at which a young person is subject to the adult criminal justice system is 18, aiding the direct comparison of these studies. The age ranges of samples vary, with some studies focusing on a broad age range, such as 11 to 20, and others focused only on older young

people, such as 16 to 18 year olds. The samples for all but four studies are male only. In many cases this is reported as reflective of the populations of the institutions included in the study. Information on the ethnicity of study participants is less consistently provided. While variation might be assumed by study population, only three studies report the ethnicity of the sample and only two studies provide meaningful comparisons by ethnicity. Demographic variation in reported prevalence rates of TBI are reported in the Discussion section.

[ADD TABLE 1 AROUND HERE]

As shown in Table 1, the reported lifetime prevalence rates of TBI amongst incarcerated youth range from 16.5% to 72.1%, with the exception of a study of 14 young people sentenced to death for crimes committed when aged under 18, all of whom reported having experienced some form of head injury in their childhood.. There are many explanations for this variability. Table 1 illustrates the varying definitions of TBI applied in different studies, ranging from ‘any head injury’, including cuts, whiplash and blows to the head not resulting in LOC, to trauma resulting in LOC for a minimum of 20 minutes. It is clear therefore that these studies are measuring very different concepts. Nonetheless, as will be examined in the discussion that follows, even where definitions appear similar, reported prevalence rates still vary.

The variability in definition is reflected in the various measures, tools and methods used to assess prevalence rates, which include: analyses of medical records; self-administered surveys; semi-structured interviews; and the use of validated instruments or clinical tests. Methodologies also vary in whether the respondent is the young person or parent, and whether surveys are self-administered, or data is collected by a researcher or medical

professional. It is apparent that there is the potential for these varied approaches to lead to different assessments of levels of prevalence [51].

Comparisons are also made difficult by the variation in samples and populations on which individual studies are focused. This includes variation in the age range considered, which was typically dependent on the age of young people within a particular custodial setting. The latter relates to a further, more significant challenge in drawing together studies from various national contexts. The comparison of populations of incarcerated youth masks considerable differences in the use of custodial interventions for young people in particular nation states. As illustrated by the study reporting a prevalence rate of 100%, variations in the seriousness of offence committed may also influence findings.

Studies also vary in their intent. While some studies are designed in order to establish a prevalence level within a custodial population, in other studies the reported rate is a by-product of a broader focus on physical and/or mental health issues or criminal justice experiences. In such studies data regarding TBI may result from one or two simple questions, with little depth of discussion. This variation in purpose is reflected in the sampling frames utilised within the studies, ranging from convenience or purposive samples, to those that deliberately include an entire custodial population.

Given this heterogeneity in definition, methodology and population, it is not possible to calculate a robust and meaningful overall estimate of the prevalence of TBI among incarcerated youth. Instead the following sections provide a discussion of the various definitions used, and the range of prevalence estimates reported accordingly.

Where provided, prevalence rates amongst control groups drawn from non-offenders in the general youth population are provided in Table 1. To support such comparison, the discussion below also utilizes studies of the general youth population in which similar definitions of TBI are used. These studies were purposively selected following the initial

review and analysis so as to provide comparable definitions. In most cases however there remain slight discrepancies in definition, method of data collection and/or population. To enable comparison, information on these studies is provided in Table 2.

[ADD TABLE 2 AROUND HERE]

Though the degree of difference varies, regardless of definition, the four studies inclusive of a control group within the general youth population consistently demonstrate a prevalence of TBI amongst young offenders in custodial institutions that is greater than that in the general population. Similarly, where comparisons are made to studies utilising similar definitions in examining prevalence in the general population, the rate amongst incarcerated youth is typically higher. In part this may be explained by the higher proportion of females in general population samples and the apparent lower prevalence of TBI amongst young females, as discussed further below. In the following discussion, these patterns are examined in relation to the common categories of definition of TBI.

Discussion

Any head injury

In four studies a broad definition of head injury is used, incorporating a range of injuries, such as cuts, and/or including blows to the head that do not result in loss of consciousness. Three such studies directly compare samples of incarcerated youth to a control group within school settings. Hux et al [54] asked parents a series of twenty-one 'yes/no' questions examining awareness of head injuries experienced by their child before the age of 18. The study reports that 49.7% of the incarcerated sample had experienced a

concussion or cut to the scalp or forehead requiring stiches, compared to 42.1% of the control group.

