Validating the Brain Injury Screening Index (BISI) and the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID) as Screening Tools for Head Injury in a Scottish Prison Setting

& Clinical Research Portfolio

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Chapter One: Systematic Review

Head Injury in Female Prisoners

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Abstract

Objective: Head injury (HI) is associated with offending behaviour. Both the National Health Service (NHS) and the Scottish Government are now prioritising the needs of people with HI in prison. Initial research has shown that the prevalence of HI among female prisoners may be high. This paper systematically reviews the literature on females with HI in prison, with a view to improving understanding around need and service provision.

Methods: Electronic databases were searched for relevant research (PsycINFO, CINAHL, EMBASE, Medline®, Web of Science, Wiley Cochrane Library)**.** Two published meta-analyses and two published systematic reviews were reviewed to identify further relevant papers. Papers were assessed for risk of bias.

Results: Twelve studies were included. Prevalence of self-reported HI ranged from 21-72%. There is a broad suggestion that the experiences and needs of female prisoners with HI may differ from their male and female counterparts. Risk of bias was high overall, with differences between studies in their assessment and definition of HI. Further, the representativeness of samples was often not clear.

Conclusion: There is an indication that the needs of female prisoners with HI require very specific consideration in terms of service provision. Future research must address the limitations highlighted here in order to strengthen the current evidence base.

Keywords: systematic review, prison, head injury, female

Introduction

Head injury (HI) is associated with offending behaviour. Two meta-analyses on prisoners with HI estimated a lifetime prevalence of 51% (Farrer and Hedges, 2011) and 60% (Shiroma et al, 2010). These figures are high compared to an estimated prevalence of 12% in the general population (Frost et al, 2013).

It is thought that the psychological changes associated with HI, such as reduced mentalisation capacity and increased impulsivity, can precipitate offending behaviour (Levinson & Fonagy, 2004; Miller, 1999). Other studies have found that HI commonly results in disability and impaired cognitive function (e.g. Whitnall et al, 2006). This raises important questions about HI in prison settings, and is particularly relevant in light of the recent transfer of prison health care from the Scottish Prison Service (SPS) to NHS Scotland. Addressing the needs of people with HI in prison is now a priority for the NHS and the Scottish Government (NPHN, 2016).

There is an issue with the lack of female data in the literature. When studies gather female data it is often not separated from male data and reported in its own right. For example, a meta-analysis on the prevalence of HI in incarcerated groups (Farrer and Hedges, 2011) examined 24 studies with a total of 5049 participants; they reported that the majority of participants were male, and did not report data for female participants separately. A recent review of the prison literature by Allely (2016), reported that whilst there were 17 prison-based studies on HI, only seven collected both male and female data, and two of these did not report this data separately. This bias in reporting is probably due to the relatively small number of female offenders in the prison population, and female data that is collected may be insufficient for separate statistical analysis (Timonen et al, 2002).

The meta-analysis by Shiroma et al (2010) carried out sub-group analyses on gender, combining four studies with a total n=387 females. In those with a minimum injury severity of any loss of consciousness (LOC), the prevalence of HI in females was 55%. This was similar to the estimate of 59% in males, and standard errors were comparable in both sub-groups. This suggests that despite the relative dearth of female data, HI is highly prevalent in both male and female offenders.

Given this evidence for a high prevalence of HI in female offenders, it is problematic if female prison services are largely based on data for males. A recent systematic review investigated HI and co-occurring problems in prisoners (O'Rourke et al, 2016). It briefly reported the female literature and concluded that the needs of female prisoners with HI differ from their male counterparts. However, they did not consider the risk of bias in these studies. Further, they did not comment on how the needs of female prisoners with HI might differ from non-HI females. The current review evaluates whether the needs of female prisoners with HI are distinct, and if so, factors that prison services may need to consider in terms of service provision.

Review Questions

1. What is the prevalence of HI among female prisoners?
2. Does the epidemiology of HI differ in female and male prisoners (i.e. age, cause and severity of injury)?
3. What is the impact of HI upon female prisoners, in terms of ongoing disability?
4. How might the needs of female prisoners with HI differ from:
    a. Male prisoners with HI?
    b. Female prisoners without HI?

Methods

Inclusion and exclusion criteria

For comparative purposes, only quantitative studies were eligible for inclusion. To be included, studies must meet the following criteria:

Female participants are included in the sample, are serving a custodial sentence, and have had a HI.

Search strategy

The search and selection strategy was carried out by one researcher. The following databases were searched for research published by the 16th June 2017:

- Ebsco PsycINFO
- Ebsco CINAHL
- Ovid EMBASE
- Ovid Medline®
- Web of Science
- Wiley Cochrane Library

Search terms were chosen by examining relevant published systematic reviews (NPHN, 2016, O'Rourke et al, 2016; O'Sullivan et al, 2015). The following text word searches were used in the above databases:

1. (("Traumatic Brain Injury" OR TBI OR "Head Injur*"))
2. ((crim* OR inmate* OR prison* OR offend*))
3. ((sex OR gender OR female OR wom?n))
4. 1 AND 2 AND 3

To search for the phrase ‘Traumatic Brain Injury’, the following were used:

- “Traumatic Brain Injury” in EBSCO, OVID and Web of Science
- *Traumatic Brain Injury* in Wiley Cochrane Library

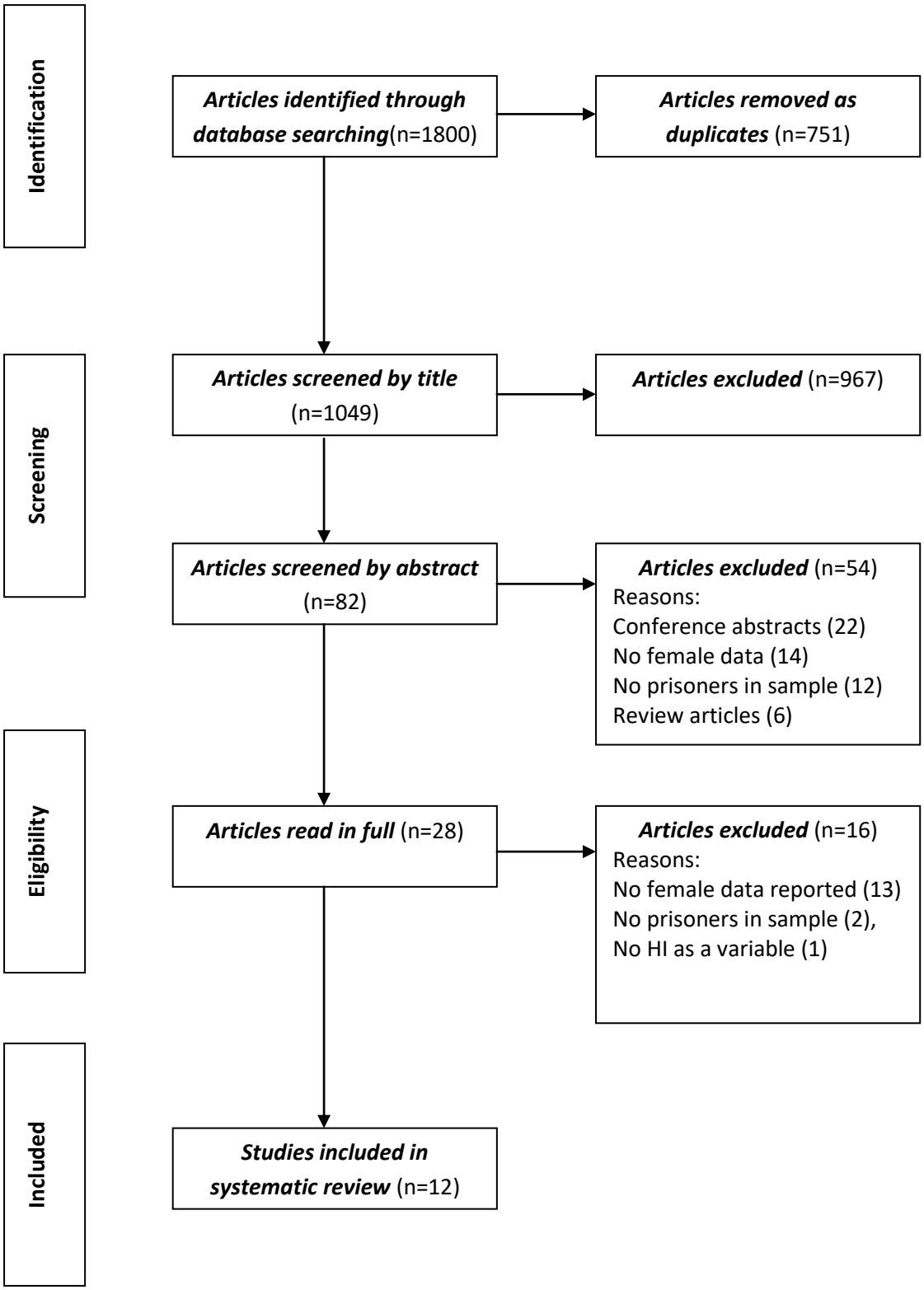
Additionally, the papers included in two published meta-analyses (Shiroma et al, 2010; Farrer & Hedges, 2011) and two published systematic reviews (O’Sullivan et al, 2015; O’Rourke et al, 2016) were reviewed to identify further relevant papers. This search found four articles that reported female data which were not identified by the initial search terms. Following from this, text word search 3 was removed and the search was repeated as follows:

1. ((“Traumatic Brain Injury” OR TBI OR “Head Injur*”))
2. ((crim* OR inmate* OR prison* OR offend*))
3. 1 AND 2

This revised search detected the four papers missing from the original search. This is perhaps symptomatic of the problem discussed above, in that gender is not included within article keywords, titles or abstracts.

After removing duplicates, 1049 articles were identified. On screening for relevance, 967 were excluded by title and a further 54 by abstract. The author read 28 articles in full. From this, 16 articles were excluded; of these, thirteen did not report any female data, two did not sample from a prison population, and one did not assess HI. Twelve studies were included in the final review (see figure 1).

Figure 1. Flow chart detailing included/excluded studies



Quality Rating

Seven domains were derived from the research questions (see table 1) and from criteria developed for use in observational studies in epidemiology (Sanderson et al, 2007) and modified for use in systematic reviews of HI and offending (Moynan & McMillan, in press). For studies to be rated as low in risk of bias, the criteria within table 1 must be met. Articles were rated independently in each domain by two raters. There was inter-rater concordance for 78/84 ratings (93%). The six exceptions were resolved by discussion. For each article, domains were categorised as 'high' or 'low' risk of bias (see table 2). Where data were collected but not reported separately for male and female participants, domains were categorised as 'not reported' (N/R). Where domains did not apply, they were categorised as 'not applicable' (N/A).

Table 1. Domains and criteria for assessing risk of bias

Domain	Criteria
1. Methods for selecting study participants	Inclusion and exclusion criteria are clear.
2. Design-specific confounders	Sample should be demographically representative of: (i) the larger offender population from which it is taken (e.g. a particular prison), *and*; (ii) the offender population in the larger geographical area.
3. Methods to control confounding	These may include methods to control confounding for factors including, but not limited to: (i) current misuse of substances; (ii) whether hospital records were cross-referenced with self-reported HI.
4. Methods for assessing the prevalence of HI in female prisoners	(i) Use of assessment tools which have been validated in a prison population; (ii) Use of definitions of HI severity which are internationally recognised; (iii) Use of a matched control group is also desirable.
5. Methods for assessing the epidemiology of HI in female prisoners	Where such data is collected, it is statistically compared with male prisoners, e.g.: (i) Age at HI; (ii) Cause, number and severity of HI.
6. Methods for assessing the impact of HI	Where disability is assessed, this should be:

upon female prisoners, in terms of ongoing disability, mental health and neuropsychological outcomes	(i) Using tools which are relevant to outcomes in HI; (ii) Statistically compared with the prevalence of these outcomes to those in: (a) female prisoners without HI *and/or* (b) male prisoners with HI.
7. Methods for assessing how the needs of female prisoner with HI differ from other prisoner groups	Where needs are assessed (e.g. early experiences, substance misuse, recidivism, in-prison behaviour: incident reports and use of services) this data is statistically compared with: (i) female prisoners without HI *and/or* (ii) male prisoners with HI.

Results

Nine of the 12 studies included (see summary in table 3) sampled from adult prison populations and 2 from juvenile prisons. One study included adult and juvenile prisoners (Durand et al, 2016), although only 1 juvenile with HI participated.

In relation to the questions in this review, risk of bias was low for two domains, mixed for two domains and was high for three domains (see table 2).

All but one paper detailed inclusion and exclusion criteria. However, all but one study (Shiroma et al, 2010,) was high in risk of bias in terms of the representativeness of their samples. One study used a sample that was representative of the prison itself, but it was not clear if it represented the prison population in the wider prison system (Slaughter et al, 2003). Others (Brewer-Smyth et al, 2004; Brewer-Smyth and Burgess, 2008; Durand et al, 2016) reported that their sample was representative, but did not provide data to support this. The remaining studies did not report representativeness or were not demographically representative (Diamond et al, 2007; Fishbein et al, 2016, Kaba et al, 2014, Moore et al, 2014, Nolan et al, 2017). In assessing HI, all studies had high risk of bias in their methods to control confounding; for example none controlled for potential effects of current substance misuse. Two studies used medical records to corroborate self-report (Brewer-Smyth et al, 2004; Brewer-Smyth & Burgess, 2008), but it is not clear what type of records they used or if they accessed records for all participants (see table 3).

Table 2. Risk of bias

	Methods for selecting study participants	Design-specific confounders	Methods to control confounding	Methods for assessing the prevalence of HI in female offenders	Methods for assessing the epidemiology of HI in female prisoners	Methods for assessing the impact of HI upon female offenders	Methods for assessing how the needs of female offenders with HI differ from other offender groups
Brewer-Smyth 2008	HIGH	HIGH	HIGH	HIGH	HIGH	N/A	N/A
Brewer-Smyth 2004	LOW	HIGH	HIGH	HIGH	N/A	N/A	LOW
Colantonio 2014	LOW	HIGH	HIGH	HIGH	LOW	N/A	LOW
Diamond 2007	LOW	HIGH	HIGH	N/R	LOW	N/R	N/R
Durand 2016	LOW	HIGH	HIGH	HIGH	LOW	N/A	LOW
Ferguson 2012	LOW	HIGH	HIGH	HIGH	HIGH	HIGH	N/A
Fishbein 2016	LOW	HIGH	HIGH	HIGH	LOW	LOW	N/A
Kaba 2014	LOW	HIGH	HIGH	HIGH	HIGH	LOW	LOW
Moore 2013	LOW	HIGH	HIGH	HIGH	LOW	HIGH	N/A
Nolan 2017	LOW	HIGH	HIGH	HIGH	N/A	N/A	N/A
Shiroma 2010	LOW	LOW	HIGH	HIGH	HIGH	N/A	LOW
Slaughter 2003	LOW	HIGH	HIGH	HIGH	N/A	N/R	N/A

Table 3. Summary of included papers

Reference	Sample	HI measure and definition	Prevalence	Epidemiology of female HI compared to male HI	Disability	Needs
Brewer-Smyth & Burgess, 2008[1]	149 adult femals from minimum and maximum security units of a USA women's prison Mean age: 34.59 (no history of family childhood sexual abuse (CSA); 34.16 (history of family CSA)	Measure: As for Brewer-Smyth et al, 2004 Definition: Any HI with LOC	Not assessed (recorded as mean number of HI per participant)	Not assessed	Not assessed	Female victims of childhood sexual abuse by a family member experienced more HIs (OR = 1.49, p = .01) compared with those not sexually abused by a family member.
Brewer-Smyth et al, 2004[1]	133 adult females from minimum and maximum security units of a USA women's prison Mean age: 32.86 (violent); 33.57 (non-violent)	Measure: Self-report interview corroborated by criminal and medical records (where available), physical evidence of injuries/deficits – examination carried out (three-word recall, cranial nerves, extremity strength, coordination, gait) Definition: Any HI with LOC	42%	No comparison to male prisoners The mean number of HI was significantly higher for violent (n=1.75) than non-violent (n-0.74) offenders Most HI occurred as a result of violence and/or during high-risk behaviours, such as substance abuse	Not assessed	Not assessed
Colantonio et al, 2014	Four Canadian prisons: three male (n=131) and one female (n-104) Mean age: Male HI: 32.5; no HI: 36.6 Female HI: 35.1, no HI: 33.6	Measure: Self-report interview Definition: Any HI, with or without LOC LOC < 30 = mild; LOC > 30 = moderate/severe	38% 27% HI with LOC	Significantly more likely than men to have had HI prior to criminal involvement	Not assessed	After first HI, females with HI has significantly higher substance abuse and alcohol use than men. Females with HI had significantly higher rates of abuse than females without HI and males overall

Reference	Sample	HI measure and definition	Prevalence	Epidemiology of female HI compared to male HI	Disability	Needs
Diamond et al, 2007	Males (n=107) and females (n=118) from six low, medium, and high security USA prisons. Mean age: Male=34; female = 36; total = 35	Measure: Traumatic Brain Injury Questionnaire Definition: Any HI, with or without LOC Suspected/minimal HI: no reported alteration of consciousness/PTA Mild HI: LOC < 1 hour, PTA < 1 day Mod/sev HI: LOC > 1 hour, PTA > 1day	Not reported separately for gender.	No significant difference in number of HIs between males and females Higher percentage of females than males reported cause of HI as assault. Females less likely than males to report HI with LOC.	Not reported separately	Not reported separately
Durand et al, 2016	Paris prison – adult (n=88) and juvenile (n=12) females. Both who have been sentenced and are on remand Mean age: Adult: 32.4, juvenile: 15.5	Measure: Self-report interview Definition: All HI with or without LOC Severe : coma Moderate: hospitalization without coma Mild: all other HI	21% 10% HI with LOC	No significant differences in cause, but violence was the first cause in women (35%), and equal first cause with road traffic accidents in men (26 vs 27%). No significant difference in age at first HI, though females were older (20.7 yrs vs 18.5yrs). No significant difference in severity.	Not assessed	Compared with females who did not report a HI: • Higher epilepsy • Higher use of alcohol • Worse perceived health Compared with males with HI: • Worse perceived health • More use of anxiolytics and anti-depressants • Less use of cannabis

Reference	Sample	HI measure and definition	Prevalence	Epidemiology of female HI compared to male HI	Disability	Needs
Ferguson et al, 2012[2]	Male and female prisoners in South Carolina, USA Release prisoners: completed sentence: 267 female, 175 male; parole: 15 female, 19 male Non-release prisoners: life/death sentence: 34 female, 26 male Mean age: Completed sentence: Male 34; female 35 Paroled: 34 male; 36 female Life/death: 40 male, 42 female	Measure: OSU TBI-ID Definition: Any HI with and without LOC	72% 50% HI with LOC	HI was more common and more severe in female release prisoners compared with male release. The opposite effect was the case for non-release prisoners. A higher proprotion of females than males overall reported HI before age 15. The only exception to this was release prisoners, where less females than males had HI with LOC before age 15.	55% of female releases and 58% of nonreleases reported ongoing symptoms from HI (measured by a checklist)	Not assessed
Fishbein et al, 2016[2]	Male (n=320) and female (n=316) prisoners in South Carolina, USA Mean age: Males=34.8; females= 36.1; total=35.5	Measure: OSU TBI-ID Definition: All HI with or without LOC	71.5% 47.5% HI with LOC	Females reported an older mean age at first HI and HI with LOC	Being female was associated with a lower level of total aggression after cognitive and emotional dysregulation are taken in to account	Not assessed
Kaba et al, 2014	Male (n=300) and female (n=84) juvenile prisoners in New York, USA. Mean age: 17.1	Measure: Traumatic Brain Injury Questionnaire Definition: One or more HI with LOC/PTA	49%	An equal proportion of males and females had no injury (30%), multiple mild injuries (20%), and one or more injury with LOC/PTA (50%).	HI females reported significantly higher scores than HI males on TBIQ symptom severity and frequency scales	No comparison with females without HI HI females significantly more likely to use mental health services than HI males HI females significantly less likely to reoffend than HI males

Reference	Sample	HI measure and definition	Prevalence	Epidemiology of female HI compared to male HI	Disability	Needs
Moore et al, 2014	Male (n=277) and female (n=39) juvenile prisoners in Australia. Mean age: 17	Measure: Self-report interview Definition: HI with LOC Mild: LOC < 30 Moderate/severe: LOC > 30	33%	No gender difference in prevalence of TBI Females more likely to report recent HI than males Females more likely to report assault as cause than males	Females report ongoing neurological effects of HI significantly more frequently than men	N/A
Nolan et al, 2017	Female Canadian prisoners (n=280) (results compared to previous male study (n=2273) (Stewart et al, 2015) Median age: 31.5	Measure: Comprehensive health assessment questionnaire Definition: Not known	26%	Not assessed	Not assessed	Not assessed
Shiroma et al, 2010[2]	Male (20,098) and female (n=1518) prisoners in South Carolina. Median age: male HI: 20, male no HI: 33, female HI: 34, female no HI: 36	Measure: Hospital records of medically attended HI – ICD code at discharge Definition: Mild = ICD-9-CM/AIS 2 Moderate/severe = >3	6%	Not assessed	Not assessed	A smaller proportion of females with HI than males with HI had in-prison infractions The violent behavioral infraction rate was significantly increased in females with HI compared with no HI
Slaughter et al, 2003	Washington prisoners (63 male, 6 female) Age bands for total sample: 18-29: 44%; 30-39: 29%; 40-49: 25%; 50-59: 2%	Measure: Self-report interview Definition: Any HI, with or without LOC Mild < 30 LOC, alteration of mental status, or loss of memory Moderate/sev – any greater	100%	5 of six females reported HI in past 12 months (compared with a third of males – but small female sample size makes group comparison difficult)	Not reported separately	Not assessed

LOC: loss of consciousness; PTA: post-traumatic amnesia; OSU TBI-ID: Ohio State University Traumatic Brain Injury Identification Method; ICD-9-CM: International Classification of Diseases, Ninth Revision, Clinical Modification; AIS: Abbreviated Injury Scale; [1] and [2] indicate where samples may have overlapped

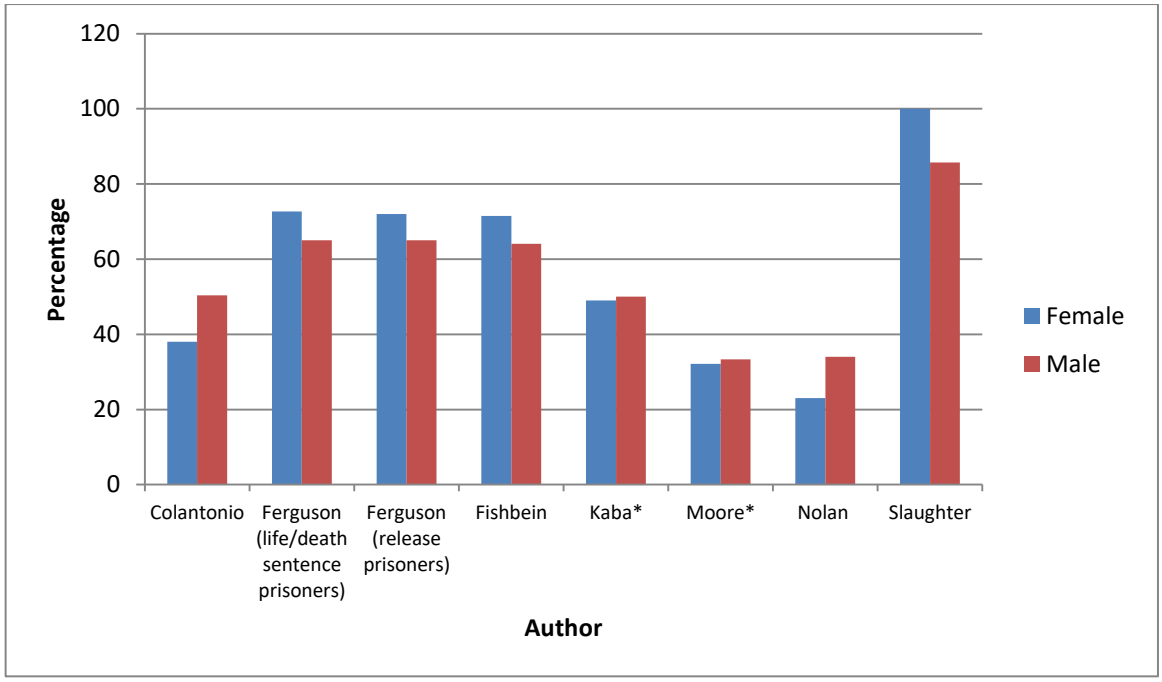
What is the prevalence of HI among female prisoners?

Prevalence of HI in females was reported in 8 adult and 2 juvenile studies and all were high in risk of bias. Self-report studies on adult prisoners found a prevalence of 21-72%, excluding one study with a small n=6 (Slaughter et al, 2003), which reported that 5/6 females in their sample had experienced a HI in the past 12 months. Prevalence was considerably lower in a large study, which used hospital records to investigate medically attended HI (6%) (Shiroma et al, 2010). Studies on HI with LOC report a prevalence of 10-50%. In the two papers on juveniles, the prevalence of HI with LOC was 49% (Kaba et al, 2014) and 33% (Moore et al, 2014). Another study found that 1/ 12 female juvenile participants had a history of HI (Durand et al, 2016). Only one adult study (Colantonio et al, 2014: 19% LOC < 30 minutes; 14% LOC > 30 minutes) and one juvenile study (Moore et al, 2014: 28% LOC < 30 minutes; 4% LOC > 30 minutes) used internationally recognised definitions of HI severity (Carroll et al, 2004) and reported the prevalence of these by gender.

Seven studies reported prevalence for both male and female participants (see figures 2, 3 and 4), though only two examined this statistically (Moore et al, 2014; Fishbein et al, 2016). Of the juvenile studies, Moore et al (2014) reported no significant difference in prevalence of HI (any HI) between male and female participants. Kaba et al (2014) reported equal prevalence rates. Of the adult studies, Fishbein et al (2016) reported a significantly higher prevalence of HI (any HI) in female participants. Rates reported in other studies were mixed, but none examined the differences statistically. No studies that report HI prevalence compare prisoners with the general population. Only 2/8 adult studies (Fishbein et al, 2016; Ferguson et al, 2012) and one juvenile study (Kaba et al, 2014) used a HI screening tool which is validated in a prison population. Overall, the

prevalence of HI seems to be similar in female and male prisoners, but methodological limitations make it difficult to make confident estimates about prevalence.

Figure 2. Prevalence of HI (any HI) in females compared with males



*Studies are with adult participants except where denoted, * = juvenile sample*

Figure 3. Prevalence of HI with LOC (any duration) in adult female and male prisoners

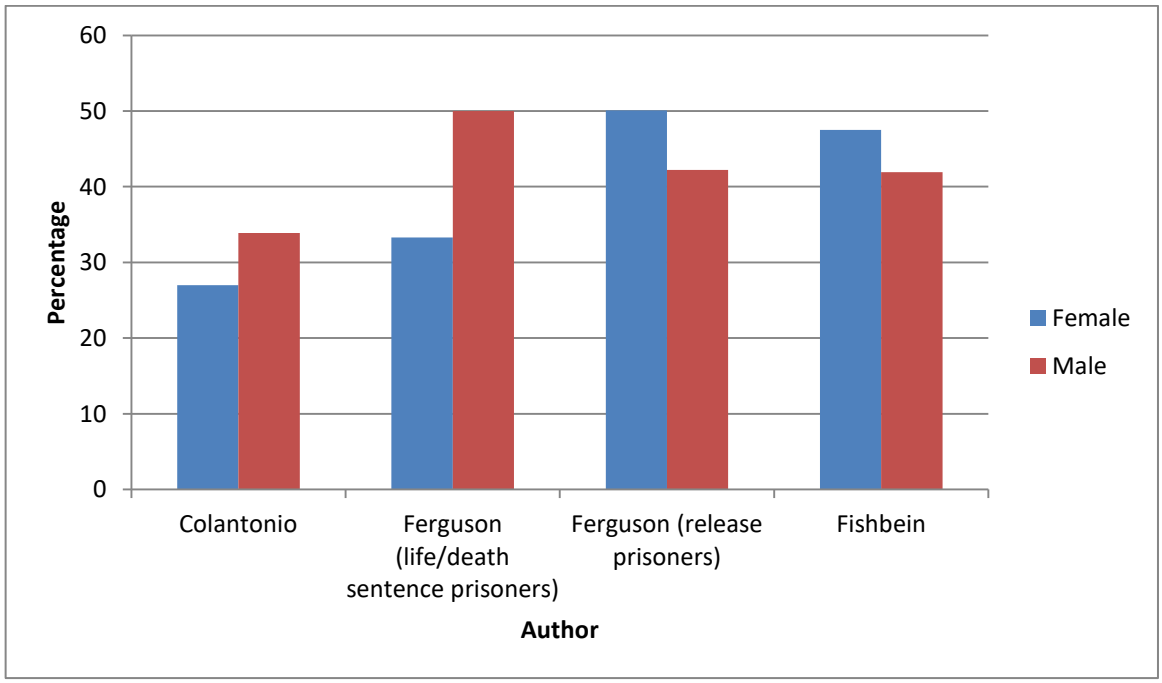
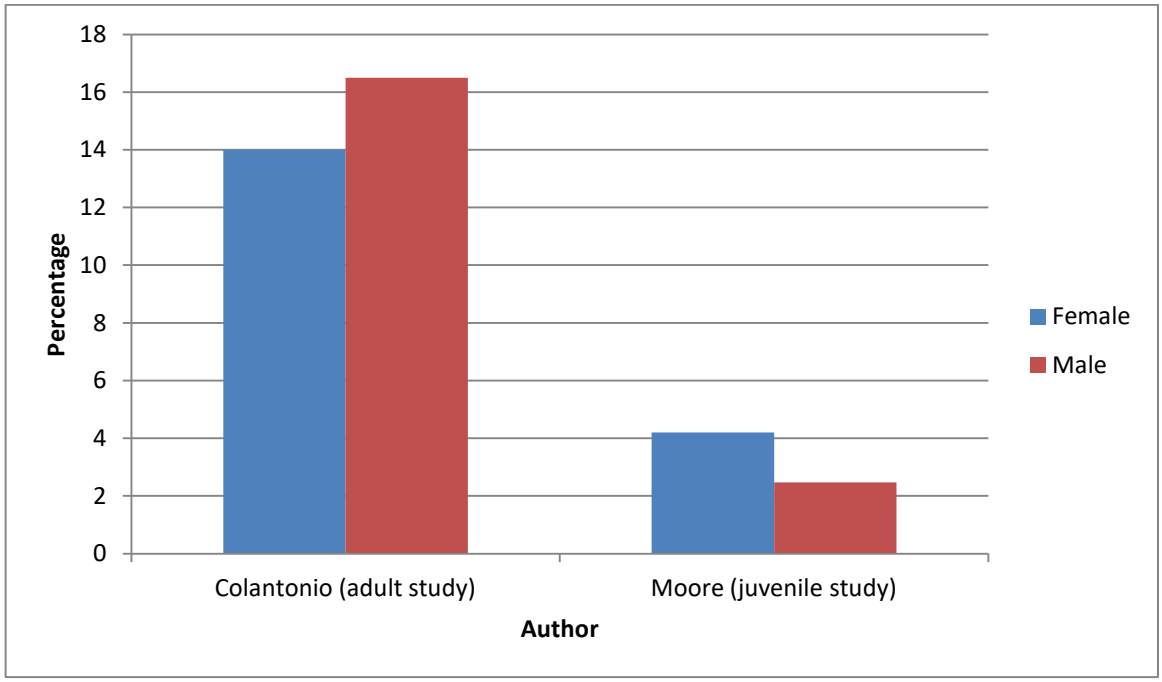


Figure 4. Prevalence of HI with LOC (> 30 minutes) in female and male prisoners



Does the epidemiology of HI differ in female and male prisoners?

Eight studies investigated the epidemiology of HI in adult female prisoners. Four were low in risk of bias (Colantonio et al, 2014, Diamond et al, 2007, Durand et al, 2016, Fishbein et al, 2016) in this domain, and compared female and males. Of these, three studies (Fishbein et al, 2016, Durand et al, 2016, Colantonio et al, 2014) looked at age at first HI and one found females to be older than males (Fishbein et al, 2016). Two studies reported the number of HI; one found no significant gender difference (Diamond et al, 2007), and the other that females were more likely to report more than one HI than males (Durand et al, 2016). Three studies looked at HI severity. Two of these found no gender difference (Colantonio et al, 2014; Durand et al, 2016), and one found that females were significantly less likely to report HI with LOC (Diamond et al, 2007). Two studies found that females were more likely to report assault as the cause of HI (Diamond et al, 2007; Durand et al, 2016), and this was significant in Diamond et al (2007). One paper looked at HI relative to first criminal involvement, and found that females were significantly more

likely than males to report HI prior to their first criminal involvement (Colantonio et al, 2014).

Only one of the juvenile studies (Moore et al, 2014) was low in risk of bias, and found no gender difference in severity or number of HI, but found that females were more likely to report recent HI and assault as cause.

Four studies were high in their risk of bias in this domain (Brewer-Smyth et al, 2004; Ferguson et al, 2012; Shiroma et al, 2010; Slaughter et al, 2003). One of these (Brewer-Smyth et al, 2004) investigated epidemiology and found that most females reported assault as cause and that HI was more common among violent than non-violent female offenders, and did not compare this with male prisoners. The other three did not statistically consider gender effects. This comparison was able to be calculated as part of the current review for Shiroma et al (2010); the proportion of males and females with moderate to severe HI did not differ (χ^2=2.01, p=0.16).

What is the impact of HI upon female prisoners?

No studies examined disability after HI using a validated measure (e.g. the Glasgow Outcome Scale Extended or the Glasgow Outcome at Discharge Scale (Wilson et al, 1998, McMillan et al, 2013)). Four studies assessed mental health and neuropsychological outcomes after HI. Three of these did not report this data separately by gender (adult studies: Diamond et al, 2007; Slaughter et al, 2003, juvenile studies: Moore et al, 2014). Fishbein et al (2016) used validated measures to assess aggression (the Buss Perry Aggression Questionnaire) and dysregulation (Abbreviated Dysregulation Inventory) in a study that was low in risk of bias. After controlling for cognitive and emotional dysregulation, they found that aggression was associated with HI in males but not females.

Other adult (Ferguson et al, 2012) and juvenile (Kaba et al, 2014; Moore et al, 2014) studies examined impact by looking at symptom reporting. Only one (Kaba et al, 2014) used a validated outcome measure (the symptom scales from the TBIQ) and was low in risk of bias. All three studies found that females were significantly more likely to report ongoing symptoms (including headaches, poor sleep, poor concentration, memory loss and difficulties with balance) than males.

How might any other needs of female prisoners with HI differ from male prisoners with HI and female prisoners without HI?

Four adult studies (Brewer-Smyth & Burgess, 2008; Colantonio et al, 2014; Durand et al, 2016; Shiroma et al, 2010) and one juvenile study (Kaba et al, 2014) examined other needs of female prisoners with HI; all were low in their risk of bias in this domain. One study looked at history of abuse across a range of indicators, and found that females with HI more often reported a history of physical and sexual abuse than females without HI. They also reported that females with HI reported higher rates of abuse than males, although the type of abuse is not clear (Colantonio et al, 2014). Females with a history of childhood sexual abuse by a family member reported more HI than those not abused by a family member (Brewer-Smyth & Burgess, 2008). Two papers found that use of alcohol and drugs was higher in females than in males (Durand et al, 2016; Colantonio et al, 2014), particularly after first HI (Colantonio et al, 2014). The exception was use of cannabis, which was higher in males in one study (Durand et al, 2016). One study (Durand et al, 2016) reported poorer physical and mental health outcomes in females with HI, including more frequent diagnoses of epilepsy than in non-HI female prisoners. Further, they found more common use of anxiolytics and anti-depressants in female than in male prisoners with HI. Finally, they found that female prisoners with HI reported worse perceived health

than both males with HI and females without HI. Finally, Shiroma et al (2010) found that females with HI were 2.44 times more likely to have in-prison violent infractions than females without HI.

The juvenile study by Kaba et al (2014) found that females with HI were significantly more likely to use mental health services than males, and were significantly less likely to be recidivists.

Discussion

What is the prevalence of HI among female prisoners?

Previous meta-analyses report a pooled prevalence of HI in all prisoners of 50-60% (Shiroma et al, 2010; Farrer & Hedges, 2011), and 55% for female prisoners (Shiroma et al, 2010). However, neither meta-analysis assessed quality or bias. None of the studies included here were low in risk of bias, though studies generally indicate that prevalence of HI in females in prison is significantly higher than in the general population (self-report: 21-72%). However, prevalence figures vary widely across studies, as do definitions of HI and methods used to assess prevalence. The overarching high risk of bias makes it difficult to reach a conclusion about prevalence of HI in female prisoners with confidence.

Does the epidemiology of HI differ in female and male prisoners?

Studies which statistically compare females and males indicate that the epidemiology of HI may differ. Results from studies high in risk of bias are mixed, but those low in risk of bias suggest that females tend to be older at first HI, and are more likely to report assault as the cause. Other findings are less consistent across studies, such as gender differences in the number and severity of HI.

Further work is required, however these findings suggest potentially important considerations for prison services. Women are more likely to report physical assault as the cause of their HI. It is possible that some of these assaults occur in the context of intimate partner violence, which has significant associations with trauma and depression (Mitchell & Anglin, 2009; Golding, 1999). If this were the case, services for HI females in prison may need to develop in a very trauma-informed way. This is speculative at this stage and is beyond the scope of the current review, however it is an area that merits further research.

Whilst there were studies that were low in their risk of bias in assessing epidemiology, they are limited by a lack of matched controls, potential use of unrepresentative samples, and failure to control for potential sources of confounding. Further, the issues discussed above in relation to the assessment and definition of HI will affect any aspect of HI examined. Studies with high risk of bias are further limited by their lack of comparison with male prisoners. In line with the conclusion from O'Rourke et al (2016), this review agrees that there is an indication that the epidemiology of HI may differ between male and female prisoners but caution is required given the limited evidence base.

What is the impact of HI upon female prisoners, in terms of ongoing disability?

There is a dearth of research looking at the functional impact of HI on female prisoners. Non-prison studies have found that severe HI commonly results in persisting disability (Whitnall et al, 2006). Studies on prisoners indicate that females have more ongoing symptoms after HI than males, but the quality of the evidence is low, as all but one study failed to use validated measures of cognition, mental health or disability. Females with HI were less aggressive than males after controlling for cognitive and emotional dysregulation (Fishbein et al, 2016), but services cannot be based on findings from one study.

How might other needs of female prisoners with HI differ to male prisoners with HI and female prisoners without HI?

Studies have begun to suggest that the needs of female prisoners with HI may differ from males with HI and females with no HI. Complex trauma, poor physical and mental health, and high alcohol and substance misuse appear to be more common in female prisoners with HI (Brewer-Smyth & Burgess, 2008; Colantonio et al, 2014; Durand et al, 2016; Kaba et al, 2014). This is likely to have implications for interagency working between prison

and health services, and may require an increase in access to psychological therapy as well as support from third sector organisations (NPHN, 2016). Further, there is initial evidence that female prisoners with HI are more likely to have in-prison disciplinary incidents for violent behaviour (Shiroma et al, 2010). If this evidence is replicated in future research, this will have implications for giving management advice to prison staff. However, only four adult and one juvenile study have investigated the other needs of female prisoners with HI. Although they are all low risk of bias, synthesis of their findings is complicated by high risk of bias in other domains, such as representativeness and definition of HI.

Limitations

Only one researcher was involved in the process of searching for and selecting appropriate papers. Results are only relevant to Western countries due to the lack of geographic variation between studies, and comparison between countries is further complicated by variation in their legal systems. The majority of studies were carried out with samples from the USA (n=8), whilst others were based in Canada (n=2), France (n=1), and Australia (n=1). Five of the USA studies may have had samples that overlapped with others that were included. In addition, only studies published in English were included.

Future research

Research on female prisoners with HI needs improvement and expansion. It should recruit samples which are demographically representative of the wider prison population, and use prison and general population comparisons. Self-report of HI should be corroborated with hospital records, and studies should control for potentially confounding factors such as current substance use. A uniform approach to HI severity definition, in line with established cut-offs, is required (Carroll et al, 2004). This will make it easier to compare studies and will aid in building a strong evidence base. Studies should also use validated

tools to assess HI and associated disability. The epidemiology of HI in female prisoners should be compared with their male counterparts. Finally, studies examining the characteristics of female prisoners with HI (e.g. early experiences, drug and alcohol use, physical and mental health, and in-prison behaviour), should compare female offenders with and without HI as well as males with HI. Such comparisons will inform thinking around differential need and in turn, recommendations about potential differences in service design and intervention for female prisoners with HI.

Conclusion

Research on female prisoners with HI is limited by a high risk of bias, making it difficult to draw firm conclusions about the questions of this review. The evidence broadly suggests that HI is prevalent in female prisoners, and that their needs and experiences may differ from females without HI and males with HI in prison. Studies with lower risk of bias suggest that prison services for females with HI may require very specific considerations (e.g. the need for trauma-informed services). Future research needs to carefully consider how to resolve the limitations in the current literature. This will help build a valid evidence base upon which services and interventions for female prisoners with HI can be developed.

References

Allely, C.S., 2016. Prevalence and assessment of traumatic brain injury in prison inmates: A systematic PRISMA review. *Brain Injury*, 30 (10), pp.1161-1180.

Brewer-Smyth, K. & Burgess, A. W., 2008. Childhood sexual abuse by a family member, salivary cortisol, and homicidal behavior of female prison inmates. *Nursing Research*, 57, pp.166-174.

Brewer-Smyth, K., Burgess, A. W. & Shults, J., 2004. Physical and sexual abuse, salivary cortisol, and neurologic correlates of violent criminal behavior in female prison inmates. *Biological Psychiatry*, 55, pp.21-31.

Carroll, L.J., Cassidy, J.D., Holm, L., Kraus, J. & Coronado, V.G., 2004. Methodological issues and research recommendations for mild traumatic brain injury: The WHO collaborating centre task force on mild traumatic brain injury. *Journal of Rehabilitative Medicine*, 43, pp.113-125.