Levine et al [57] compare 53 young people in custody to an 'age-matched comparison group' of 51 non-offenders from a community that is 'demographically representative of the region under study'. Parental report suggests that 55% of the offender population had experienced a head injury significant enough to require medical attention, compared to 24% of the control group. A higher rate is reported by Davies et al [52]. Following semi-structured interviews of young people in one custodial institution in the UK, they conclude that 72.1% had experienced a head injury causing them to be 'knocked out and/or dazed and confused for a time'.

The rates amongst incarcerated youth reported in these studies appear to be greater than those identified when comparable definitions are applied in studies of the general youth population. For example, comparable definitions utilised in studies of high school students in the US suggest a prevalence rate for any head injury of between 31% [65] and 35% [66]. One study runs counter to this trend. When surveying young offenders in custody in New South Wales, Australia, Kenny and Lennings [56] suggest that 35.1% had experienced any kind of head injury, a rate in keeping with that of general population studies.

A different measure is employed by Forrest et al [53] who consider prevalence rates in the previous 12 months. In this study 'head injury' is one of a number of 'acute major disorders' measured within the Child Health and Illness Profile used to assess a wide range of health needs. Among incarcerated youth, 12.5% experienced a head injury in the last 12 months, a significantly higher rate than that of 5.8% within a control group of school children. The latter is comparable to a rate of 4.7% identified by Riley et al [57] utilising the same tool and measure on a population of adolescents, aged 11 to 17, in public schools in urban and rural Maryland.

296

297 ***TBI resulting in LOC***

298 The disparity between prevalence rates within incarcerated and non-incarcerated
299 populations appears increasingly pronounced as the severity of the reported TBI increases.
300 This is apparent in the single study including a control group in which a range of severities of
301 TBI are measured. In the study by Hux et al [54] the relative difference in prevalence rates
302 between the two samples increases when respondents report concussion and LOC; 11.7% of
303 the control group report some form of concussion, compared with 16.5% of the incarcerated
304 young people, while 1.5% of the control group report 'moderate' or 'severe' concussion
305 compared to 3.5% of the incarcerated young people. (A definition of the levels of severity is
306 not provided, however.)

307 The increasing disparity in relation to more severe injuries is also evident when
308 comparing reported rates in studies of incarcerated populations to studies of the general youth
309 population. Three further studies in our review consider the prevalence of TBI with any LOC
310 amongst incarcerated youth, with reported rates of 32% [60], 41% [52] and 49.7% [55]. This
311 compares to rates of between 5% and 24% identified by a review of studies of self-report
312 surveys of college students in the US [48].

313 The lower of these prevalence rates defines TBI as trauma resulting in LOC of
314 'greater than 20 minutes'. This definition is directly comparable to that of Perron and Howard
315 [61] who report that 18.3% of their sample of incarcerated youth experienced such an injury.
316 While limited to two studies, this suggests a near four times increase of such head injuries
317 amongst the incarcerated sample.

318 Elsewhere 'moderate' or 'severe' TBI is defined as a LOC of more than 30 minutes,
319 with an injury classified as 'very severe' if the LOC is greater than 60 minutes. Two studies
320 utilise this definition in examining prevalence in custodial populations; both involving self-

report of experience of TBI by the young person, though one in the UK [52] and one in Australia [60]. The two studies report an identical prevalence rate of 8.2%.

Repeat incidence of TBI

Two studies report on multiple experiences of TBI. Davies et al [52] report that 45.8% of their sample of incarcerated young people had experienced more than one head injury of any severity, including 22.9% reporting four or more such injuries, while Moore et al [60] suggest that around 13% of their sample of incarcerated youth had experienced a LOC on two or more occasions. While these studies did not include a control group, a self-report questionnaire of high school students in the US [65] found that 12% had experienced multiple head injuries of any kind, and a birth cohort study in New Zealand [63] with a sample size of 1265 reports that, by the age of 25, 9.2% had experienced more than one TBI for which a diagnosis of concussion was given.