Colantonio, A., Kim, H., Allen, S., Asbridge, M., Petgrave, J. & Brochu, S., 2014. Traumatic brain injury and early life experiences among men and women in a prison population. *Journal of Correctional Health Care*, 20, pp.271-279.

Diamond, P. M., Harzke, A. J., Magaletta, P. R., Cummins, A. G. & Frankowski, R., 2007. Screening for traumatic brain injury in an offender sample: A first look at the reliability and validity of the Traumatic Brain Injury Questionnaire. *The Journal of Head Trauma Rehabilitation*, 22, pp.330-338.

Durand, E., Watier, L., Fix, M., Weiss, J. J., Chevignard, M., & Pradat-Diehl, P., 2016. Prevalence of traumatic brain injury and epilepsy among prisoners in France: Results of the Fleury TBI study. *Brain injury*, *30*(4), pp.363-372.

Farrer, T. J., & Hedges, D. W., 2011. Prevalence of traumatic brain injury in incarcerated groups compared to the general population: A meta-analysis. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 35(2), pp.390-394.

Ferguson, P. L., Pickelsimer, E. E., Corrigan, J. D., Bogner, J. A. & Wald, M., 2012. Prevalence of traumatic brain injury among prisoners in South Carolina. *Journal of Head Trauma Rehabilitation,* 27, E11-E20.

Fishbein, D., Dariotis, J. K., Ferguson, P. L. & Pickelsimer, E. E., 2016. Relationships Between Traumatic Brain Injury and Illicit Drug Use and Their Association With Aggression in Inmates. *International journal of offender therapy and comparative criminology,* 60, pp.575-597.

Frost, R. B., Farrer, T. J., Primosch, M., & Hedges, D. W., 2013. Prevalence of traumatic brain injury in the general adult population: A meta-analysis. *Neuroepidemiology*, *40*(3), pp.154-159.

Golding, J.M., 1999. Intimate partner violence as a risk factor for mental disorders: A meta-analysis. *Journal of family violence*, *14*(2), pp.99-132.

Kaba, F., Diamond, P., Haque, A., Macdonald, R. & Venters, H., 2014. Traumatic brain injury among newly admitted adolescents in the New York City jail system. *Journal of Adolescent Health,* 54, pp.615-617.

Levinson, A. & Fonagy, P., 2004. Offending and attachment: The relationship between interpersonal awareness and offending in a prison population with psychiatric disorder. *Canadian Journal of Psychoanalysis*, 12 (2) pp.225 - 251.

McMillan, T. M., Weir, C. J., Ireland, A., & Stewart, E., 2013. The Glasgow Outcome at Discharge Scale: an inpatient assessment of disability after brain injury. *Journal of Neurotrauma*, *30* (11), pp.970-974.

Miller, E., 1999. Head injury and offending. *The Journal of Forensic Psychiatry,* 10 (1), pp.157-166.

Mitchell, C. & Anglin, D., 2009. Intimate partner violence: A health-based perspective. New York: Oxford University Press.

Moore, E., Indig, D. & Haysom, L., 2014. Traumatic brain injury, mental health, substance use, and offending among incarcerated young people. *Journal of Head Trauma Rehabilitation,* 29, pp.239-247.

Moynan, C. & McMillan, T., 2017. Prevalence of Head Injury and Associated Disability in Prison Populations: A Systematic Review. *Journal of Head Trauma and Rehabilitation*, in press.

National Prisoner Healthcare Network (NPHN)., 2016. Brain Injury and Offending. NPHN.

Nolan, A.M., Stewart, L.A., 2017. Chronic health conditions among incoming Canadian federally sentenced women. *Journal of Correctional Health Care*, 23 (3), pp.93-103.

O'Sullivan, M., Glorney, E., Sterr, A., Oddy, M. & Da Silva Ramos, S., 2015. Traumatic brain injury and violent behavior in females: A systematic review. *Aggression and Violent Behavior*, 25, pp.54-64.

O'Rourke, C., Linden, M. A., Lohan, M. & Bates-Gaston, J., 2016. Traumatic brain injury and co-occurring problems in prison populations: A systematic review. *Brain Injury*, 30, pp.839-854.

Sanderson, S., Tatt, I. D., & Higgins, J. P., 2007. Tools for assessing quality and susceptibility to bias in observational studies in epidemiology: a systematic review and annotated bibliography. *International journal of epidemiology*, *36*(3), pp.666-676.

Shiroma, E. J., Ferguson, P.L. & Pickelsimer, E.E., 2010. Prevalence of traumatic brain injury in an offender population: A meta-analysis, *Journal of Correctional Health Care* 16 (2), pp.147-159.

Shiroma, E. J., Pickelsimer, E. E., Ferguson, P. L., Gebregziabher, M., Lattimore, P. K., Nicholas, J. S., Dukes, T. & Hunt, K. J., 2010. Association of medically attended traumatic brain injury and in-prison behavioral infractions: A statewide longitudinal study. *Journal of Correctional Health Care*, 16, pp.273-286.

Slaughter, B., Fann, J. R. & Ehde, D., 2003. Traumatic brain injury in a county jail population: prevalence, neuropsychological functioning and psychiatric disorders. *Brain Injury*, 17, pp.731-741.

Timonen, M., Miettunen, J., Hakko, H., Zitting, P., Veijola, J., von Wendt, L., &Räsänen, P., 2002. The association of preceding traumatic brain injury with mental disorders, alcoholism and criminality: the Northern Finland 1966 Birth Cohort Study. *Psychiatry research*, *113*(3), pp.217-226.

Whitnall, L., McMillan, T. M., Murray, G. D., & Teasdale, G. M., 2006. Disability in young people and adults after head injury: 5–7 year follow up of a prospective cohort study. *Journal of Neurology, Neurosurgery & Psychiatry*,*77*(5), pp.640-645.

Wilson, J.L., Pettigrew, L.E. and Teasdale, G.M., 1998. Structured interviews for the Glasgow Outcome Scale and the extended Glasgow Outcome Scale: guidelines for their use. *Journal of neurotrauma*, *15*(8), pp.573-585.

Chapter Two: Major Research Project

Validating the Brain Injury Screening Index (BISI) and the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID) as Screening Tools for Head Injury in a Scottish Prison Setting.

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Plain English Summary

Title

Validating the Brain Injury Screening Index (BISI) and the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID) as Screening Tools for Head Injury in a Scottish Prison Setting.

Background

Head injury (HI) has been linked with offending. Accordingly, a report by the National Prisoner Healthcare Network (NPHN, 2016) has recommended the introduction of routine screening for HI in Scottish prisons. Given the high prevalence of HI in Scottish prisons (McMillan et al, in preparation), the purpose of screening would be to identify those who are likely to demonstrate impairment and disability on more detailed assessment. This can potentially reduce future offending through the implementation of appropriate interventions. There is a need to validate a screening tool for this purpose. To validate a tool is to establish that it accurately identifies what it sets out to identify. Two screening tools have shown initial promise with prison populations in England and America, namely the Brain Injury Screening Index (BISI) (Pitman et al, 2015) and the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID), Short Version (Bogner & Corrigan, 2009; Ray et al, 2014).

Aims and Questions

This study examines the extent to which the BISI and the OSU TBI-ID are practical and accurate in identifying HI associated disability in Scottish prisons. The following research questions were examined:

1. To what extent is disability shown in those who are identified as having a HI by the two screening tools?
2. To what extent do the screening tools identify those who are disabled as a result of a HI and those who are not?
3. How practical are the tools to administer in prison settings?

Methods

Participants were recruited from Her Majesty's Prison (HMP) Shotts. They were randomly split into two groups and were screened with either the BISI or the OSU TBI-ID. Information was recorded around the practical aspects of administering these tools for each participant (time taken to administer, whether or not extra clarification/explanation was required beyond the standardised questions, and the number of those able to complete the screening). Disability, mental health difficulties, and neuropsychological impairment were also assessed, and the ability of the tools to detect these was compared.

Results

Both tools were equally practical to use in the SPS, but the OSU TBI-ID was more useful in terms of its association with and ability to identify disability and impairment. This study has a number of limitations which should be addressed to improve the validity of future research.

Conclusion

This study suggests that the OSU TBI-ID may more useful than the BISI as a screening tool for HI in Scottish prisons, though future research is required.

Key References

Bogner, J., & Corrigan, J. D., 2009. Reliability and predictive validity of the Ohio State University HI identification method with prisoners. *The Journal of head trauma rehabilitation*, 24(4), pp.279-29

Pitman, I., Haddlesey, C., Ramos, S. D., Oddy, M., & Fortescue, D., 2015. The association between neuropsychological performance and self-reported traumatic brain injury in a sample of adult male prisoners in the UK. *Neuropsychological rehabilitation*, *25*(5), pp.763-779.

Abstract

Background: Head injury (HI) has been linked with offending behaviour. Self-report studies indicate a high prevalence of HI amongst offenders. Routine screening for HI for offenders has been recommended, to inform triage towards needs-led assessment and intervention (NPHN, 2016). However, there is a need to validate a screening tool for HI that can be used with offenders in the Scottish Prison Service (SPS).

Aims: To examine the sensitivity, specificity and construct validity of the BISI and the OSU TBI-ID against the reference standards of evidence of neuropsychological or psychiatric impairment or disability. The practical usefulness of the tools will also be considered. A parallel study by a second trainee examined the prevalence of disability associated with HI using the same data.

Methods: A retrospective, cross-sectional design was utilised to gather data from 82 male participants (aged >21) from a Scottish prison. The two screening measures were used alongside measures of disability, mental health, cognitive function, and effort.

Results: Construct validity was better for the OSU TBI-ID than the BISI. The OSU TBI-ID was significantly associated with neuropsychological, mental health and disability outcomes ($p<0.05$). Both tools had measures with good sensitivity (BISI injury severity rating: 86-100%; OSU TBI-ID clinical rating: 100%), but specificity was low (BISI injury severity rating: 17-24%; OSU TBI-ID clinical rating: 11-17%). The tools were equally practical to use in the SPS, and any differences were not clinically meaningful.

Conclusion: This study indicates that the OSU TBI-ID may be more useful than the BISI as a screening tool for HI-related impairment or disability in Scottish prisons. Limitations and implications for future research are discussed.

Introduction

Head Injury and Offending

Head injury (HI) has been linked with offending behaviour. Cohort studies report increased offending in those with HI compared to those without (McIsaac et al., 2016), and cross-sectional studies report the prevalence of HI as 50-60% in offending samples compared to 12% in the general population (Shiroma et al., 2012, Farrer & Hedges, 2011).

Severe HI commonly results in disability, neuropsychological impairment, and difficulties with mental health (Whitnall et al, 2006). Another consequence includes alterations in personality, such as impulsivity and aggression (Wood & Thomas, 2013). These changes can impact significantly on wellbeing and quality of life, and can be associated with rule breaking and can lead to Criminal Justice System (CJS) involvement (Miller, 1999). However, there are seldom outward signs of a HI having taken place, and consequently its role in antisocial behaviour often goes unrecognised. As a result, interventions and adaptations that address the issue of HI and may reduce recidivism are not implemented (NPHN, 2016).

Identifying Head Injury in Criminal Justice Settings

In Scotland, an audit on behalf of the National Prisoner Healthcare Network (NPHN, 2016) found that routine screening for HI does not currently occur within the Scottish Prison Service (SPS). Accordingly, the NPHN recommended the introduction of routine screening across Scotland. Given the high prevalence of HI in Scottish prisons (McMillan et al, in preparation), the purpose of screening would be to identify those who are likely to demonstrate impairment and disability on more detailed assessment. These assessments can then be used to inform interventions and adaptations which take the effects of HI into

account. In turn, these might improve the management of the prison environment (e.g. engagement and behaviour) and reduce the likelihood of re-offending or further HI (NPHN, 2016).

There are several tools which can be used to screen for HI, but none have been validated in the SPS. The NPHN (2016) report suggested two tools for potential use in the SPS due to their brief administration time and association with neuropsychological function and psychiatric morbidity in studies in the USA and England, respectively. These are the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID) – Short Version (Ray et al, 2014; Bogner & Corrigan, 2009) and the Brain Injury Screening Index (BISI) (Pitman et al, 2014).

The current study evaluated whether the BISI or the OSU TBI-ID is more valid or practical to use in the identification of HI and associated difficulties in male prisoners in the SPS. To do this, it was important to consider which reference standards might be most suitable to measure the tools against. As discussed above, HI can result in disability (Whitnall et al, 2006), demonstrated by limitations in daily independent functioning including self-care, work, leisure and social relationships. Secondly, HI can have adverse effects on mental health, and is associated with anxiety and depression (Whitnall et al, 2006). Finally, HI can result in impaired neuropsychological function, particularly in the domains of executive function, learning and memory, and processing speed (Miller, 1999; Meijers et al, 2015). These domains are particularly relevant to HI outcomes in offending populations as deficits in these areas are linked with offending behaviour. Impaired executive function may lead to poor impulse control, and an inability to think flexibly to generate prosocial solutions to a problem. Further, impaired processing speed may lead to a failure to effectively process information from a range of environmental sources in a way

which aids appropriate and informed decision making. This may lead to an increase in risk taking behaviours. Fianlly, individuals with deficits in learning and memory may find it difficult to hold relatively complex goals in mind, such as finding housing and employment (both risk factors for recidivism) (Meijers et al, 2015; Miller, 1999; Morgan & Lilienfeld, 2000; NPHN, 2016).

In this respect, these consequences are markers of outcome (and recovery) after HI, and there are a number of measures which are often used in clinical practice for this purpose (selection of specific measures is discussed later). As such, it was decided that the following outcomes would be appropriate reference standards for assessing the validity of the screening tools:

1. Disability
2. Neuropsychological impairment
    a. Learning and memory
    b. Processing speed
    c. Executive function
3. Mental health

Aims and Research Questions

The following research questions were examined:

1. What is the construct validity of the BISI and the OSU TBI-ID in relation to persisting disability, neuropsychological impairment and mental health difficulties associated with HI?

2. How sensitive and specific are the BISI and the OSU TBI-ID in terms of their ability to identify persisting disability, neuropsychological impairment and mental health difficulties associated with HI?
3. How practical are the BISI and the OSU TBI-ID for use in the SPS?

Methods

Ethical Approval

Ethical approval was obtained from NHS Research Ethics (WOSREC 16/WS/0216), NHS Research and Development, and the Scottish Prison Service Ethics Committee (see Appendix 2.1).

Design

The study utilised a retrospective, quantitative, cross-sectional design. Measures of disability, neuropsychological function and mental health were used as reference standards to determine if one screening measure was superior in predicting outcome. Further, the practical usefulness of both tools were compared.

Study Site and Participants

Participants were recruited from Her Majesty's Prison (HMP) Shotts. HMP Shotts houses about 500 male prisoners aged over 21 and serving sentences of at least 4 years. The main prison (excluding the segregation and re-integration unit (SRU)) is organised across two halls, each with four 'flats' housing approximately 60 prisoners each. The study recruited from all of these flats (recruitment procedures detailed below). Prison officers who act as participant's personal officers (PO) completed a proxy measure described below.

Eligibility Criteria

Participants were included if: (a) currently serving a custodial sentence within HMP Shotts; (b) aged over 18 (i.e. all prisoners within HMP Shotts); (c) fluent in English; (d) not experiencing severe mental health difficulties (e.g. psychosis); (e) not demonstrating significant communication difficulties which would preclude them from completing

assessments; (f) no deteriorating neurological condition diagnosis; (g) not considered a risk to researcher safety by prison staff (this automatically excluded participants housed within the prison SRU).

For prison officers to be included to provide a proxy rating for the Glasgow Outcome at Discharge Scale (GODS), it was required that their relationship to the participant was that of PO.

Demographic data

A semi-structured interview was undertaken using a data capture form (see Appendix 2.8) devised by the researchers. Demographic and background information included age, ethnicity, education and occupation, alcohol and drug use, offence history and duration of time spent in custody, length of hospital stay and details of any follow-up after HI. Postcodes were also recorded to estimate socio-economic status using the Scottish Index of Multiple Deprivation (SIMD, 2016).

Measures

There are a number of tools and measures which are relevant to outcomes in HI. The following were selected on the basis that they had good psychometric properties, were relevant to outcomes in HI, and were brief enough for the purpose of the present study (or for use in the SPS, in the case of the screening tools).

Screening tools

A form was devised to note any practical issues arising when administering the screening tools with each participant (see Appendix 2.12).

The Brain Injury Screening Index (BISI)

This 11 question tool screens for HI using self-report. Scoring measures have been published by the test developers, and are detailed in the guidance notes which accompany the BISI (see Appendix): (i) the 'BISI Injury Severity' rating, which categorises severity of HI as shown in table 1; (ii) The 'BISI TBI Index' score, which is calculated by multiplying the number of HI by the duration of the longest loss of consciousness (minutes). The index score can be categorised (i.e. 0-10 = mild; 11-30 = moderate; 31-60 = severe; 61-300 = very severe; >301 = extremely severe). In clinical practice, those screening positive for 'moderate to severe' HI in clinical practice would be referred for specialist neuropsychological assessment.

In a sample of offenders from HMP Leeds (Pitman et al, 2014), presence of HI (as assessed by the BISI) and BISI scores were both correlated with behavioural and psychological outcomes ($d>0.55$ for all dependent variables; $n=189$). However, Pitman et al (2014) did not categorise HI severity as described in the BISI guidance notes, and devised an alternative version of the TBI Index score. For the purpose of this study, results are given only in relation to the measures detailed in the published BISI guidance notes, as these are the ones that are available to those using the tool in clinical practice.

The Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID) - Short Version

This is a structured interview which uses self-report. It contains 5 questions, with follow up questions to ascertain injury severity, the presence of repeated/multiple HI and any other sources of central nervous system (CNS) compromise. It then uses five key

indicators (see table 1) to identify whether an individual is 'likely' or 'not likely' to have ongoing problems as a result of HI. In clinical practice, those who meet one or more indicator are rated as 'likely', and would be referred for specialist neuropsychological assessment. The OSU TBI-ID can be evaluated using the overall rating, as described above, as well as using each of the five individual summary measures that the overall clinical rating is composed of. The 'worst injury' measure is concordant with internationally recognised definitions of HI severity (Carroll et al, 2004).

The short version is based on the original version of the OSU TBI-ID, which has been validated in USA prisons (n=210). Bogner and Corrigan (2009) found good test-retest reliability (r>0.6) and large effect sizes (R^2 >0.36) when comparing scores on the original version of the OSU TBI-ID with several cognitive, psychiatric and behavioural outcomes (Bogner & Corrigan, 2009). The short version provides several of the summary indices on which the original version was validated, and it has been significantly associated with current psychiatric morbidity in a US prison sample (Ray et al, 2014).

Table 1. Definitions of HI severity

	Mild HI / Not likely to have ongoing problems	**Moderate/severe HI / Likely to have ongoing problems**
BISI injury severity rating	HI's leaving the recipient dizzy, unsteady or dazed, but without LOC	HI with LOC or PTA (any duration), or > 1 HI
BISI TBI Index	TBI Index score <11	TBI Index score ≥11
OSU TBI-ID rating	None of the five criteria indicating likelihood of ongoing problems are present.	One or more of the following: • Worst: One moderate or severe HI (i.e. any HI with >30 minutes LOC) • First: HI with any LOC before age 15 • Multiple: Two or more HIs close together, including a period of time when they experienced multiple

		blows to the head even if apparently without effect • Recent: A mild HI in recent weeks, or a more severe HI in recent months • Other: Any HI combined with another way that their brain has been impaired.

LOC: loss of consciousness
PTA: post-traumatic amnesia

Measures of disability and mental health

The Glasgow Outcome at Discharge Scale (GODS)

This is an assessment of disability outcome after HI, which was devised as an inpatient version of the Glasgow Outcome Scale – Extended (GOS-E). It has significant associations with health and disability (effect sizes: 36-Item Short Form Survey: r=0.22-0.46; Disability Rating Scale: r=0.72) and high inter-rater reliability (98%) (McMillan et al, 2013). It is a structured interview which includes questions around aspects of independence with activities of daily living, work ability, social and leisure activities, social relationships, and the ongoing impact of HI (e.g. headaches, dizziness, memory and concentration difficulties). The answers to these questions produce an overall rating which can fall in to one of eight outcome categories (1=Dead; 2=Not conscious; 3=Lower Severe Disability; 4=Upper Severe Disability; 5=Lower Moderate Disability; 6=Upper Moderate Disability; 7 =Lower Good; 8=Upper Good Recovery. For the purpose of this study, only categories 3-8 were relevant. For the purpose of using the tool in a prison context, reference to the 'ward' was replaced with 'prison hall' or 'prison flat'. Further, questions relating to work, travel, shopping and social pursuits were amended to the prison context (e.g. 'shopping' referred to use of the prison canteen sheet, and how participants coped

with ordering their weekly supplies and managing their money; 'travel' referred to how well they could find their way around within the constraints of the prison regime (e.g. to and from work).

The Hospital Anxiety and Depression Scale (HADS)

This measure has good reliability and validity in assessing depression and anxiety in people with HI (Whelan-Goodson et al, 2009). It consists of 14 items and responses are entered on a 4-point Likert scale. Clinical levels of anxiety or depression are indicated by scores ≥11 (Zigmond & Snaith, 1983).

Test of Learning and Memory

The Adult Memory and Information Processing Battery (AMIPB) - List Learning Sub-Test

This is a measure of learning and working memory (Coughlan & Hollows, 1985). The participant is read 15 unrelated words before being asked to recall them. It is sensitive to the effects of HI and test re-test reliability is high (Lezak, 2012; pp531).

Test of Processing Speed

The Symbol Digit Modalities Test (SDMT)

This test (Smith, 1982) assesses attention, visual scanning, and motor speed. It presents examinees with a coding key, which consists of 9 abstract symbols. Each symbol is paired with a number from 1-9. Beneath the coding key are a series of rows containing small

blank squares. Each square has one of the 9 symbols above it, presented in a random order. The examinee is required to scan the coding key and write down the number that corresponds to each symbol in the blank squares. The examinee is instructed that they have ninety seconds to do as many of these as possible, but must work in order from left to right across each row. It has high test-retest reliability (Lezak, 2012; pp421), and is sensitive to the effects of HI (Strauss et al, 2006; pp625).

Tests of Executive Function

Trail Making Test (TMT)

This test assesses ability to switch attention (Armitage, 1946). Part A involves connecting circled numbers (1-20) by a continuous line. Part B involves alternating between two sequences of circled numbers and letters (e.g. 1-A-2-B). It is scored by recording the total time taken to complete each part (Lezak, 2012; pp423). The TMT is sensitive to neurological disorder (Burgess et al, 1998).

Hayling Sentence Completion Test

This is a measure of initiation speed and response suppression (Burgess & Shallice, 1997; Strauss et al, 2006; pp460). It consists of two sets of 15 sentences with the last word missing from each. In the first section the participant completes the sentences and response initiation is timed. In the second section the participant completes sentences with a word which does not make sense, assessing response suppression ability. This test has good test–retest reliability ($r=0.72–0.93$) and internal consistency ($\alpha=0.62–0.76$).

Test of Effort

If an examinee does not put in good effort, cognitive assessment results can be invalid, and assessment of effort is important in interpreting neuropsychological test results (BPS, 2009).

Word Memory Test (WMT)

The examinee is read 20 word pairs before being asked to identify the word from the original list in each of 40 new word pairs in an immediate recognition (IR) trial (e.g., "dog" from "dog-rabbit"). This is repeated after 30 minutes in a delayed recognition trial (DR). This measure is highly sensitive and specific in categorising effort, and has been validated in clinical forensic samples (Green et al, 2003). Failure on either trial indicates poor effort. Given the constraints in using computers in prison, the paper version of the test was administered.

Recruitment and Research Procedures

Recruitment took place between February and April 2017. Eighty-two prisoners took part in the study. SPS managers displayed study posters and information sheets in individual flats and the prison health centre. Prison staff asked individuals to indicate interest in participating by writing their name on a sheet of paper that was passed to researchers by SPS managers. Meetings with individual participants were arranged where the content of the information sheet was reviewed with each participant and informed written consent was obtained. The assessment then took place in the following order: Word Memory Test (WMT) Immediate Recall (IR) (Delayed Recognition (DR)) took place 30 minutes later), BISI or OSU TBI-ID (each was randomly administered to half of the participants using a

random number generator (Microsoft Excel, 2010), demographic and background details, Glasgow Outcome at Discharge Scale (GODS), Trail Making Test (TMT A & B), Hospital Anxiety and Depression Scale (HADS), Hayling Sentence Completion, Symbol Digit Modalities Test (SDMT), List Learning sub-test of the Adult Memory and Information Processing Battery (AMIPB). Interviews took between 40 and 100 minutes to complete, with most taking less than 60 minutes. Where particular concerns were identified, these were passed on to the SPS. A follow-up meeting or phone call took place with each participant's PO to complete a proxy measure of the GODS.

The study was carried out in parallel with another DClinPsy trainee study, which examined the prevalence of disability, emotional and neuropsychological outcomes in prisoners reporting HI. The same data was collected simultaneously for both projects and the dataset was shared. Each trainee assessed about half of the participants. A pilot (n=5) was carried out to ensure consistency of administration between researchers. During the pilot, both researchers were present and alternately administered one of the two screening tools and the outcome measures with each participant. Measures were then scored independently and compared. Inconsistencies between researchers were resolved by discussion.

Sample size

Research question 1

G*Power (Faul et al, 2007) was used to estimate the required sample size for this question, using executive function as the primary outcome variable (Rabinowitz & Levin, 2014). Pitman et al (2014) reported a correlation of 0.45 between the BISI and the Frontal Systems Behaviour Scale; with power of 0.80, probability of 0.05, a two-sided test, and a medium effect size of 0.3, a sample of 84 would be required.

Research questions 2 and 3

The data were descriptive, so a sample size calculation was not required.

Data Analysis

Statistical analysis was undertaken using IBM SPSS version 21. Data were assessed for normality using the Shapiro-Wilk test.

Demographic data

Measures of central tendency (means and standard deviations (SD)) and frequency (percentages) are used to present demographic data. With the exception of age, the demographic data did not meet the assumptions for parametric testing ($p<0.05$). An independent t-test examined age differences, and Mann Whitney U tests examined between-group differences for all other continuous demographic and background variables. For categorical variables, chi-squared was used to examine between group differences.

Construct validity

The data for the screening tool indices and the outcome measures (with the exception of the SDMT and AMIPB list learning did not meet parametric assumptions ($p<0.05$). As such, Spearman correlations examined the extent to which the screening tools were associated with disability, neuropsychological impairment, and emotional outcome. Independent t-tests and Mann-Whitney U tests were used where screening measures were binary. Adjustments for multiple statistical testing were not carried out. This research was responding to specific and informed research questions, arising from literature. Therefore, the study was not exploratory in nature, and tests were carried out in relation to ten specific outcome measures, all of which are established as relevant to outcomes in HI. The

aim of the study was to assess the comparative validity of two screening tools for HI, and applying corrections to the statistical analysis for this may make results less clear. To assess the potential impact of effort on significant results, the scores for the WMT-DR trial were included in partial correlations. This trial was chosen over IR as it represents the score at which participants have had maximum opportunity to learn the words, with IR presenting an additional learning trial (Strauss et al, 2006; pp1185).

Sensitivity and specificity

Data were presented using percentages. Data were collapsed into 'mild HI' (unlikely to have ongoing problems and not requiring referral for specialist assessment) and 'moderate-severe HI' (likely to have ongoing problems, and requiring referral for specialist assessment) and compared. Severity is defined differently for each screening tool (see table 1).

Scores on neuropsychological tests were converted to z scores using published norms for ease of between-group comparison. Higher scores indicate better performance (scores for the TMT were multiplied by -1). For each participant, the z scores were averaged to compute an overall cognitive score (Whitnall et al, 2006). This was carried out as all of the tests measure aspects of cognition that are commonly affected by HI, and the aim of this aspect of the study was to obtain an overview of how sensitive and specific the screening tools were to cognitive impairment, generally. To prevent disproportionate weighting for tests with multiple components, the TMT B (due to its measurement of mental flexibility and divided attention) and the Hayling overall efficiency score were used. Z scores for individual cognitive tests are considered separately where correlations were significant in the construct validity analysis. Data were presented according to three established cut-offs for impairment, namely scores below the 10^{th}, 5^{th} and 1^{st} percentiles (-

1.28, -1.64 and -2.33 standard deviations below the normative mean, respectively) (Strauss et al, 2006; pp5). Sensitivity and specificity >74% was considered high and <51% was considered low, with values in between as moderate. These cut-offs reflect textbook recommendations and are used in clinical practice (e.g. Strauss et al, 2006; pp876-877; 977). Table 2 details definitions of specificity, sensitivity, and positive and negative predictive values (PPV/NPV) and how they are calculated.

Table 2. Definitions and formula for sensitivity, specificity, PPV and NPV

Measurement	Definition	Formula
Sensitivity	The ability of the tool to correctly identify those who were impaired.	True positives / true positives +false negatives
Specificity	The ability of the tool to correctly identify those who are not impaired.	True negatives / true negatives + false positives
PPV	Probability of impairment when HI is moderate/severe.	True positives / true positives + false positives
NPV	Probability of non-impairment when HI is mild.	True negatives / true negatives / false negatives

Screening tool practicality

As completion time did not meet parametric assumptions, a Mann-Whitney U test examined between-group differences.

Frequencies (percentages) and chi-squared tests were used to explore differences between tools in the occurrence of need for extra explanation or clarification and whether participants were able to complete the tools.

Results

Demographic data

Eighty-two participants took part. Age-bands represent those used in the 2015 prison census (McMillan et al, in preparation; see table 3). Differences in age between the sample and the male Scottish prison population were non-significant ($\chi 2 = 0.20$, $p = 0.66$ (odds ratio 0.90; 95% CI 0.57, 1.43). Odds ratios refer to age bands that were collapsed in to two groups (16-29 and 30-39 combined; 40-49 and 50-79 combined).

Table 3. Age distribution of the sample and of the male Scottish prison population

Age band	Sample n (%)	Prison census n (%)
16-29	22 (26.8)	2557 (35.2)
30-39	32 (39.0)	2390 (32.9)
40-49	15 (18.3)	1400 (19.3)
50-79	13 (15.9)	913 (12.6)

Socioeconomic status was ascertained using the Scottish Index of Multiple Deprivation 2016 (SIMD), which defines deprivation across Scotland according to postcode. SIMD data is presented as quintiles. The first quintile represents the most deprived and the fifth the least deprived. Differences in SIMD quintiles between the sample and the male Scottish prison population (McMillan et al, in preparation; see table 4) were non-significant ($\chi 2 = 1.78$, $p= 0.18$; OR 1.52, 95% CI 0.82, 2.83; table 4*)*. Odds ratios refer to combined quintiles (1 and 2 combined; 3,4 and 5 combined).

Table 4. SIMD distribution in the sample and the Scottish Prison Population

Quintile (rank)	Sample n[1] (%)	Prison census n (%)
1 (0-1395)	40 (48.8)	3861 (53.7)
2 (1396-2790)	21 (25.6)	1669 (23.2)
3 (2791-4185)	6 (7.3)	887 (12.3)
4 (4186-5580)	3 (3.7)	525 (7.3)
5 (5581-6976)	3 (3.7)	244 (3.4)

Regarding ethnicity, 93.9% of participants described themselves as white, 3.7% as Asian and 2.4% as black/Caribbean. Fifty-four percent said they attended mainstream school, and a further 11% that they received one-to-one support within mainstream education. Thirty-five percent had specialist schooling, including additional support needs schooling and residential schooling. Groups did not differ significantly on any demographic variable ($p>0.05$; see table 5).

Table 5. Demographic characteristics of the sample

	BISI group n=41	**OSU TBI-ID group** n=41	**Total**	**Test statistic (p)**
Age (years) mean (SD)	36.1 (10.5)	37.6 (10.7)	36.8 (10.5)	t=-0.62 (0.54)
Years of education mean (SD)	10.5 (1.2)	10.1 (1.5)	10.3 (1.3)	z=-1.84 (0.07)
SIMD rank mean (SD)	1621.5 (1523.8)	1662.5 (1672.7)	1642.3 (1590.0)	z=-0.21 (0.83)
Occupation: Professional/managerial n (%)	2 (4.9)	3 (7.3)	5 (6.1)	z=-1.77 (0.08)
Occupation: Skilled n (%)	8 (19.5)	15 (36.6)	23 (28)	
Occupation: Unskilled n (%)	15 (36.6)	12 (29.3)	27 (32.9)	
Occupation: Unemployed n (%)	16 (39)	11 (26.8)	27 (32.9)	
Reported previous problematic alcohol use n (%)	25 (61)	23(56.1)	48 (58.5)	X^2=0.20 (0.65)
Reported previous problematic drug use n (%)	26 (63.4)	30 (73.2)	56 (68.3)	X^2=0.90 (0.34)

Offence history

[1] Missing data (n=9) occurred where participants were of no fixed abode or whose residence was out with Scotland.

No significant differences were found between groups (p>0.05; see table 6).

Table 6. Offence history of participants

	BISI group n=41	**OSU TBI-ID group** n=41	**Total**	**Test statistic (p)**
Number of convictions mean (SD)	16.6 (20.1)	19.2 (21.8)	17.6 (19.3)	z=-0.96 (0.34)
Longest sentence given (years) mean (SD)	13 (6.5)	12.2 (5.9)	12.6 (6)	z=-1.94 (0.06)
Violent offences n (%)	37 (90.2)	33 (80.5)	70 (85.4)	X^2=1.56 (0.35)
Sexual offences* n (%)	0 (0)	0 (0)	0 (0)	N/A
Property offences n (%)	20 (48.8)	15 (36.6)	35 (42.7)	X^2=1.25 (0.26)
Other offences n (%)	28 (68.3)	27 (65.9)	55 (67.1)	X^2=0.06 (0.81)

** In Scotland, individuals convicted of sexual offences serve custodial sentences at other SPS sites.*

Head injury Characteristics

Participants were randomly allocated to the BISI group or the OSU TBI-ID group (table 7). Eighty-one participants reported a history of HI.

No significant differences were found in age at first injury, estimated number of days spent in hospital, or length of LOC (p>0.05). The number of HI was higher in those screened using the OSU TBI-ID (U = 504, z = -3.2, p=0.002, r = 0.35; table 7).

Table 7. Means and standard deviations, or frequencies and percentages, for participant HI history

	BISI group n=41	**OSU TBI-ID group** n=41	**Total**	**z (p)**
Age at first HI mean (SD)	12.7 (11.1)	10.6 (6.1)	11.6 (8.9)	-0.34 (0.73)
Number of HI mean (SD)	3.8 (2.1)	5.1 (2.2)	4.4 (2.3)	-3.15* (0.002)

Estimated number of days spent in hospital (total) mean (SD)	12.7 (37.9)	6.9 (18.6)	9.7 (30.0)	-0.22 (0.83)
No LOC n (%)	10 (25)	12 (29.3)	22 (26.8)	-0.72 (0.47)
LOC < 30 mins n (%)	21 (52.5)	22 (53.7)	43 (52.4)	
LOC > 30 mins n (%)	9 (22.5)	7 (17.1)	16 (19.5)	

** Difference is significant (p<0.05)*

Construct validity

OSU TBI-ID rating and BISI Injury Severity rating: For both measures, there were very small numbers of participants that would not be referred to more specialist assessment (i.e. 81% (n=37) screened positive for moderate-severe HI on the BISI and 90% (n=34) were categorised as 'likely to have ongoing problems' by the OSU TBI-ID). Consequently, statistical comparison between those who would and would not be referred was not appropriate.

Due to this, the OSU TBI-ID worst injury measure (described above) and BISI TBI Index (categories) (both described in the methods section, above) are considered as primary measures of construct validity, as both categorise HI severity and would have the potential to be used in clinical practice

Primary measures

BISI TBI Index (categories) and OSU TBI-ID Worst Injury: There were no significant associations between the BISI TBI Index (categories) and cognitive function, mental health, or disability measures (see table 8). For the OSU TBI-ID worst injury measure, significant associations were found with the SDMT (r=-0.44, n=39, p=0.01), GODS HI (r=-0.41, n=41, p=0.01), HADS anxiety (r=0.43, n=41, p=0.01) and depression (r=0.55, n=41, p=0.01) (see table 8).

Table 8. Associations (Spearman's rho) between BISI and OSU TBI-ID primary indices and cognitive, mental health and disability outcomes

	OSU TBI-ID 'Worst' r (p)	**BISI TBI Index (categories)** r (p)
SDMT	-0.44* (0.01)	-0.01 (0.99)
AMIPB list learning	0.02 (0.92)	0.03 (0.83)
Trails A	0.03 (0.84)	0.08 (0.64)
Trails B	0.12 (0.47)	-0.11 (0.51)
Hayling A	-0.11 (0.49)	-0.05 (0.76)
Hayling B	-0.08 (0.65)	-0.16 (0.31)
Hayling C	-0.17 (0.29)	-0.08 (0.64)
HADS anxiety	0.43* (0.01)	0.17 (0.28)
HADS depression	0.55* (<0.001)	0.07 (0.69)
GODS HI	-0.41* (0.01)	-0.09 (0.59)

**. P<0.05*

Secondary BISI indicators

BISI TBI Index (raw score): This was not significantly associated with any of the outcome measures (see table 9).

Secondary OSU TBI-ID Indicators

First: Age at first LOC was significantly associated with HADS anxiety (r=-0.38, n=29[2], p=0.05), (see table 9).

Multiple: The number of repeated HI was significantly associated with TMT A (r=-0.32, n=40, p=0.05), (see table 9).

Recent: No participants had sustained a mild HI in recent weeks or a severe HI in recent months.

[2] 12 participants 'missing' from this correlation as they reported no history of HI with LOC.

Other: There were no significant differences on the outcome measures for those who did and did not have other sources of CNS compromise (p>0.05) (see table 9).

Table 9. BISI and OSU TBI-ID secondary indices and cognitive, mental health and disability outcome

	BISI TBI Index (raw score)		OSU TBI-ID Multiple		OSU TBI-ID First		OSU TBI-ID Other	
	r	**p**	**R**	**p**	**r**	**p**	**t/z**	**p**
SDMT	-0.04	0.79	-0.12	0.47	-0.00	0.98	1.24°	0.69
AMIPB	-0.03	0.84	-0.04	0.83	0.05	0.79	-0.40°	0.69
Trails A	-0.06	0.70	-0.32*	0.05	-0.05	0.80	-0.12	0.90
Trails B	-0.10	0.55	-0.01	0.95	-0.18	0.36	-1.28	0.20
Hayling A	0.03	0.87	0.13	0.43	-0.11	0.57	-0.08	0.94
Hayling B	-0.18	0.27	0.04	0.81	-0.03	0.87	-0.41	0.68
Hayling error	-0.14	0.39	0.10	0.53	-0.10	0.61	-0.22	0.83
HADS anxiety	0.24	0.13	0.16	0.32	-0.38*	0.05	-1.78	0.08
HADS depression	0.07	0.65	0.02	0.88	0.06	0.77	-1.11	0.27
GODS HI	-0.15	0.37	-0.01	0.94	-0.10	0.61	-1.48	0.14

N.B. All r are Spearman's rho
**. Correlation or difference is significant*
°. Independent t-test, otherwise Mann-Whitney U test

Validity: Effort

A high proportion of the sample scored below the cut-off for passing the WMT (table 10). There were no significant differences in WMT scores between the two screening tool groups (z=-1.39 (IR); -0.75 (DR); -1.60 (Consistency); p>0.05).

Table 10. Effort outcomes

	Pass n (%)	Caution n (%)	Fail n (%)
Word Memory Immediate	33 (40.7)	24 (29.6)	24 (29.6)
Word Memory Delayed	40 (49.4)	23 (28.4)	18 (22.2)
Word Memory Consistency	22 (27.2)	29 (35.8)	30 (37.0)

Partial correlations for non-parametric data were used to further examine significant associations between the outcome variables and the screening tools after adjusting for effort. All significant associations were unchanged (see Appendix 2.13).

Sensitivity and specificity *(full results table in Appendix 2.15)*

OSU TBI-ID (Clinical Rating and Worst Injury)

For the OSU TBI-ID clinical rating, sensitivity was high for all outcomes (100%), and specificity was low (11-17%). PPVs were low (11-49%) and NPVs high (100%). For the 'worst injury' measure, sensitivity varied. A 5th percentile cut-off optimised sensitivity on cognitive tests, which was high for SDMT scores (80%) and low for overall cognitive function (42%). Sensitivity was high for depression (75%) but low for anxiety (37.5%) and disability (44%). Specificity was high (79-92%) for all outcome measures. PPVs were low to moderate for the majority of outcomes (13-63%; 75% for HADS anxiety), and NPVs were moderate to high (61-97%).

BISI (TBI Index and Injury Severity)

For the TBI Index, sensitivity was high for disability (75%) and anxiety (80%) and was low/moderate for specificity (40% and 54% respectively). For all other outcomes, sensitivity was low to moderate (43-67%) and specificity was low (38-50%). For the Injury Severity measure, sensitivity was high (82-100%) and specificity low (15-24%) for all outcome measures. PPVs were not high for either measure (12-71%), and NPVs were moderate for cognitive measures (71%) and high for mental health (77-86%) and disability (86-100%).

Screening tool practicality

Administration time (minutes) for the BISI (Mdn = 5.47, Interquartile Range = 4.0, 9.0, N= 39) was significantly shorter than for the OSU TBI-ID (Mdn = 7.43, IQR = 5.48,12.89, N= 40: U = 572.5, z = -2.0, p <0.05, r = 0.2). Completion time within 10 minutes occurred in 80% (n=33) for the BISI and 63% (n=26) for the OSU TBI-ID (χ^2 (1) = 4.02, p=0.045). Further explanation was required for the BISI in 49% (n=19) and OSU in 39% (n=16), (χ^2 (1) = 0.76, p>0.05). All participants were able to complete the screening tool to which they were randomly allocated.