Sociodemographic variation in prevalence

Four studies compare prevalence rates of TBI by gender amongst incarcerated youth with contradictory results. Two studies report a significantly higher rate of TBI amongst males than females. Perron and Howard [61] report that 19.6% of males and 9.6% of females had experienced a TBI resulting in LOC for at least 20 minutes, while Kenny and Lennings [56] suggest that 37.7% of males and only 5.3% of females have experienced one of a wide range of head injury types.

In contrast two studies demonstrate very similar rates amongst males and females. A recent study which screened young offenders in custody in New York State for TBI resulting in LOC reported only one percentage point difference with a prevalence of 50% amongst male respondents and 49% amongst female respondents [55]. While the reported rates are

notably different, Moore et al [60] also suggest equivalency in prevalence with 32.1% of males and 33.3% of females in their sample experienced TBI with LOC.

It is difficult to explain this variation between studies, even with reference to the varying definitions of TBI and diverse sampling frames. While there is variation in the degree of difference reported, studies of the general youth population consistently suggest a significantly higher prevalence of TBI amongst males [62,63,65].

Two studies consider variation by ethnicity, though neither study reports any significant difference. In a study of nine Australian detention centres [60], the rate of TBI is slightly higher amongst Aboriginal young people (33.8%) than non-Aboriginal young people (30.9%). Interviews with 72 young people in custody in Missouri, USA [61], suggest that 17.8% of white young people experienced TBI with LOC for more than 20 minutes, compared to 16.9% of non-white young people.

There is insufficient evidence upon which to draw firm conclusions, however these findings would suggest that TBI might act as a risk factor for criminality independent of ethnicity. Further such research examining sociodemographic characteristics is needed. In particular consideration must be given to factors known to increase risk of criminality and/or criminalisation that might therefore act as confounding variables in seeking to understand the relationship between TBI and offending.

Comorbidity

Several studies have identified patterns of comorbidity of TBI with other neurodevelopmental disorders or mental health problems. Such associations are of two distinct types. Firstly, the pre-existence of other disorders, such as Attention-Deficit Hyperactivity Disorder, may heighten the risk of brain injury due to the types of behaviour or activity that might more readily be engaged in [68]. Secondly, there is evidence to suggest that

TBI might increase the risk of developing other disorders. For example, TBI can result in speech and language difficulties [69] and can increase the risk of mental health problems, such as depression, anxiety and suicidality [29,70]. Young offenders reporting TBI have also been found to be at greater risk of mental health problems and misuse of cannabis [47].

Despite the heightened risk of comorbidity, none of the studies reviewed examined the co-occurrence of TBI and other conditions amongst incarcerated youth. Further research is required to understand experiences of comorbidity within this vulnerable population. Evidence is presented elsewhere in this special issue. In their study of young male offenders in custody, Chitsabesan et al [71] found that the prevalence of deliberate self-harm and suicide risk factors was significantly increased in those experiencing a TBI, although rates of depression and other neurodevelopmental disorders, including ADHD and speech and language disorders, were not increased in this subgroup. The authors consider possible mediating factors for the co-morbidity of TBI with self-harming behaviour, including the presence of shared risk factors such as a history of being in care.

Conclusion

This review has identified a significant prevalence of TBI amongst young people in custody in multiple national contexts. Between 49.7% and 71.2% of incarcerated young people are reported to have experienced some kind of head injury, with between 16.5% and 49% having experienced TBI with LOC. While diverse definitions of TBI lead to a wide disparity in reported rates, this suggests high levels of associated need amongst young people in custody.

There is also strong and consistent evidence of a prevalence of TBI amongst incarcerated youth that is substantially greater than that in the general population and amongst offenders in community service settings. Where control groups or comparable

studies within the general population exist, the rates of all forms of TBI appear higher amongst incarcerated youths. This disparity is seemingly more pronounced as the severity of the injury increases.

The correlation between TBI and incarceration does not imply causation. Engaging in types of behaviour related to antisocial behaviour, aggression and criminality may result in a greater risk of TBI. Nonetheless, as outlined in the Introduction, the strong evidence base regarding the association between TBI and subsequent deficits in a wide range of known risk factors for criminality, including cognitive skills, impulse control, academic engagement, and susceptibility to negative peer group influence, provides a strong theoretical framework with which to understand and explain the relationship between TBI and serious and / or persistent offending, and therefore the disproportionate prevalence among incarcerated youth.