Discussion

Main findings

The OSU TBI-ID, was associated with persisting disability, neuropsychological impairment and mental health difficulties, and demonstrated better construct validity than the BISI which was not significantly associated with these outcomes. Both the BISI and the OSU TBI-ID had measures which had good sensitivity to disability and impairment. The practicality of to using the BISI and the OSU TBI-ID in the SPS was similar.

Demographics

The sample was demographically similar to that of the Scottish male prison population, and the two screening tool groups did not differ significantly in terms of demography, offence history and most aspects of their HI. There was a significant difference in the number of HIs reported by those in the BISI and OSU TBI-ID group. This may be a sampling effect, or may be a difference in the nature of the screening tools themselves as each uses different sets of questions to ascertain number of HI. In this sense, there may be a difference in precision between the two measures, in that one may be over-inclusive (OSU TBI-ID) or the other may be missing HI (BISI). However, the sample is currently too small to interpret this any further. Future work linking self-report and records of hospital admissions with HI may help to elucidate this.

Construct validity

The primary measure for the OSU TBI-ID, but not the BISI, was associated with outcome. These findings were robust, and remained after effort was partialled out. Specifically, as injury severity increased on the OSU TBI-ID worst injury measure, so did impaired processing speed, mental health difficulties and disability. This supports Bogner &

Corrigan (2009) and Ray et al (2014) who reported that indices of OSU TBI-ID contribute independently to the prediction of outcome in prisoners.

One difference in the present study is that the association with measures of executive function was non-significant. This is surprising given the established association with HI (Rabinowitz & Levin, 2014). This may have been the case because executive function in prisoners is generally impaired (Meijers et al, 2015), and the overall impairment in the sample may not have been closely linked to HI severity. There are a number of co-morbid issues that are common in prisoners, such as early trauma (DePrince et al, 2009) and long-term drug and alcohol abuse (Fernandez-Serrano et al, 2010). It is possible that such factors also affected executive function scores in this sample. However, investigation of this is beyond the scope of the current study.

Further, unlike the overall OSU TBI-ID rating, the worst injury measure does not take other aspects of HI into account, such as the potential cumulative effects of multiple mild HI (NPHN, 2016). In this respect, someone whose worst injury had a LOC < 30 minutes may have been exposed to many such injuries over their lifespan. Such people would not be referred for further assessment using this measure, though the evidence shows that they may well have persisting difficulties. Finally, it is possible that differences in Bogner & Corrigan's (2009) sample compared to ours (USA prisons, females included, offence history unclear) may have led to different results.

The present study was the first to evaluate the validity of the BISI in its published format, and found no association between the TBI Index and disability or impairment. One explanation for this may be that, unlike the OSU TBI-ID, the published TBI Index does not classify HI severity in line with internationally agreed definitions (Carroll et al, 2004).

Whilst the BISI injury severity measure does not do this either, the current study was unable to examine the construct validity for this measure. Whilst the use of internationally agreed definitions contributes to the strength of a tool, the definition of HI severity is a wider issue which needs to be resolved across the literature as a whole (Shiroma et al, 2010). It would have been remiss for the present study to exclude the BISI on the basis of not using an internationally acknowledged definition. To date, the BISI is the only screening tool which has been validated in a UK prison population (Pitman et al, 2014), and further investigation of this was warranted given the significance of results. In light of the non-significant results found in the present study, we looked at the TBI Index used by Pitman et al (2014), but this also produced non-significant results (see Appendix 2.15).

Sensitivity and specificity

In clinical practice, it would be preferable to use a tool that captures most of those who are impaired or disabled. Both the BISI Injury Severity measure and the OSU TBI-ID rating would do this effectively, as they have high sensitivity and NPVs. However, both have low specificity and PPVs, so using them may lead to a high level of inappropriate triage to further assessment for those that are not impaired or disabled. This would have implications for resources. One suggested solution to this would be to have nurses or support workers administer computerised cognitive assessments which could then be interpreted by clinical neuropsychologists (NPHN, 2016). Advantages to this are that test administration would be standardized and scoring efficient. However, this would also mean that the clinical neuropsychologist interpreting would have no direct opportunity for clinical observation of the client during testing. This requires further consideration.

Practicality

Statistically, the OSU TBI-ID takes longer to administer, but this does not equate to a clinically meaningful difference, as it takes only two minutes longer on average. The longer time reflects its content which includes more specific detail about HI than the BISI. In practice, both tools are equally practical to use, as they will not be embedded into the initial prison healthcare assessment, but will be used after this has taken place. Large numbers pass through prison reception, so it is envisaged that only those who respond positively to an initial question about HI during the initial prison healthcare assessment will be triaged to a separate HI screen. From here, increasingly smaller numbers will then be triaged towards more specialist and detailed assessment.

Limitations

The study was limited to male offenders, and the needs of female offenders with HI may differ. The sample did not contain sex offenders, so findings are possibly not relevant to this group. The sample size was modest, and all but one participant reported a history of HI, suggesting a self-selection bias. Due to the modest sample size, the effects found in this study are not precise and are subject to wider margins of error than would be the case if the sample size were larger. Additionally, the same researcher administered both the screening measure and the outcome measures in each individual interview. This lack of blinding may have introduced interviewer bias to the study. Finally, it had originally been planned to compare self-report of HI with Scottish Morbidity Records (SMR-01) of hospital attendance. This would have allowed evaluation of the sensitivity and specificity of the screening tools against objective evidence for HI. This data could not be retrieved on time due to funding delays.

Implications for future research

Future research should consider the limitations of the current study and examine the utility of the BISI and the OSU TBI-ID across the wider SPS. Both males and female participants should be included, as well as different types of offenders (i.e. long-term and short-term prisoners, at varying points of their custodial sentence, with a range of offence histories such as violent, sexual, property and drug offences). During recruitment, future research should consider how best to capture both those with and without HI, and self-report should be cross-referenced with the SMR-01 to compare the specificity and sensitivity of the tools in this respect. By expanding the sample size of the current study, the construct validity of the BISI injury severity rating and the OSU TBI-ID clinical rating should also be examined, as these both have good sensitivity and are relevant to clinical practice.

Conclusion

Both the BISI and the OSU TBI-ID have measures which effectively identify those who are impaired or disabled, but both produce a high number of false positives which would have implications for resources. However, results suggest that the OSU TBI-ID has better construct validity than the BISI. Further, both tools are practical to use within the SPS. These findings provide support for the further investigation of the utility of these tools within the SPS. To improve the validity of results, future research should attempt to resolve some of the limitations highlighted here. This will support the identification of an appropriate HI screening tool for use in the SPS.

References

Armitage, S., 1946. Analysis of certain psychological tests used for the evaluation of brain damage. Psychological Monographs, 60(1), pp.1–277.

Bogner, J., & Corrigan, J. D., 2009. Reliability and predictive validity of the Ohio State University HI identification method with prisoners. *The Journal of head trauma rehabilitation*, *24*(4), pp.279-291.

British Psychological Society., 2009. Assessment of Effort in Clinical Testing of Cognitive Functioning for Adults. Leicester: BPS.

Burgess, P. W., Alderman, N., Evans, J., Emslie, H., & Wilson, B. A., 1998. The ecological validity of tests of executive function. *Journal of the International Neuropsychological Society*, *4*(06), pp.547-558.

Burgess, P. W., & Shallice, T., 1997. The Hayling and Brixton Tests. Thurston, Suffolk: Thames Valley Test Company.

Carroll, L.J., Cassidy, J.D., Holm, L., Kraus, J. & Coronado, V.G., 2004. Methodological issues and research recommendations for mild traumatic brain injury: The WHO collaborating centre task force on mild traumatic brain injury. Journal of Rehabilitative Medicine, 43, pp.113-125.

Coughlan, A.K. & Hollows, S.E., 1985. The Adult Memory and Information Processing Battery Test Manual. Psychology Department, University of Leeds, Leeds, UK.

DePrince, A.P., Weinzierl, K.M. and Combs, M.D., 2009. Executive function performance and trauma exposure in a community sample of children. *Child abuse & neglect*, *33*(6), pp.353-361.

Farrer, T. J., & Hedges, D. W., 2011. Prevalence of traumatic brain injury in incarcerated groups compared to the general population: A meta-analysis. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 35(2), pp.390-394.

Faul, F., Erdfelder, E., Lang, A.G., & Buchner, A., 2007. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, pp.175-191.

Fernández-Serrano, M.J., Pérez-García, M., Schmidt Río-Valle, J. and Verdejo-García, A., 2010. Neuropsychological consequences of alcohol and drug abuse on different components of executive functions. *Journal of Psychopharmacology*, *24*(9), pp.1317-1332.

Green, P., Lees-Haley, P.R. & Allen, L.M., 2003. The Word Memory Test and validity of neuropsychological test scores. Journal of Forensic Neuropsychology, 2, pp.97–124

Lezak, M. D., 2012. *Neuropsychological assessment*. Oxford University Press, USA.

McIsaac, K. E., Moser, A., Moineddin, R., Keown, L. A., Wilton, G., Stewart, L. A., et al., 2016. Association between traumatic brain injury and incarceration: a population-based cohort study. *CMAJ open*, *4*(4), E746-E753.

McMillan, T.M., Graham, L., Pell, J., Mackay, D., (in preparation). The Prevalence of Hospitalised Head Injury in Scottish Prisons: A Population Study.

McMillan, T. M., Weir, C. J., Ireland, A., & Stewart, E., 2013., The Glasgow Outcome at Discharge Scale: an inpatient assessment of disability after brain injury. *Journal of neurotrauma*, *30*(11), pp.970-974.

Meijers, J., Harte, J. M., Jonker, F. A., & Meynen, G., 2015. Prison brain? Executive dysfunction in prisoners. *Frontiers in Psychology*, *6*, pp.43.

Miller, E., 1999. Head injury and offending. *The Journal of Forensic Psychiatry*, 10 **(1)**, pp.157-166.

Morgan, A.B. and Lilienfeld, S.O., 2000. A meta-analytic review of the relation between antisocial behavior and neuropsychological measures of executive function. *Clinical psychology review*, *20*(1), pp.113-136.

National Prisoner Healthcare Network (NPHN)., 2016. Brain Injury and Offending. NPHN.

Pitman, I., Haddlesey, C., Ramos, S. D., Oddy, M., & Fortescue, D., 2014. The association between neuropsychological performance and self-reported traumatic brain injury in a sample of adult male prisoners in the UK. *Neuropsychological rehabilitation*, (ahead-of-print), pp.1-17.

Rabinowitz, A. R., & Levin, H. S., 2014. Cognitive Sequelae of Traumatic Brain Injury. *The Psychiatric Clinics of North America*, *37*(1), pp.1–11.

Ray, B., Sapp, D. and Kincaid, A., 2014., Traumatic brain injury among Indiana state prisoners. *Journal of forensic sciences*, *59*(5), pp.1248-1253.

Shiroma, E. J., Ferguson, P. L., & Pickelsimer, E. E., 2012. Prevalence of traumatic brain injury in an offender population: A meta-analysis. *Journal of Head Trauma Rehabilitation, 27*(3), E1-E10.

Smith, A., 1982. Symbol Digits Modalities Test. Western Psychological Services: Los Angeles.

Strauss, E., Sherman, E. M., & Spreen, O. 2006. *A compendium of neuropsychological tests: Administration, norms, and commentary*. Oxford University Press, USA.

The Scottish Government., 2016. *Scottish Index of Multiple Deprivation 2016 (31st August 2016).* Retrieved from The Scottish Government website: http://simd.scotland.gov.uk

Whelan-Goodinson R, Ponsford J, Schonberger M., 2009. Validity of the Hospital Anxiety and Depression Scale to assess depression and anxiety following traumatic brain injury as compared with the Structured Clinical Interview for DSM-IV. *Journal of Affective Disorders* .114, pp.94–102.

Whitnall, L., McMillan, T. M., Murray, G. D., & Teasdale, G. M., 2006. Disability in young people and adults after head injury: 5–7 year follow up of a prospective cohort study. *Journal of Neurology, Neurosurgery & Psychiatry*,*77*(5), pp.640-645.

Wood, R. L., & Thomas, R. H., 2013. Impulsive and episodic disorders of aggressive behaviour following traumatic brain injury. *Brain injury*, *27*(3), pp.253-261

Zigmond, A.S. and Snaith, R.P., 1983. The hospital anxiety and depression scale. *Acta psychiatrica scandinavica*, *67*(6), pp.361-370.

Appendix 1.1. Author guidelines for the Journal of Head Trauma Rehabilitation

SCOPE

The *Journal of Head Trauma Rehabilitation (JHTR)* is a bimonthly journal devoted to presenting scientific information on restoring function and limiting disability due to traumatic brain injury (TBI). The primary aim of JHTR is to disseminate original research to professionals from multiple disciplines who study and/or treat persons who have experienced a TBI. All published research manuscripts receive masked peer review.

Articles appearing in JHTR address functional effects of TBI and interventions intended to ameliorate those effects. Findings should inform the treatment of individuals and families affected by TBI, the systems of care in which services are provided, or the epidemiologic and public health issues relevant to TBI. Manuscripts are expected to address questions that would be of interest to the wide range of professionals involved in TBI care--articles that are narrowly focused or relevant to only a single discipline typically are not published.

Populations of interest. Research reported in JHTR is generally limited to human subjects with a history of TBI, the families and caregivers of individuals with TBI, and/or the systems of care in which TBI services and research are undertaken. Studies may address injuries of any severity, sustained by any age group. If a study's sample includes individuals with acquired brain injuries other than TBI, analyses must be included to confirm that the findings reported for the entire sample are specifically true for those with a history of TBI.

Case ascertainment. Procedures used to determine that participants incurred a TBI must employ proven clinical techniques or validated research methods of TBI identification.

Transparency and openness. Please state in the article whether data, programming code or other materials are available to other researchers and, if so, how to access them. Data or code that was not the authors' own should be cited in the text and listed in the reference section.

Randomized controlled trials must be preregistered on *clinicaltrials.gov* or similar independent, institutional registry, prior to the initiation of data collection. Preregistration, including of pre-analysis plans, is recommended for all study designs. If a trial is preregistered, a link to the registry should be provided in the main text.

Inclusion of diverse participants. Please provide sex or gender-specific and racial/ethnic-specific data in describing the outcomes of experimental and observational analyses, or specifically state that no sex-based or racial/ethnic-based differences were present. Where applicable, authors should explain why people of a particular age, race, ethnicity, gender or sex were excluded from a study.

The term "sex" should be used as a classification, generally as male or female, according to the reproductive organs and functions that derive from the chromosomal complement. In the study of human subjects, the term "gender" should be used to refer to a person's self-representation as male or female, or how that person is responded to by social institutions on the basis of the individual's gender presentation.

MANUSCRIPT SUBMISSION

Article types: Original articles may employ experimental, observational or qualitative designs. JHTR will publish replication studies. Systematic reviews, scoping reviews and meta-analyses are also of interest.

Commentaries and Letters to the Editor will be reviewed and accepted at the discretion of the Editors. Other special communications must be discussed with the Editor-in-Chief prior to submission.

Investigations of the efficacy of interventions using only quasi-experimental designs typically are not accepted. Case studies or case series, unless they address a seminal clinical condition or procedure that has not been previously reported in the published literature, will not be reviewed.

Authors are strongly encouraged to consult relevant guidelines for research reporting found at <www.equatornetwork.org>. Authors have the option of uploading a completed checklist with page and line numbers indicated for each criterion met. Unless an author has been invited by an issue editor to submit a manuscript for a topical issue, all original research should be submitted as "Unsolicited (Focus on Clinical Research)".

Article length: Manuscripts should not exceed 3500 words excluding abstract, references, tables, and figure legends. If the author(s) feels a longer manuscript is necessary, please contact the Editor-in-Chief in advance of submission. Typically, except for review articles, the number of references should not exceed 50. Authors are encouraged to use Supplemental Digital Content (SDC) for manuscript details that enhance but are not central to the comprehension of the paper. SDC is linked to the article indefinitely via the *JHTR* website (for more information, see description below). As of 2016, JHTR will accept brief reports that do not exceed 2000 words, 3 tables and/or figures and 15 references.

Online manuscript submission: All manuscripts must be submitted online through the Web site at www.edmgr.com/jhtr, which can also be accessed through the journal's Web page.

First-time users: Please click the Register button from the menu above and enter the requested information. On successful registration, you will be sent an e-mail indicating your user name and password. *Note:* If you have received an e-mail from us with an assigned user ID and password, or if you are a repeat user, do not register again. Just log in. Once you have an assigned ID and password, you do not have to reregister, even if your status changes (ie, author, reviewer, or editor).

Authors: Please click the Log-in button from the menu at the top of the page and log-in to the system as an Author. Submit your manuscript according to the author instructions. You will be able to track the progress of your manuscript through the system. If you experience any problems, please contact John D. Corrigan, PhD, Editor-in-Chief at corrigan.1@osu.edu.

CONFLICTS OF INTEREST

Authors must state all possible conflicts of interest in the Title Page of the manuscript, including financial, consultant, institutional, and other relationships that might lead to bias or a conflict of interest. If there is no conflict of interest, this should also be explicitly stated as none declared. All relevant conflicts of interest and sources of funding should be included on the title page of the manuscript with the heading "Conflicts of Interest and Source of Funding:". For example:

Conflicts of Interest and Source of Funding: Author A has received honoraria from Company Z. Author B is currently receiving a grant (#12345) from Organization Y and is on the speaker's bureau for Organization X—the CME organizers for Company A. For the remaining authors none were declared.
In addition, each author must complete and submit the journal's copyright transfer agreement, which includes a section on the disclosure of potential conflicts of interest based on the recommendations of the International Committee of Medical Journal

Editors, "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" (www.icmje.org/update.html).

A copy of the form is made available to the submitting author within the Editorial Manager submission process. Co-authors will automatically receive an Email with instructions on completing the form upon submission.

LWW AUTHOR'S MANUSCRIPT CHECKLIST FOR JOURNALS

Authors should pay particular attention to the following items before submitting their manuscripts:

Manuscript Preparation

- *JHTR* uses the *American Medical Association Manual of Style*, 10th edition.
- *JHTR* requires authors to use person-first language—avoid phrasing such as "the brain-injured participant"or the "TBI patient"and replace with "participant with a brain injury" or "patient with a TBI."
- Manuscripts should be line numbered in their original format (eg, Microsoft Word line numbering).
- Manuscripts should be double-spaced, including quotations, lists, references, footnotes, figure captions, and all parts of tables. Do not embed tables in the text.
- Manuscripts should be ordered as follows: title page, abstracts, text, references, appendices, tables, and any illustrations.
- To maintain a masked review process, it is the author's responsibility to make every attempt to mask all information in the manuscript that would reveal the identity of the author to the reviewer. This version of the manuscript is referred to as the "masked" manuscript when uploading documents.
- An accompanying cover letter should include attestations that (1) the work is original and has not been published or under review elsewhere; (2) all authors contributed to the work; and (3) the research was conducted consistent with ethical guidelines for the conduct of research.
- The cover letter should also summarize any conflicts of interest affecting any authors.
- Title page including (1) title of the article; (2) author names (with highest academic degrees) and affiliations (including titles, departments, and name and location of institutions of primary employment); (3) all possible conflicts of interest including financial, consultant, institutional, and other relationships that might lead to bias or a conflict of interest; (4) disclosure of funding received for this work including from any of the following organizations with public or open access policies: National Institutes of Health (NIH), National Institute on Disability Independent Living and Rehabilitation Research, Veterans Administration, Wellcome Trust, and the Howard Hughes Medical Institute; and (5) any acknowledgments, credits, or disclaimers.
- A structured abstract of no more than 200 words should be prepared. Authors should use telegraphic language where possible, including omission of introductory clauses. Headings should typically include the following: Objective, Setting, Participants, Design, Main Measures, Results, and Conclusion. The Conclusion section should encapsulate the clinical implications of the results, not merely restate the findings.
- Include up to 10 key words that describe the contents of the article such as those that appear in the Cumulative Index to Nursing and Allied Health Literature (CINAHL) or the National Library of Medicine's (NLM's) Medical Subject Headings (MeSH).
- There should be a clear indication of the placement of all tables and figures in text.
- The author is responsible for obtaining written permission for any borrowed text, tables, or figures.

References

- References must be cited in text and styled in the reference list according to the *American Medical Association Manual of Style*, 10th edition, copyright 2007 American Medical Association. They must be numbered consecutively in the order they are cited and listed in that sequence (not alphabetically); reference numbers may be used more than once throughout an article. Page numbers should appear with the text citation following a specific quote. References should be double-spaced and placed at the end of the text.
- References should not be created using Microsoft Word's automatic footnote/endnote feature.

Figures

A. Four Steps for Submitting Artwork

1. Learn about Digital Art creation here.
2. Create, Scan, and Save your artwork according to the Digital Artwork Guideline Checklist.
3. Upload each figure to Editorial Manager in conjunction with your manuscript text and tables.

B. Color Figures: The journal accepts color figures for publication that will enhance an article. Authors who submit color figures will receive an estimate of the cost for color reproduction in print. If they decide not to pay for color reproduction in print, they can request that the figures be converted to black and white at no charge. All color figures can appear in color in the online version of the journal at no charge. (Note: this includes the online version on the journal website and Ovid, but not the iPad edition currently.)

C. Digital Artwork Guideline Checklist Basics to have in place before submitting your digital art.

- Artwork saved as JPG, TIFF and EPS files. Do not save TIFFs as compressed files.
- Artwork created as the actual size (or slightly larger) than it will appear in the journal. (To get an idea of the size images should be when they print, study a copy of the journal. Measure the artwork typically shown and scale your image to match.)
- Crop out any white or black space surrounding the image.
- Text and fonts in any figure are one of the acceptable fonts: Helvetica, Times Roman, Symbol, Mathematical PI, and European PI.
- Color images are created/scanned and saved and submitted as CMYK only. Do not submit any figures in RGB mode because RGB is the color mode used for screens/monitors and CMYK is the color mode used for print.
- Line art saved at a resolution of at least 1200 dpi.
- Images saved at a resolution of at least 300 dpi.
- Each figure saved as a separate file and saved separately from the accompanying text file.
- For multipanel or composite figures only: Any figure with multiple parts should be sent as one file, with each part labeled the way it is to appear in print.

Remember:

- Artwork generated from office suite programs such as CorelDRAW, MS Word, Excel, and artwork downloaded from the Internet (JPEG or GIF files) cannot be used because the quality is poor when printed.
- Cite figures consecutively in your manuscript.
- Number figures in the figure legend in the order in which they are discussed.

- Upload figures consecutively to the Editorial Manager Web site and number figures consecutively in the Description box during upload.
- All electronic art that cannot be successfully uploaded must be submitted on a 31/2-inch high-density disk, a CD-ROM, or an Iomega Zip disk, accompanied by high-resolution laser prints of each image.

Tables Tables should be on a separate page at the end of the manuscript. Number tables consecutively and supply a brief title for each. Include explanatory footnotes for all nonstandard abbreviations. Cite each table in the text in consecutive order. If you use data from another published or unpublished source, obtain permission and acknowledge fully.

Supplemental Digital Content Authors may submit SDC that enhances their article's text to be considered for online posting. SDC may include standard media such as text documents, graphs, audio, video, etc. On the Attach Files page of the submission process, please select Supplemental Audio, Video, or Data for your uploaded file as the Submission Item. If an article with SDC is accepted, our production staff will create a URL with the SDC file. The URL will be placed in the call-out within the article. SDC files are not copyedited by LWW staff; they will be presented digitally as submitted. For a list of all available file types and detailed instructions, please visit the Checklist for Supplemental Digital Content.

SDC Call-outs: SDC must be cited consecutively in the text of the submitted manuscript. Citations should include the type of material submitted (Audio, Figure, Table, etc.), be clearly labeled as "Supplemental Digital Content," include the sequential list number and provide a description of the supplemental content. All descriptive text should be included in the call-out, as it will not appear elsewhere in the article.

Example: We performed many tests on the degrees of flexibility in the elbow (see Video, Supplemental Digital Content 1, which demonstrates elbow flexibility) and found our results inconclusive.

List of Supplemental Digital Content: A listing of SDC items must be submitted at the end of the manuscript file. Include the SDC number and file type. This text will be removed by our production staff and not be published.
Example:
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Appendix 1.2. Risk of bias ratings for second rater

	Methods for selecting study participants	Design-specific confounders	Methods to control confounding	Methods for assessing the prevalence of HI in female offenders	Methods for assessing the epidemiology of HI in female prisoners	Methods for assessing the impact of HI upon female offenders	Methods for assessing how the needs of female offenders with HI differ from other offender groups
Brewer-Smyth 2008	HIGH	HIGH	HIGH	HIGH	HIGH	N/A	N/A
Brewer-Smyth 2004	LOW	HIGH	HIGH	HIGH	N/A	N/A	**HIGH**
Colantonio 2014	LOW	HIGH	HIGH	HIGH	LOW	**HIGH**	LOW
Diamond 2007	LOW	HIGH	HIGH	N/R	LOW	N/R	N/R
Durand 2016	LOW	HIGH	HIGH	HIGH	LOW	**HIGH**	LOW
Ferguson 2012	LOW	HIGH	HIGH	HIGH	HIGH	HIGH	N/A
Fishbein 2016	LOW	HIGH	HIGH	HIGH	LOW	LOW	N/A
Kaba 2014	LOW	HIGH	HIGH	HIGH	**HIGH**	LOW	LOW
Moore 2013	LOW	HIGH	HIGH	HIGH	LOW	HIGH	**LOW**
Nolan 2017	LOW	HIGH	HIGH	HIGH	N/A	N/A	N/A
Shiroma 2010	LOW	LOW	HIGH	HIGH	HIGH	N/A	LOW
Slaughter 2003	LOW	HIGH	HIGH	HIGH	N/A	**HIGH**	N/A

Differences between raters which were later resolved by discussion are highlighted in red.

Appendix 2.1. Letter and emails confirming ethical approval

WoSRES
West of Scotland Research Ethics Service

NHS
Greater Glasgow and Clyde

Professor Tom McMillan
Professor of Clinical Neuropsychology
University of Glasgow
1st Floor, Admin Building
Gartnavel Royal Hospital, 1055 Great Western Road
Glasgow
G12 0XH

West of Scotland REC 4
West Ambulatory Care Hospital
Dalnair Street
Yorkhill
Glasgow
www.nhsggc.org.uk

Date 16 November 2016
Direct line 0141-232-1806
e-mail Wosrec4@ggc.scot.nhs.uk

Dear Professor McMillan

Study title: **Head injury in Scottish Prisons: Identifying the prevalence, associated disability and validating the Brain Injury Screening Index (BISI) and the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID) as screening tools.**
REC reference: **16/WS/0216**
Protocol number: **N/A**
IRAS project ID: **209565**

Thank you for your submission of 15 November 2016. I can confirm the REC has received the documents listed below and that these comply with the approval conditions detailed in our letter dated 09 November 2016

Documents received

The documents received were as follows:

Document	*Version*	*Date*
Other [Participant information sheet for prisoners v4]	V4	15 November 2016
Other [Participant information sheet prison officer V3]	V3	15 November 2016

Approved documents

The final list of approved documentation for the study is therefore as follows:

Document	*Version*	*Date*
Copies of advertisement materials for research participants [Recruitment Poster v3]	v3	19 September 2016
Covering letter on headed paper [Cover letter to prison health professionals v2]	V2	23 August 2016

Document	*Version*	*Date*
Interview schedules or topic guides for participants [Data Capture Form v3]	v3	19 September 2016
Non-validated questionnaire [Brain Injury Screening Index v1]	V1	21 January 2016
Non-validated questionnaire [Ohio State University Traumatic Brain Injury Identification form v1]	V1	21 January 2016
Other [CV Student Abi Rorison v1]		22 August 2016
Other [Participant information sheet for prisoners v4]	V4	15 November 2016
Other [Participant information sheet prison officer V3]	V3	15 November 2016
Participant consent form [Consent form participant prisoner v2]	V2	19 September 2016
Participant consent form [Participant consent form prison officer v1]	V1	23 August 2016
Participant information sheet (PIS) [Participant Information sheet for prisoners v2]	V2	19 September 2016
Participant information sheet (PIS) [Participant Information sheet prison officer v1]	v1	23 August 2016
REC Application Form [REC_Form_19102016]		19 October 2016
Research protocol or project proposal [Project proposal]	V4	22 September 2016
Summary CV for Chief Investigator (CI) [CI Prof Tom McMillan CV v1]		30 June 2016
Summary CV for student [CV Student Vicky Walker v1]		22 August 2016
Validated questionnaire [Glasgow Outcome at Discharge Scale]		
Validated questionnaire [Hospital Anxiety and Depression Scale]		

You should ensure that the sponsor has a copy of the final documentation for the study. It is the sponsor's responsibility to ensure that the documentation is made available to R&D offices at all participating sites.

16/WS/0216 **Please quote this number on all correspondence**

Yours sincerely

Sophie Bagnall
Assistant Coordinator

Copy to: *Ms Emma-Jane Gault*
Ms Elaine O'Neill, NHS Greater Glasgow and Clyde

From: Tom McMillan
Sent: 30 August 2016 09:09
To: Vicky Walker; Abigail Rorison
Subject: FW: sps approval

Approval from SPS

I will sign the form and return to them

Bw

Tom McMillan
Professor of Clinical Neuropsychology
Institute of Health and Wellbeing
University of Glasgow
Tel: +44 (0)141 211 0354

From: Carnie James [mailto:James.Carnie@sps.pnn.gov.uk]
Sent: 26 August 2016 14:59
To: Tom McMillan
Cc: McKillop Forbes; Porter John (HEALTHCARE IMPROVEMENT SCOTLAND - SD039) (john.porter1@nhs.net); Parker Ruth
Subject: RE: planning for implementation of the BI and Offenders report

Tom

The Research Access and Ethics Committee met on Wednesday and was content to approve access for your Brain Injury study.

With the closing of Cornton Vale, the study was now focusing on Shotts and Low Moss. RAEC encouraged as broad a sampling range as possible across other establishments with different populations to include LTPs/STPs; violent/non-violent; male/female etc. prisoners.

Please sign the standard access regulations and return to me in Calton House.

RAEC wished you well with the completion of the study.

Jim

From: Tom McMillan [mailto:Thomas.McMillan@glasgow.ac.uk]
Sent: 22 July 2016 13:54
To: Carnie James <James.Carnie@sps.pnn.gov.uk>
Cc: McKillop Forbes <Forbes.McKillop@sps.pnn.gov.uk>; Porter John (HEALTHCARE IMPROVEMENT SCOTLAND - SD039) (john.porter1@nhs.net) <john.porter1@nhs.net>; Parker

Ruth <Ruth.Parker@sps.pnn.gov.uk>
Subject: RE: planning for implementation of the BI and Offenders report

Dear James

The Brain Injury and Offenders report was recently published
: http://www.nphn.scot.nhs.uk/nphn-brain-injury-and-offending-final-report-publication/

We have moved on with the research proposal (attached) which relates to research questions R1 and R5 in the report and would be carried out by two Doctorate in Clinical Psychology trainees as part of their professional training (under my supervision). To do this they need to begin recruiting around September/October and finish recruiting in April 2017. We are mid-application to NHS ethics and need to apply now for approval to SPS.

This project basically is looking at (i) the practicality and usefulness of two screening tests for HI in prisoners (ii) the prevalence by self-report and (iii) the numbers who are disabled bu HI and may need specialist input. We plan to do this in two prisons- Shotts (who have agreed in principle) and Low Moss –NPHN are going to make an initial approach to them.

Is there a specific application form to the SPS – or can this proceed via the attached proposal?

Best wishes

Tom McMillan

Professor of Clinical Neuropsychology

Institute of Health and Wellbeing

University of Glasgow

Tel: +44 (0)141 211 0354

REGULATIONS CONCERNING RESEARCH ACCESS TO PRISON ESTABLISHMENTS FOR

THE PURPOSES OF CONDUCTING RESEARCH

All access to prison establishments for the purposes of conducting research is conditional on the

researcher(s) agreeing to abide by the undernoted requirements.

1. All data and research material arising out of the study must be dealt with on an anonymous,

unattributable and confidential basis. No individual should be named or identified. Researchers must

comply with the Data Protection Act (1998).

2. If the study is to involve interviewing respondents, all such respondents must give voluntary consent

and be informed of the purpose of the study; anticipated uses of data; identity of funder(s) (if

applicable); and the identity of the interviewer.

3. All research data and material of whatever kind (i.e. interview notes, questionnaires, tapes, transcripts,

reports, documents, specifications, instructions, plans, drawings, patents, models, designs, whether in

writing or on electronic or other media) obtained from the Scottish Prison Service shall remain the

property of the Crown. Information collected during the course of a research project must not be

supplied to another party or used for any other purpose other than that agreed to and contained in the

original research proposal. All confidential research data obtained from SPS must be held securely for

up to a maximum of 60 months on completion of the research and destroyed thereafter.

4. All researchers must abide by the ethical guidelines of their profession or discipline and must nominate

below the guidelines to which they will adhere. (e.g. Social Research Association, British Sociological

Association etc.) All researchers must arrange to be cleared with Enhanced Disclosure if contact with

prisoners in envisaged.

5. Where appropriate, research proposals may require to be submitted to the Ethics Committee of the

Area Health Board (or MREC) and to receive its approval before access is granted.

6. The Chair of the SPS Research Access and Ethics Committee (RAEC) must be informed in writing and

agree to any changes to the project which involve alterations to the essential nature of the agreed work.

7. The Scottish Prison Service reserves the right to terminate access to SPS establishments at any time for

any Operational reason that may arise or for any breach by the researcher of the Access Regulations or

for any failure on the part of the researcher to conduct the study as agreed with the RAEC. In the event

of access being terminated for any reason whatsoever, all data obtained from SPS during the course of

the research shall be returned to the Scottish Prison Service.

8. The Scottish Prison Service has a duty of care to staff and visitors on its premises and has public

liability indemnity.

9. It is a condition of access that a copy of any final report or dissertation or other written output arising

from the research MUST be submitted to SPS to be lodged in its Research Library. Any material

resulting from access which is intended to be presented publicly must also be submitted to SPS. In

principle, the Scottish Prison Service supports the publication and dissemination of research findings

arising from approved work, but the Service reserves the right to amend factual inaccuracies.

10. Reports and presentations should be sent to the Chair of the Research Access and Ethics Committee,

Analytical Services, SPS Headquarters, Calton House, Redheughs Rigg, Edinburgh EH12 9HW.

Ethical guidelines nominated_____

I have read the above regulations and agree to be bound by them.

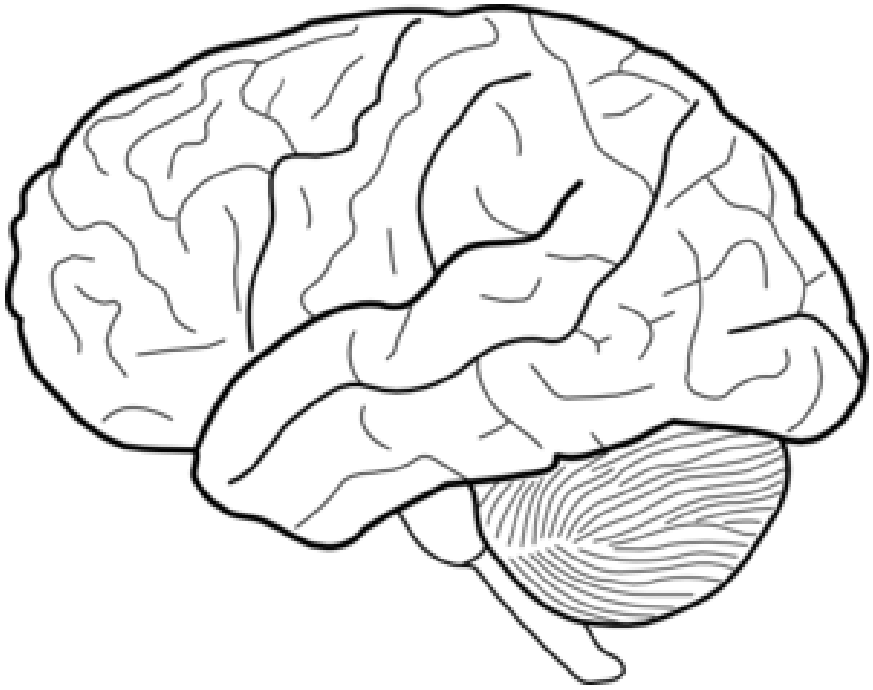
(Signature) 1.12.16 (Date)

Appendix 2.2. Recruitment poster

University of Glasgow | College of Medical, Veterinary & Life Sciences

NHS Greater Glasgow and Clyde

RECRUITING: HEAD INJURY STUDY



WE ARE TRYING TO UNDERSTAND THE NEEDS OF THOSE IN PRISON WHO MAY HAVE HAD A HEAD INJURY.

THIS STUDY IS OPEN TO ALL SERVING A SENTENCE WITHIN THE PRISON.

DO YOU HAVE ABOUT 40-60 MINUTES TO SPARE?

PLEASE TAKE AN INFORMATION SHEET AND SPEAK TO A STAFF MEMBER IF YOU ARE INTERESTED.

Version 3
19th September 2016

Appendix 2.3. Participant Information Sheet

University of Glasgow | College of Medical, Veterinary & Life Sciences

NHS Greater Glasgow and Clyde

PARTICIPANT INFORMATION SHEET

Identifying Head Injury & Associated Disability in Scottish Prisons

We would like you to help us in a research study on head injury. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. If anything is unclear and you would like to ask us questions about the study please speak to a staff member who will notify us. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

We are carrying out this study to consider the needs of those with undiagnosed head injuries in prison. We aim to understand the rates of head injury and associated disability in prisons. We also aim to examine how practical and accurate screening tools are in identifying head injury and associated disability. This study will contribute towards the researchers' qualifications, and will fulfill a component of their Doctorate in Clinical Psychology.

Why have I been chosen?

You have been chosen because you are currently serving a custodial sentence in Scotland.

Do I have to take part?

It is up to you to decide whether or not to take part, and there will be no consequences for you either way except the time required to complete the study, should you decide to take part. You will be given this information sheet to keep and if you wish to partake you will be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?

You will be invited to attend for a single assessment lasting approximately 60 minutes. You will be randomly allocated to a group which will use one of two questionnaires to ask you about any potential head injury you may have had. This will involve:

(i) a brief interview about recent health and history of head injury (ii) questionnaires about psychological wellbeing; (iii) tests of cognition such as concentration and memory.

Additionally, researchers will need to obtain NHS records pertaining to any hospital admission that you have had which involved a head injury, and will access details of any prison incident reports from your current custodial sentence.

Where will the assessment take place?

The assessment will take place within the prison. If you need to be excused from work to attend the study, you will not lose out on any work payments.

What do I have to do?

You just have to attend for the assessment lasting approximately 60 minutes.

What are the possible disadvantages and risks of taking part?

There are no particular disadvantages to taking part and your participation will have no impact upon your custodial sentence.

What are the possible benefits of taking part?

You will receive no direct benefit from taking part. The information collected in the study will give us a better understanding of head injury within prisons, and may allow us to make recommendations for prison health service improvements.

Will my taking part in this study be kept confidential?

You will be identified by an identity number, and any information about you will have your name removed so that you cannot be recognised from it. Information collected will be kept within the University of Glasgow department in a locked cabinet for 10 years in order to meet record keeping guidelines and for future research. Scientific publications arising from the research will not identify you or anyone taking part. Researchers will obtain information from NHS records pertaining to any hospital admission which will be kept confidential. All information collected about you during the research will be kept strictly confidential, accessible only to two researchers and study supervisors, University of Glasgow, and representatives of the study Sponsor, NHS Greater Glasgow & Clyde, who will make sure that the study is being conducted correctly. However, the following exceptions apply. If during the course of the research we become concerned that you or another person is at risk of harm, or if a crime has been committed, we are obligated to pass this information on to the Scottish Prison Service. Further, if a severe head injury, with disability, is identified, we will inform the Prison Health Service of this so that it can inform your future care.

What will happen to the results of the research study?

When the project is completed, the findings will be submitted for publication in peer reviewed international journals. Further, the results may be used in conference

presentations, and will be detailed within theses to fulfill the requirements of the Doctorate in Clinical Psychology.

Who is organising and funding the research?

The research is organised by the University of Glasgow. The research is funded by the University of Glasgow and partly by the National Prison Healthcare Network.

Who has reviewed the study?

The project has been reviewed by the University of Glasgow College of Medical Veterinary and Life Sciences, the West of Scotland NHS Research Ethics Committee and the Scottish Prison Service.

Contact for Further Information

You can contact Vicky Walker, Abi McGinley or Professor Tom McMillan (0141 211 0354) who are organising the research.

Thank you for considering this request to take part in the study.

Appendix 2.4. Participant Consent Form

Participant ID Number: _____

CONSENT FORM

Title: Identifying Head Injury & Associated Disability in Scottish Prisons

Please initial box

1. I confirm that I have read and understand the information sheet dated 15/11/16 (Version 4) for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary, that it will have no effect on my custodial sentence and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected. ☐

3. I agree that if researchers believe that I or another person is at risk of harm, they will pass this information to prison staff. ☐

4. I agree that the researchers can obtain NHS records pertaining to any hospital admission that I have had. ☐

5. I agree that, if the researchers find evidence that I have had a significant head injury, they will inform prison staff of this so that they can consider this in terms of my care. ☐

6. I agree that, if a severe head injury, with associated disability, is identified during the course of the study, researchers will inform the Prison Health Service of this so that it can inform future care. ☐

7. I consent to researchers accessing my medical records to determine the details of any hospital admission that I have had involving a head injury.

8. I consent to researchers accessing prison incident reports ☐

9. I understand that anonymous data collected during the study, will be looked at by individuals from University of Glasgow (2 researchers and study supervisors), from representatives of the study, specifically the study Sponsor & NHS Greater Glasgow & Clyde, for audit purposes, by regulatory authorities or by the NHS Board, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐

10. I agree to my data being retained for 10 years, including following loss of capacity. I understand this is for the purpose of future research and that all data will be destroyed confidentially after this period. ☐

11. I agree to take part in the above study. ☐

_____	_____	_____
Name of participant	***Date***	***Signature***

_____	_____	_____
Name of Person taking consent	***Date***	***Signature***

Appendix 2.5. Prison officer information sheet

University of Glasgow | College of Medical, Veterinary & Life Sciences

NHS Greater Glasgow and Clyde

PARTICIPANT INFORMATION SHEET FOR PRISON OFFICERS

Identifying Head Injury & Associated Disability in Scottish Prisons

We would like you to help us in a research study on head injury. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. If anything is unclear and you would like to ask us questions about the study please speak to a staff member who will notify us. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

We are carrying out this study to consider the needs of those with undiagnosed head injuries in prison. We aim to understand the rates of head injury and associated disability in prisons. We also aim to examine how practical and accurate screening tools are in identifying head injury and associated disability. This study will contribute towards the researchers' qualifications, and will fulfill a component of their Doctorate in Clinical Psychology.