There are a number of limitations with regard to the effectiveness of this review in addressing its aims. As discussed above, there are numerous challenges in seeking to combining and comparing disparate research studies with diverse definitions, samples and methodologies so as to form a coherent picture of the prevalence of TBI amongst young people in custodial institutions. In particular, variation in the definition of TBI utilised in research, and indeed practice, inhibits clear understanding of both the prevalence of TBI and its relationship to offending. Furthermore, the relatively small number of sources identified demonstrates that, while greater focus is rightly being placed on this as an issue, there remains a lack of robust data upon which to draw comprehensive conclusions regarding levels of need or associations between serious and persistent offending and degrees of severity of TBI.

The heterogeneity in definition of TBI and study design limits the meaningfulness of combining estimates of prevalence to establish a general estimate. The review identified 10 studies across three countries. There are, therefore, insufficient studies from each country to

draw firm and meaningful comparative conclusions. Such comparison is further limited by variations in policy and practice in specific states within each country, as well as by the varied definitions and measures employed in each study. This precludes any meaningful reflections on the relative impact or effectiveness of specific state policy and practice systems.There are also some specific gaps in the available evidence. Despite the likely vulnerability within this population, there appear to be particular limitations in the available evidence regarding experiences of comorbidity of TBI and other developmental and mental health difficulties amongst young people in custody. Similarly, few studies consider the prevalence or impact of repeat experiences of childhood TBI within this population. There is also insufficient consideration to sociodemographic characteristics that are commonly identified within criminological research as impacting on experiences within the criminal justice system, including ethnicity and socio-economic status. Given concern for experiences of criminalisation and disablement amongst young people who experience childhood TBI, the potential for complex and multiplicative experiences of disadvantage must be considered.

Notwithstanding these limitation in the evidence base, the findings presented here have clear implications for youth justice systems. The high levels of need emphasise the requirement for effective screening and assessment of TBI amongst offending populations so as to support the development of practices and interventions better able to meet the needs of young people in custody, both individually and collectively. Effective assessment provides the means to understand an individual young person's history of TBI and address its potential impact on aspects of behaviour and functioning. In turn, such screening and assessment can provide an understanding of the collective level of need so as to inform the commissioning and development of specialist services. In addition, the prevalence of TBI, and indeed other neurodevelopmental disorders, amongst young people who offend suggests the need for youth justice processes to be revised, given the significant proportions of young people on

trial or in contact with the police who may struggle to engage effectively with key aspects of the legal system, including forensic interviewing and courtroom procedures.

An awareness of this disparity amongst populations in custody also suggests a necessary focus on preventative services and earlier intervention where young people are known to have been affected by TBI. This might include specialist, responsive interventions during community youth justice orders. It might also inform interventions prior to any significant engagement in criminal behaviour, including: the sharing of information regarding TBI between health services and schools; routine follow-up support with children and their families at various time points following medical attention for TBI; the provision of information to parents regarding the potential short, medium and long term impacts of TBI, and the availability of support services. While requiring resources, such approaches might offer cost savings if preventing persistent engagement with the criminal justice system and eventual incarceration for a proportion of young people experiencing childhood TBI.

The findings of this review also have implications regarding research in this field. Comparative research between countries using standardised definitions and measures of severity will support analysis regarding the influence of youth justice practices, including preventative measures, on the criminality and criminalisation of young people experiencing childhood TBI. This can be further supported by qualitative examination of the experiences of the youth justice system and criminal justice processes of young people who have experienced TBI. Consideration to and evaluation of interventions and practices better able to meet the needs of young people who have experienced TBI in custodial and community settings can support the development of youth justice practices better able to address the needs of these vulnerable young people.