Why have I been chosen?

You have been chosen because you are currently working as a prison officer within the Scottish Prison Service, and part of your role is that of key worker to one of our participants.

Do I have to take part?

It is up to you to decide whether or not to take part, and there will be no consequences for you either way except the time required to complete the study, should you decide to take part. You will be given this information sheet to keep and if you wish to partake you

will be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

What will happen to me if I take part?

You will be invited to attend for a single meeting lasting approximately 15 minutes. This can either be carried out in person or over the phone, to suit you. The meeting will involve the completion of a questionnaire, the Glasgow Outcome at Discharge Scale (McMillan et al, 2013). This is a measure which is specifically designed to detect disability following HI. It requires to be rated both by the individual who may have had a head injury, and by an informant who is able to comment on their level of functioning as they have observed it. You will also be asked to provide incident report information relating to the participant.

Where will the meeting take place?

The meeting will take place within your working day in the prison, either face to face or over the phone.

What do I have to do?

You have to attend for the meeting lasting approximately 15 minutes. During this you will be asked questions from the GODS and to provide information on the participants' incident reports.

What are the possible disadvantages and risks of taking part?

No, there are no particular disadvantages to taking part.

What are the possible benefits of taking part?

You will receive no direct benefit from taking part. The information collected in the study will give us a better understanding of head injury within prisons, and may allow us to make recommendations for prison health service improvements.

Will my taking part in this study be kept confidential?

You will be identified by the identity number which corresponds with that which is given to the participant. Any information about you will have your name removed so that you

cannot be recognised from it. Information collected will be kept within the University of Glasgow department in a locked cabinet for 10 years in order to meet record keeping guidelines and for future research. Scientific publications arising from the research will not identify you or anyone taking part. All information collected from you during the research will be kept strictly confidential, accessible only to two researchers and study supervisors, University of Glasgow, and representatives of the study Sponsor, NHS Greater Glasgow & Clyde, who will make sure that the study is being conducted correctly. However, the following exceptions apply. If during the course of the research we become concerned that you or another person is at risk of harm, or if a crime has been committed, we are obligated to pass this information on to the Scottish Prison Service.

What will happen to the results of the research study?

When the project is completed, the findings will be submitted for publication in peer reviewed international journals. Further, the results may be used in conference presentations, and will be detailed within theses to fulfill the requirements of the Doctorate in Clinical Psychology.

Who is organising and funding the research?

The research is organised by the University of Glasgow. The research is funded by the University of Glasgow and partly by the National Prison Healthcare Network.

Who has reviewed the study?

The project has been reviewed by the University of Glasgow College of Medical Veterinary and Life Sciences, the West of Scotland NHS Research Ethics Committee and the Scottish Prison Service.

Contact for Further Information

You can contact Vicky Walker: v.walker.1@research.gla.ac.uk or Abi McGinley: a.rorison.1@research.gla.ac.uk; who will be arranging and carrying out the assessments or Professor Tom McMillan thomas.mcmillan@glasgow.ac.uk (0141 211 0354); who is organising the research.

Thank you for considering this request to take part in the study.

Appendix 2.6. Prison officer consent form

Participant ID Number: _____

CONSENT FORM FOR PRISON OFFICERS

Title: Identifying Head Injury & Associated Disability in Scottish Prisons

Please initial box

1. I confirm that I have read and understand the information sheet dated 15.11.16 (Version 3) for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected. ☐

3. As key worker for the participant, I consent to completing the Glasgow Outcome at Discharge Scale (GODS) as a measure of disability and providing incident reports for the relevant participant(s) ☐

4. I understand that anonymous data collected during the study, will be looked at by individuals from University of Glasgow (2 researchers and study supervisors), from representatives of the study, specifically the study Sponsor & NHS Greater Glasgow & Clyde, for audit purposes, by regulatory authorities or by the NHS Board, where it is relevant to the participant taking part in this research. I give permission for these individuals to have access to my ratings on the GODS. ☐

5. I agree to this data being retained for 10 years, including following loss of capacity. I understand this is for the purpose of future research and that all data will be destroyed confidentially after this period. ☐

6. I agree to take part in the above study. ☐

_____	_____	_____
Name of key worker	*Date*	*Signature*
_____	_____	_____
Name of Person taking consent	*Date*	*Signature*

Appendix 2.7. Template letter to prison health professionals

University of Glasgow
Institute of Health and Wellbeing
First floor Admin building
Gartnaval Royal Hospital
1055 Great Western Road
Glasgow
G12 0XH

HEALTH PROFESSIONAL
HMP Shotts
Health Centre
Canthill Road
Shotts
ML7 4LE

Dear .....

Re:

We are recruiting prisoners to take part in our study as we are aiming to understand the needs of prisoners with undiagnosed head injury.

I am writing to inform you that the above named gentleman has agreed to participate in our research study, 'Head Injury in Scottish Prisons: Prevalence, Associated Disability, and Routine Screening'. An information sheet with details of the study is enclosed.

We are recruiting prisoners who may or may not have a head injury. Many of our participants will not have a head injury therefore we cannot infer this about the above named gentleman's care at this stage. One of our researchers will meet with the above named gentleman over the upcoming months. If our study identifies that the above named gentleman has had a significant head injury with resulting disability, we will write to you following the study.

In the meantime, should you wish to contact us regarding the study, contact details are contained within the enclosed information sheet.

Yours sincerely

Professor Tom McMillan
Vicky Walker
Abi McGinley

Appendix 2.8. Data capture form

Data Capture Form: Head Injury in Scottish Prisons: Prevalence, Associated Disability, and Routine Screening (v3, 19th September 2016)

University of Glasgow | College of Medical, Veterinary & Life Sciences

NHS Greater Glasgow and Clyde

Participant ID no				
Age				
Ethnicity	White			
	Mixed or multiple			
	Asian			
	Asian/Caribbean/Black			
	Other			
Postcode - Socio-economic status (DEPCAT or SIMD scores)				
Years of education				
Schooling type	Mainstream			
	Mainstream with 1:1 support			
	Specialist			
Did you miss any school? Approximately how often?		<20 times through school career	At least once/ month (from – until)	At least once/ Week (from – until)
	Truancy			
	Illness			
	Suspension /exclusion			
Most recent occupation category	Managers, directors and senior officials			
	Professional occupations			
	Associate Professional And Technical Occupations			
	Administrative And Secretarial Occupations			
	Skilled Trades Occupations Caring, Leisure And Other Service Occupations			
	Sales And Customer Service Occupations			

	Process, Plant And Machine Operatives		
	Elementary Occupations		
	None		
Previous problematic alcohol use	Yes		
	No		
Previous problematic substance use	Yes		
	No		
Offence history	Number of arrests		
	Number of charges		
	Number of convictions		
	Length of custodial sentence served to date		
	Offence types	Violent	
		Sexual	
		Property	
		Other	
	Age at first offence		
Age at first HI			
How many HI's			
HI's occurred before or after 1994	Before		
	After		
Loss of consciousness	None		
	< 30 minutes		
	30 minutes – 24 hours		
	>24 hours		
Glasgow Coma Scale Score	Unknown		
	Mild: 13-15		
	Moderate: 9-12		
	Severe: 3-8		
Any PTA?	Unknown		
	Mild: <1 hour		
	Moderate: 30 mins – 24 hours		
	Severe: >24 hours		
Estimated number of days spent in hospital?			
What was follow up after HI?	Verbal guidance		
	Written guidance		

	Appointment with health professional	
	On-going therapy/rehabilitation	
	Other	
Brain Injury Screening Index (BISI) score		
BISI category of severity	Mild (reports a blow to the head resulting in feeling dizzy/dazed)	
	Moderate-Severe (includes multiple)- Reports no memory after incident and told LOC	
	Acquired	
Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID) category	Likely	
	Not likely	
OSU TBI-ID category of severity	No HI	
	Mild (no LOC)	
	Mild (LOC <30 minutes)	
	Moderate (includes multiple) – most severe injury LOC between 30 minutes and 24 hours	
	Severe includes multiple most severe injury LOC > 24 hours	
Glasgow Outcome at Discharge Scale (GODS) category	Dead (1)	
	Not conscious (2)	
	Lower Severe Disability (Lower SD) (3)	
	Upper Severe Disability	

	(Upper SD) (4)	
	Lower Moderate Disability (Lower MD) (5)	
	Upper Moderate Disability (Upper MD) (6)	
	Lower Good Recovery (Lower GR) (7)	
	Upper Good Recovery (Upper GR) (8)	
Glasgow Outcome at Discharge Scale (GODS) category *(proxy rating)*	Dead (1)	
	Not conscious (2)	
	Lower Severe Disability (Lower SD) (3)	
	Upper Severe Disability (Upper SD) (4)	
	Lower Moderate Disability (Lower MD) (5)	
	Upper Moderate Disability (Upper MD) (6)	
	Lower Good Recovery (Lower GR) (7)	
	Upper Good Recovery (Upper GR) (8)	
Hospital Anxiety and Depression Scale (HADS) score	Depression score	
	Anxiety score	
Adult Memory and Information Processing Battery (AMIPB) - List Learning Sub-Test score		
Symbol Digit Modalities Test (SDMT) score		
Trail Making Test (TMT) score	Part 1 score (seconds)	
	Part 2 score (seconds)	
Hayling Sentence Completion Test score (seconds)		
Word Memory Test score		
Scottish Morbidity Records (SMR-01) ICD-10 code(s) ***Codes from ICD-10 start with 'S', codes from ICD-9 start with 8****	S02.0Fracture of vault of skull	
	S02.1Fracture of base of skull	
	S02.7Multiple fractures involving skull and facial bones	
	S02.8Fractures of other skull and facial bones	
	S02.9Fracture of skull and facial bones, part unspecified	
	S06.0Concussion	
	S06.1Traumatic cerebral oedema	
	S06.2Diffuse brain injury	
	S06.3Focal brain injury	

	S06.4Epidural haemorrhage	
	S06.5Traumatic subdural haemorrhage	
	S06.6Traumatic subarachnoid haemorrhage	
	S06.7Intracranial injury with prolonged coma	
	S06.8Other intracranial injuries	
	S06.9Intracranial injury, unspecified	
	(800) Fracture of vault of skull	
	(801) Fracture of base of skull	
	(803) Other and unqualified skull fractures	
	(804) Multiple fractures involving skull or face with other bones	
	(850) Concussion	
	(851) Cerebral laceration and contusion	
	(852) Subarachnoid, subdural, and extradural hemorrhage, following injury	
	(853) Other and unspecified intracranial hemorrhage following injury	
	(854) Intracranial injury of other and unspecified nature	
Worst HI (in terms of LOC- taken from SMR-01)	When	
	Nature of HI (e.g. RTA)	
	Duration of LOC	
Number of incident Reports		

Brain Injury Screening Index (BISI®)

Date: ____/____/_____ **Age:** _____ **Gender:** ☐ Male ☐ Female ☐ Prefer not to say

Education (years of full time education and/or highest qualification obtained): _____

BISI BRAIN INJURY SCREENING INDEX

	1st Injury		2nd Injury		3rd Injury		4th Injury		5th Injury	
Q 1. Have you ever had a serious blow to the head?	YES ☐	NO ☐ Ask Q 8.								
Q 2. When and how did it happen? Record here ➡	_____		_____		_____		_____		_____	
Q 3. Did it leave you feeling dizzy, unsteady or dazed?	YES ☐	NO ☐	YES ☐	NO ☐	YES ☐	NO ☐	YES ☐	NO ☐	YES ☐	NO ☐
Q 4. Were you able to remember what happened to you in the hours after the injury?	YES ☐	NO ☐	YES ☐	NO ☐	YES ☐	NO ☐	YES ☐	NO ☐	YES ☐	NO ☐
Q 5. Were you told you were unconscious at the time? For how long? Record here (in minutes) ➡	YES ☐ _____	NO ☐	YES ☐ _____	NO ☐	YES ☐ _____	NO ☐	YES ☐ _____	NO ☐	YES ☐ _____	NO ☐ Ask Q 8.
Q 6. Following the injury, did you (tick all that apply)										
Go to hospital	☐		☐		☐		☐		☐	
See a paramedic	☐		☐		☐		☐		☐	
Do nothing	☐		☐		☐		☐		☐	
Don't know	☐		☐		☐		☐		☐	
Other (please specify)	☐		☐		☐		☐		☐	
Q 7. Have you had any other blows to your head? How many? Record here ➡	YES ☐ _____ Repeat Q 2-6 for 2nd to 5th injuries		NO ☐ Ask Q 8.							

Q 8. Have you ever had an illness affecting your brain?	YES ☐	NO ☐	
What was it (give as many details as possible)?	Record here ➡		_____ _____
Q 9. Have you suffered from epilepsy, fits or blackouts?	YES ☐	NO ☐	
Q 10. Do you have any significant problems with your (tick all that apply)...	Memory ☐	Speech ☐	
	Concentration ☐	Other (please specify) _____	
Q 11. Have you ever seen a doctor for, or been diagnosed with...	Tick all that apply below		
Attention Deficit Hyperactivity Disorder (ADHD)	☐		
Learning difficulties or learning disabilities	☐		
Serious mental health problems	☐		

The Disabilities Trust Foundation
The Disabilities Trust

Appendix 2.10. The Brain Injury Screening Index Guidance Notes

BISI
BRAIN INJURY SCREENING INDEX

The Disabilities Trust Foundation
The Disabilities Trust

Brain Injury Screening Index

GUIDANCE NOTES

The Brain Injury Screening Index [BISI®] is a validated resource to screen for head injuries and associated conditions and establish whether an individual may have sustained a brain injury.

WHO SHOULD USE IT?

Developed for use by practitioners of all levels, the BISI can be used by primary and secondary health and social care professionals, forensic and community-based services, housing support teams, probation officers, police staff and key workers.

WHY DO WE ASK THESE QUESTIONS?

The BISI records an individual's self-reported history of brain injury. Results enable professionals to ensure that the relevant support is in place to assist individuals with suspected brain injury and address complex impairments that can present following a blow to the head.

Q1. This question is designed to screen individuals who might have sustained a TBI in their lifetime. Due to the impact of a TBI on consciousness, it is possible that a person might not be aware that they have suffered a TBI.

Q2. This question gathers further detail about the injury, in particular Time Since Injury, as this variable is often correlated with outcome

Q3. This question is designed to gauge whether a brain injury is likely to have occurred.

Q4. This question gathers information as to whether Post-Traumatic Amnesia was present. This is one of the main measures of injury severity.

Q5. This question gathers information as to whether the person was unconscious. Length of loss of consciousness is another important measure of injury severity.

Q6. This question can further validate the information gathered with the BISI, but it also provides important epidemiological information, as many individuals who sustain a significant brain injury do not seek or receive adequate medical attention.

Q7. This question screens those who may have suffered more than one mild TBI and experience significant problems as a result. Research has shown that multiple mild traumatic brain injuries may have a cumulative effect that increases the long-term risk of psychiatric and neurologic problems and may be associated with longer recovery time.

BISI
BRAIN INJURY SCREENING INDEX

The Disabilities Trust Foundation
The Disabilities Trust

Q8. This question screens those who may have an acquired brain injury of a different aetiology from Traumatic Brain Injury (TBI). While TBI is a major cause of acquired brain injury and disability, particularly in younger individuals, it is not the only cause.

Q9. Symptoms of brain injury may include epilepsy, fits and blackouts.

Q10. Problems with memory, concentration and speech may be, although not necessarily, indicative of brain injury.

Q11. This question screens for neurodevelopmental problems (e. g. ADHD, Learning Disabilities) which are also common amongst offenders, and may complicate the outcome of an acquired brain injury (ABI). There is overlap between the effects of an ABI and neurodevelopmental disorders, so it is important to know if the person has these conditions.

If an individual answers 'No' to Q1 and Q8 it can be inferred that they do not have a history of acquired brain injury and therefore the result of the screen is normal.

INJURY SEVERITY

Positive for **mild Traumatic Brain Injury** if YES to Q1 AND Q3
Positive for **moderate to severe Traumatic Brain Injury** if NO to Q4 AND/OR YES to Q5 OR to Q7
Positive for other forms of **Acquired Brain Injury** if YES to Q8

TBI INDEX

The severity of a brain injury can be estimated by completing the TBI Index calculation, based on the participant's answers to question 5 and question 7.

TBI Index = Number of injuries x Greatest length of unconscious (LOC) in minutes

TBI Index	
Between 1-10	Mild
Between 11-30	Moderate
Between 31-60	Severe
Between 61-300	Very Severe
≥ 301	Extremely Severe

Name: _____ Current Age: _____ Interviewer Initials: _____ Date: _____

Ohio State University TBI Identification Method — Interview Form

Step 1

Ask questions 1-5 below. Record the cause of each reported injury and any details provided spontaneously in the chart at the bottom of this page. You do not need to ask further about loss of consciousness or other injury details during this step.

I am going to ask you about injuries to your head or neck that you may have had anytime in your life.

1. In your lifetime, have you ever been hospitalized or treated in an emergency room following an injury to your head or neck? Think about any childhood injuries you remember or were told about.
   ☐ No ☐ Yes—Record cause in chart
2. In your lifetime, have you ever injured your head or neck in a car accident or from crashing some other moving vehicle like a bicycle, motorcycle or ATV?
   ☐ No ☐ Yes—Record cause in chart
3. In your lifetime, have you ever injured your head or neck in a fall or from being hit by something (for example, falling from a bike or horse, rollerblading, falling on ice, being hit by a rock)? Have you ever injured your head or neck playing sports or on the playground?
   ☐ No ☐ Yes—Record cause in chart
4. In your lifetime, have you ever injured your head or neck in a fight, from being hit by someone, or from being shaken violently? Have you ever been shot in the head?
   ☐ No ☐ Yes—Record cause in chart
5. In your lifetime, have you ever been nearby when an explosion or a blast occurred? If you served in the military, think about any combat- or training-related incidents.
   ☐ No ☐ Yes—Record cause in chart

Interviewer instruction:
If the answers to any of the above questions are "yes," go to Step 2. If the answers to all of the above questions are "no," then proceed to Step 3.

Step 2

Interviewer instruction: If the answer is "yes" to any of the questions in Step 1 ask the following additional questions about each reported injury and add details to the chart below.

Were you knocked out or did you lose consciousness (LOC)?

If yes, how long?

If no, were you dazed or did you have a gap in your memory from the injury?

How old were you?

Step 3

Interviewer instruction: Ask the following questions to help identify a history that may include multiple mild TBIs and complete the chart below.

Have you ever had a period of time in which you experienced multiple, repeated impacts to your head (e.g. history of abuse, contact sports, military duty)?

If yes, what was the typical or usual effect—were you knocked out (Loss of Consciousness - LOC)?

If no, were you dazed or did you have a gap in your memory from the injury?

What was the most severe effect from one of the times you had an impact to the head?

How old were you when these repeated injuries began? Ended?

Step 1	Step 2						
	Loss of consciousness (LOC)/knocked out				Dazed/Mem Gap		Age
Cause	No LOC	< 30 min	30 min-24 hrs	> 24 hrs	Yes	No	

If more injuries with LOC: How many?_____ Longest knocked out?_____ How many ≥ 30 mins.?_____ Youngest age? _____

Step 3	Typical Effect		Most Severe Effect				Age	
Cause of repeated injury	Dazed/ memory gap, no LOC	LOC	Dazed/ memory gap, no LOC	LOC < 30 min	LOC 30 min - 24 hrs.	LOC > 24 hrs.	Began	Ended

Adapted with permission from the Ohio State University TBI Identification Method (Corrigan, J.D., Bogner, J.A. (2007). Initial reliability and validity of the OSU TBI Identification Method. J Head Trauma Rehabil, 22(6):318-329.