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Table 1. Studies reporting on the prevalence of TBI amongst young people in custody

Reference	Country	Population	Age range	Sample size	Data collection method	Definition of TBI	Prevalence rate in offending population	Prevalence rate in control group
Davies et al 2012 [52]	UK	Young male offenders in custody	16-18	61	Semi-structured interview carried out by researcher	Any head injury resulting in LOC or feeling 'dazed and confused'	72.1%	
						Head injury resulting in LOC of any length of time	41%	
						'Mild' TBI, with LOC of less than 10 minutes	23%	
						'Complicated mild' TBI, with LOC of 10 to 30 minutes	9.8%	
						'Moderate/severe' TBI, with LOC of 30 to 60 minutes	6.6%	
						'Very severe' TBI, with LOC of more than 60 minutes	1.6%	
Forrest et al, 2000 [53]	US	Young male offenders in custody	12-19	202	Self-administered questionnaire completed by young person Health screen	Taken from the Child Health and Illness Profile, Adolescent Edition in which head injury is considered as an 'acute major disorder'	12.5% in the last 12 months	5.8% in the last 12 months
Hux et al, 1998 [54]	US	Young male and female offenders in	11-20	753	Self-administered survey completed by parent	Any head injury, including cuts or whiplash, and 'blows to the head' resulting in headaches, dizziness or blurred vision, with or without LOC	49.7%	42.1%

		custody				Head injury resulting in concussion	16.5%	11.7%
						Head injury resulting in 'moderate' or 'severe' concussion	3.5%	1.5%
Kaba et al, 2014 [55]	US	Young male and female offenders in custody	16-18	384	Screening tool administered by professional	Head injury 'with loss of consciousness and/or posttraumatic amnesia'	49.7%	
Kenny and Lennings 2007 [56]	Australia	Young male and female offenders in custody	14-21	242	Survey administered by psychologist	Any injury 'to the scalp, skull, brain and underlying tissue and blood vessels in the head'	35.1%	
Levine et al, 1985 [57]	US	Young male offenders in custody	12-16	104	Self-administered questionnaires completed by young people and parents Medical examination Interview of parent	Head trauma significant enough to require medical attention	55%	24%
Lewis et al, 1985 [58]	US	Young male offenders in custody later convicted of murder	12-18	9	Medical records Neuropsychiatric evaluation Interview of parent	Any 'illnesses or accidents' affecting the central nervous system, including those resulting in LOC	67%	

Lewis et al, 1988 [59]	US	Young male offenders in custody sentenced to death	Under 18 at time of offence	14	Detailed clinical examination Interview of young person by a neurologist and a psychiatrist Medical records	Any 'illnesses or accidents' affecting the central nervous system, which in all cases includes a reported head injury	100%	
Moore et al, 2014 [60]	Australia	Young male and female offenders in custody	Not stated (mean 17)	316	Self-administered survey	Head injury 'where they became unconscious or "blacked out"'	32%	
						'Moderate/severe' TBI, with LOC of more than 60 minutes	8.2%.	
Perron and Howard, 2008 [61]	US	Young male and female offenders in custody	11-20	720	Interviews administered by trained team of interviewers	Head injury causing unconsciousness for more than 20 minutes.	18.3%	

Table 2. Studies reporting on the prevalence of TBI amongst young people

Reference	Country	Population	Age range	Sample size	Data collection method	Definition of TBI	Prevalence rate
Ilie et al, 2013 [62]	Canada	Male and female students aged 11-20 years	11-20	8915	Self-administered questionnaire	Head injury resulting in LOC for at least 5 minutes or overnight hospitalization	20.2%
McKinley et al, 2008 [63]	New Zealand	Males and females at age 25	0-25	1003	Birth cohort study. Reports of TBI based on medical records from 4 months to 16 years, and self report of medical attendance from 16 to 25 years old	A blow to the head for which medical treatment was sought and a diagnosis of concussion was given	31.6%
Riley et al, 1996 [64]	US	Male and female public school students, aged 11 to 17 years	11-17	2712	Self-administered questionnaire	Taken from the Child Health and Illness Profile, Adolescent Edition in which head injury is considered as an 'acute major disorder'	4.7%
Segalowitz and Lawson, 1995 [65]	Canada	Male and female high school students	14-18	1123	Self-administered questionnaire	Any form of head injury	35%
						Head injury with concussion	14.9%
Segalowitz and Brown, 1991 [66]	Canada	Male and female high school students	14-18	616	Self-administered questionnaire	Any form of head injury	31.2%
						Head injury with concussion	15.5%