(Continuation from reverse side, if needed)

Name: _____ **Current Age:** _____ **Interviewer Initials:** _____ **Date:** _____

Step 1	Step 2						
	Loss of consciousness (LOC)/knocked out				Dazed/Mem Gap		Age
Cause	No LOC	< 30 min	30 min-24 hrs	> 24 hrs	Yes	No	

If more injuries with LOC: How many?_____ Longest knocked out?_____ How many ≥ 30 mins.?_____ Youngest age? _____

Step 3	Typical Effect		Most Severe Effect				Age	
Cause of repeated injury	Dazed/ memory gap, no LOC	LOC	Dazed/ memory gap, no LOC	LOC < 30 min	LOC 30 min - 24 hrs.	LOC > 24 hrs.	Began	Ended

Interpreting Findings

A person may be more likely to have ongoing problems if they have any of the following:

- **WORST**
  One moderate or severe TBI
- **FIRST**
  TBI with loss of consciousness before age 15
- **MULTIPLE**
  2 or more TBIs close together, including a period of time when they experienced multiple blows to the head
- **RECENT**
  A mild TBI in the last weeks or a more severe TBI in the last months
- **OTHER SOURCES**
  Any TBI combined with another way that their brain function has been impaired

For more information about TBI or the OSU TBI Identification Method visit:

- Ohio Valley Center at OSU
  www.ohiovalley.org/informationeducation
- BrainLine.org
  www.brainline.org

(Updated July 2013)

Appendix 2.12. The OSU TBI-ID guidance notes

The Ohio State University Traumatic Brain Injury Identification Method

The Ohio State University (OSU) Traumatic Brain Injury (TBI) Identification Method (OSU TBI-ID) is a standardized procedure for eliciting a person's lifetime history of TBI via a 3-5 minute structured interview. While not ideal for determining lifetime exposure to potentially damaging brain injury, self-report remains the gold standard for research and clinical use. The OSU TBI-ID has proven useful in many settings, including medical, mental health, substance abuse, domestic violence, corrections and aging. Health care and social service professionals need this tool to elicit a person's history of TBI.

Why is it important to screen for TBI? Research indicates that a person's lifetime history of TBI is useful for judging current cognitive and emotional states, particularly behavior associated with the executive functioning of the frontal parts of the brain (e.g., planning, impulsivity, addiction, interpersonal abilities). Due to how TBI damages the brain, more exposure (i.e., a worse history of lifetime TBI) increases the likelihood that an individual will struggle with current life stressors, whatever they are. A person who has compromised functioning in the frontal areas of the brain:

- adapts less well in new or stressful situations
- has greater problems following through on recommendations from professionals
- has more difficulty making lifestyle changes, particularly when rewards are in the future.

As a result, it is important that professionals be aware of a person's history of TBI and the potential that current abilities are being affected.

How does the OSU TBI-ID work? The validity of the OSU TBI-ID is not based on elicitation of a perfect accounting of a person's lifetime history of TBI. Instead, the OSU TBI-ID provides a means to estimate the likelihood that consequences have resulted from one's lifetime exposure. We recommend additional consideration be given to the potential effects of this exposure when:

- WORST — there has been one moderate or severe TBI (i.e., any TBI with 30 minutes or more loss of consciousness)
- FIRST — TBI with any loss of consciousness before age 15
- MULTIPLE — had 2 or more TBIs close together, including a period of time when they experienced multiple blows to the head even if apparently without effect
- RECENT — a mild TBI in recent weeks or a more severe TBI in recent months
- OTHER SOURCES — any TBI combined with another way that their brain has been impaired.

What can I do if there is a potentially important history? If the person you've screened has had a sufficient history of TBI, consider the following treatment planning issues:

- Learn more about TBI <www.brainline.org> and share what you've learned with the impacted individual.
- Consider simple accommodations <www.ohiovalley.org/informationeduction/tbi101> you can make in your treatment.
- If cognitive problems are getting in the way of treatment or services, consider consulting a rehabilitation professional.
- Consider how side effects of any medication you are prescribing may interact with existing impairment.

For more information on the OSU TBI-ID visit <www.ohiovalley.org/tbi-id-method>.

Appendix 2.13. Pro-forma for tool practicality data

Screening tool practicalities

Length of time (minutes) taken to administer		
Was extra explanation or clarification required beyond the standardised questions?	Yes	No
Participant able to complete?	Yes	No

Appendix 2.14. Partial correlations

Table 1. Significant associations (Spearman's rho) between OSU TBI-ID measures and cognitive, mental health and disability outcome, controlling for effort

	OSU TBI-ID Worst r (p)	**OSU TBI-ID First** r (p)	**OSU TBI-ID Multiple** r (p)
SDMT	-0.46 (<0.01)	-	-
Trails A	-	-	-0.38 (0.02)
HADS anxiety	0.44 (<0.01)	-0.38 (0.05)	-
HADS depression	0.54 (<0.001)	-	-
GODS HI	-0.41 (0.01)	-	-

Appendix 2.15. Sensitivity, specificity, and positive and negative predictive values

Table 1. Sensitivity, specificity, and positive and negative predictive values

	BISI injury severity		BISI TBI Index		OSU clinical rating		OSU worst injury	
	PPV (NPV)	**Sensitivity (specificity)**	**PPV (NPV)**	**Sensitivity (specificity)**	**PPV (NPV)**	**Sensitivity (specificity)**	**PPV (NPV)**	**Sensitivity (specificity)**
Cognitive function 10th percentile (-1.28)	66.7 (28.6)	81.5 (15.4)	70.8 (41.2)	63.0 (50.0)	48.6 (100)	100 (17.4)	62.5 (60.6)	27.8 (87.0)
Cognitive function 5th percentile (-1.64)	54.5 (57.1)	85.7 (21.1)	58.3 (58.8)	66.7 (50.0)	32.4 (100)	100 (13.8)	62.5 (78.8)	41.7 (89.7)
Cognitive function 1st percentile (-2.33)	30.3 (71.4)	83.3 (17.9)	29.2 (70.6)	58.3 (41.4)	18.9 (100)	100 (11.8)	12.5 (81.8)	14.3 (79.4)
SDMT 10th percentile (-1.28)	-	-	-	-	-	-	62.5 (80.6)	45.5 (89.3)
SDMT 5th percentile (-1.64)	-	-	-	-	-	-	50.0 (96.8)	80.0 (88.2)
SDMT 1st percentile (-2.33)	-	-	-	-	-	-	25.0 (96.8)	66.7 (88.3)
Mental health (HADS anxiety)	42.4 (85.7)	93.3 (24.0)	50.0 (82.4)	80 (53.8)	43.2 (100)	100 (16.0)	75.0 (69.7)	37.5 (92.0)
Mental health (HADS depression)	18.2 (85.7)	85.7 (18.2)	12.5 (76.5)	42.9 (38.2)	10.8 (100)	100 (10.8)	37.5 (97.0)	75.0 (86.5)
Disability (GODS HI)	24.2 (100.0)	100 (16.7)	25.0 (85.7)	75.0 (40.0)	24.3 (100)	100 (12.5)	50 (84.8)	44.4 (87.5)

Appendix 2.16. Correlations for Pitman et al (2014) BISI TBI Index

Table 2. Associations (Spearman's rho) between Pitman et al (2014) TBI Index and cognitive, mental health and disability outcome

Outcome measure	Pitman BISI TBI Index r (p)
SDMT	-0.09 (0.60)
AMIPB list learning	-0.05 (0.78)
Trails A	-0.12 (0.47)
Trails B	0.07 (0.65)
Hayling A	-0.13 (0.44)
Hayling B	0.10 (0.56)
Hayling C	0.07 (0.67)
HADS anxiety	0.28 (0.09)
HADS depression	0.11 (0.52)
GODS HI	-0.21 (0.22)

The sample in current study differed from Pitman et al (2014) in a number of ways that might account for the difference in results (English prisoners at the beginning of their sentence, sentence length and offence history unclear). Further, Pitman et al (2014) screened and assessed their participants over three different sessions, whereas the current study did this in one. This may have impacted on factors that affect study results, such as participant fatigue.

Appendix 2.17. Research proposal

Major Research Project Proposal

Validating the Brain Injury Screening Index (BISI) and the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID) as Screening Tools for Head Injury in a Scottish Prison Setting.

Matriculation Number: 0702957R

Submission Date: 26th May 2016

Version number: 9

Word count: 3580

Abstract

Background: Head injury (HI) has been linked with offending behaviour. Self-report studies indicate a high prevalence of HI amongst offending populations. It has been recommended that routine screening for HI in offending populations will help inform triage towards needs-led assessment and intervention for offenders. There is a need however to validate a screening tool for HI that can be used in offenders.

Aims: To examine the sensitivity, specificity and predictive validity of the BISI and the OSU TBI-ID against the reference standards of objective evidence for HI in hospital records and evidence of neuropsychological or psychiatric caseness. The practical usefulness of the tools will also be considered. A parallel study by a second trainee will look at the association between self-report and hospital record of HI and the prevalence of HI associated disability using the same data.

Methods: A retrospective, cross-sectional design will be adopted to gather data from 100 male and female participants (aged >18) from Scottish prisons. Two screening measures will be used (the OSU TBI-ID and the BISI) alongside measures of disability, mental health, learning and memory, executive function and effort. Data on history of hospital admissions with head injury will be gathered electronically. Data will be analysed using descriptive statistics and regression analysis.

Applications: This study will help to inform decision making around the use of screening measures to identify HI in the Scottish Prison Service.

Introduction

Head Injury and Offending

Head injury (HI) has been linked with offending behaviour, with studies finding increased offending in HI populations (McKinlay, Grace, McLellan, Roger, Clarbour & MacFarlane, 2014), and elevated HI in offending samples (60% prevalence in comparison to 12% in the general population (Shiroma, Ferguson & Pickelsimer, 2010; Frost, Farrer, Primosch & Hedges, 2013).

HI commonly results in increased disability, impaired cognitive function, such as memory and executive function (Whitnall, McMillan, Murray & Teasdale, 2006) and alterations in personality, such as impulsivity and aggression (Wood & Thomas, 2013). Such changes are associated with rule breaking and can lead to social exclusion, both of which can precipitate Criminal Justice System (CJS) involvement (Miller, 1999). It is further suggested that the link between HI and offending is mediated by several demographic and behavioural factors such as substance misuse and educational achievement (Schofield, Malacova, Preen, Este, Tate, Reekie, Wand & Butler, 2015). There is an increased prevalence of symptom exaggeration or fabrication in forensic populations, thus assessment of this is crucial to the interpretation of neuropsychological or psychometric assessment (Bush, Ruff, Troster, Barth, Koffler, Pliskin, Reynolds & Silver, 2005).

Identifying Head Injury in Criminal Justice Settings

This literature on HI and offending has informed a variety of recommendations. In Scotland, a report on behalf of the National Prisoner Healthcare Network (NPHN 2016) recommended that screening for HI should become routine within Scottish Prison Service (SPS). This is a practice which is currently very rare (Hux, Schneider & Bennett, 2009), but one which could identify those who are likely to demonstrate impairment and disability on more detailed assessment. These assessments can then be used to inform interventions and adaptations. These will aim to improve the management of the prison environment

(e.g. engagement and behaviour) and reduce the likelihood of re-offending through an informed approach to care and management which takes the effects of HI into account (NPHN, 2016).

There are a number of HI screening tools which could facilitate the process of routine screening within the SPS. The NPHN (2016) report suggested two, one of which has demonstrated initial validity and reliability with offending populations in the USA (the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID), Bogner & Corrigan, 2009), and the other in England & Wales (the Brain Injury Screening Index (BISI) Pitman, Haddlesey, Ramos, Oddy & Fortescue, 2014).

Aims and Research Questions

The current study aims to evaluate whether the BISI or the OSU TBI-ID is more valid or practical to use in the identification of HI in the SPS. The following research questions will be examined:

4. How sensitive and specific are the BISI and the OSU TBI-ID against the reference standard of objective evidence for HI in hospital records?
5. What is the predictive validity of the BISI and the OSU TBI-ID in relation to persisting disability, neuropsychological impairment and mental health difficulties associated with HI?
6. How practically useful are the BISI and the OSU TBI-ID in the SPS system?

Plan of Investigation

This study is being carried out in parallel with another DClinPsy trainee study which aims to examine (i) the association between self-report and hospital records of HI and (ii) the prevalence of disability, emotional, neuropsychological and behavioural outcomes in those reporting HI compared to those without HI. The same dataset will be collected simultaneously for both projects and shared.

Participants

Participants will be recruited from the Scottish Prison Service (SPS). Prison officers who act as participant's personal officers will also be recruited to complete proxy measures for the parallel study.

Recruitment sites

HMP Shotts and HMP Cornton Vale have expressed interest in the current study. HMP Shotts houses > 500 prisoners (all male, >21 years, sentences >4 years) and HMP Cornton Vale houses approximately 250 female offenders. Discussions are on-going with HMP Barlinnie and HMYOI Polmont regarding their interest in participating. It would be ideal for 2 or 3 prisons to participate. The NHPN advisory committee have been asked to support the study and will consider it at their meeting on 3rd May.

Inclusion and Exclusion Criteria

Participants must be >18 years old and fluent in English. Individuals will be excluded if they are experiencing severe mental health difficulties (e.g. psychosis), demonstrate significant communication difficulties which preclude them from completing assessments, or are considered an imminent risk to researcher safety by prison staff.

Recruitment Procedures

Based on initial discussions with HMP Shotts, it is anticipated that recruitment will take place from their National Induction Centre (NIC) within the prison, which houses approximately 60 adult male offenders at any one time. Recruitment procedures for HMP Cornton Vale are still to be confirmed however there has been a recent announcement that the prison is to close with prisoners being relocated to HMP Polmont. An information sheet will be distributed to potential participants by the SPS. If individuals express an interest in participation, a meeting with a researcher will be arranged, who will obtain informed written consent if they wish to participate.

Measures

It is anticipated that the following measures will be completed with each participant over a 45-60 minute time period.

Screening tools (described above)

The Brain Injury Screening Index (BISI)

This tool contains eleven questions which screen for HI based on self-report. A HI index score is calculated by multiplying the number of injuries by the longest loss of consciousness. Pitman et al (2014) found medium to large effect sizes when correlating scores on the BISI with a number of behavioural and psychological outcomes with a sample of offenders in England (d>0.55 for all dependent variables; n=189).

The Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID)

This is a structured interview which uses self-report. It contains 5 questions which uses five key indicators to identify whether an individual is 'likely' or 'not likely' to have ongoing problems as a result of HI. One American study (n=210) on the OSU TBI-ID found good test-retest reliability (r>0.6) as well as large effect sizes when comparing OSU TBI-ID scores with several cognitive, psychiatric and behavioural outcomes ($r > 0.36$) (Bogner & Corrigan, 2009).

Measures of disability and mental health

The Glasgow Outcome at Discharge Scale (GODS)

This is an assessment of disability outcome after HI which is ordinarily used in inpatient settings. It is a structured interview with ratings in 8 categories of outcome. It was found to have significant associations with various measures of health and disability (effect sizes ranged from small (r=0.22), to large (r=0.72)) and high inter-rater reliability (98%) (McMillan, Weir, Ireland & Stewart, 2013).

The Hospital Anxiety and Depression Scale (HADS)

This measure has good reliability and validity in assessing depression and anxiety in people with HI (Whelan-Goodson, Ponsford & Schonberger, 2009). It consists of 14 items

and responses are entered on a 4-point Likert scale. Clinical levels of anxiety or depression are indicated by a score >11 (Zigmond & Snaith, 1983).

Tests of Learning and Memory

The Adult Memory and Information Processing Battery (AMIPB) - List Learning Sub-Test

This is a measure of learning and working memory (Coughlan & Hollows, 1985). The participant is read 15 unrelated words before being asked to recall them. This test is sensitive to the effects of HI and test re-test reliability has been found to be high (Lezak, 2012, pp531).

The Symbol Digit Modalities Test (SDMT)

This test (Smith, 1982) assesses attention, visual scanning, and motor speed. It requires examinees to identify nine different symbols which correspond with numbers 1-9. Several symbols are presented to the examinee in a random order, and they are given ninety seconds to write the correct number under the symbol to which it corresponds. It has high test-retest reliability (Lezak, 2012; pp421), and is sensitive to the effects of HI (Strauss, Sherman & Spreen, 2006; pp625).

Tests of Executive Function

Trail Making Test (TMT)

This test assesses the ability to switch attention (Armitage, 1946). Part A involves connecting circled numbers (1-20) by a continuous line. Part B involves alternating between two sequences of circled numbers and letters (e.g. 1-A-2-B). It is scored by recording the total time taken to complete each part (Lezak, 2012; pp423). The TMT is sensitive to neurological disorder (Burgess, Alderman, Evans, Emslie & Wilson, 1998).

Hayling Sentence Completion Test

This measure (Burgess & Shallice, 1997) consists of two sets of 15 sentences with the last word missing from each. In the first section the participant has to complete the sentences, giving a measure of response initiation speed. In the second section the participant is

required to complete the sentences with a word which does not make sense, assessing response suppression ability. This test has good test–retest reliability (r=0.72–0.93) and internal consistency (α=0.62–0.76).

Test of Effort

Word Memory Test

The examinee is read 20 word pairs before being asked to identify the word from the original list in each of 40 new word pairs (e.g., "dog" from "dog-rabbit"). This is then repeated after 30 minutes in a delayed recognition trial. This measure is highly sensitive and specific in categorising effort, and has been well validated in clinical forensic samples (Green, Lees-Haley & Allen, 2002). Given the constraints in use of computers in prison, the paper version of the test will be administered.

Retrospective Data Collection

Scottish Morbidity Records (SMR-01)

These are national records which detail all admissions, discharges and transfers from inpatient and outpatient hospitals. They can be accessed for research purposes via an application to the Information Services Division (ISD). They will be accessed to obtain hospital records of HI, an approximate estimate of severity will be defined by duration of hospital admission (NPHN, 2015).

Other Data Collection

For the purposes of the parallel study, data from participants risk assessments and incident reports will also be collected.

Design

The current study will utilise a retrospective, quantitative, cross-sectional design. The reference standards of hospital records, measures of disability, neuropsychological function and mental health outcome will be used to determine if one of the screening

measures is superior in terms of sensitivity to head injury and ability to predict outcome. Further, the practical usefulness of both tools will be compared.

Research Procedures

A short pilot (n=4-6) will be carried out to address any procedural issues which may arise during administration, and to increase inter-rater reliability between researchers. During this, both researchers will be present and will alternately administer one screening tool and the outcome measures with each participant and will score independently.

Following this, using the measures described above, data will be collected by two data collectors. A semi-structured interview will be undertaken and this information will be recorded on an anonymised form which will be developed by the researchers. Demographic information will be collected, as well as information on alcohol and substance use, offence history, and duration of time spent in custody.

The BISI and the OSU TBI-ID, respectively, will each be randomly administered to half of the participants using a simple randomisation technique (i.e. Participant 1 = BISI, Participant 2 = OSU TBI-ID, Participant 3 = BISI, and so on). A form will be developed to record information about the practical aspects of administering these with each participant. The outcome measures will then be administered. It is anticipated that the interview will take 45-60 minutes. Following this, retrospective data collection will be completed (details above) and self-report HI will be cross referenced with the SMR-01.

Data Analysis

Tests of normality will be used to determine if continuous data meets parametric assumptions. Covariates may include effort, level of education, substance misuse and gender.

1. Descriptive statistics will be used to describe the sensitivity and specificity of the BISI and the OSU TBI-ID against the reference standard of objective evidence for HI in

hospital records. For this purpose, groups will be collapsed into two categories (HI vs none).

2. (a) Using the BISI HI Index Score, a linear regression will be used to examine the extent to which it identifies 'caseness', defined as overall disability (as measured by a single rating in the GODS), neuropsychological impairment (as measured by a composite z score transformation with a cut-off to indicate impairment (e.g. 1 SD or 2 SD) in the list learning, SDMT, TMT and Hayling) and emotional outcome (a score of >11 on either anxiety or depression in the HADS).

   (b) Using the five key indicators which the OSU TBI-ID uses to categorise whether individuals are 'likely' or 'unlikely' to have ongoing problems, a logistic regression will be used to examine the extent to which it identifies caseness, as defined in 2a.

3. Descriptive statistics will be used to describe the comparative practical usefulness of the BISI and the OSU TBI-ID as follows:

   a) Mean length of time (minutes) taken to administer each;

   b) Whether extra explanation or clarification was required beyond the standardised questions (frequencies of 'yes' and 'no' for each tool will be compared);

   c) The percentage of those able to complete it from those who were selected for inclusion (frequencies of 'completed' and 'not completed' for each tool will be compared).

<u>Justification of sample size</u>

Given that the data arising from research questions 1 and 3 will be used descriptively, a sample size calculation was not carried out.

G*Power (Faul, Erdfelder, Lang & Buchner, 2007) was used for question 2 to estimate sample size using executive function as the primary outcome variable. Pitman et al (2014) reported a correlation of 0.45 between the BISI and the Frontal Systems Behaviour Scale;

with a power of 0.80, probability of 0.05 a two-sided test, and a medium effect size of 0.3, a sample of 84 is required. Based on these calculations, the current study will aim to recruit at least 100 participants.

Settings and Equipment

The study will take place within the SPS, and interested recruitment sites have confirmed that interview rooms will be available for the administration of the study. Equipment requirements will include the above measures.

Health and Safety Issues

Researcher Safety Issues

Given that the researchers will be working with a high risk population, they will adhere to prison policy to ensure safety during data collection. Researchers will speak to prison staff prior to interview regarding any risk issues for each participant. Further, researchers will take part in SPS training as follows: breakaway training; dealing with disclosures; boundaries training; key training where required.

Participant Safety Issues

Whilst no safety issues are anticipated, some participants may be highly vulnerable. This is considered below.

Ethical Issues

Informed consent will be taken from participants using a study information sheet and consent form. Capacity to consent will be assessed by researchers based on participant ability to comprehend the content of the consent form. This consent from will include seeking consent to inform prison staff of any head injury that is identified so as to inform care and management. Participants will be informed that their participation is voluntary and will not have any impact upon their custodial sentence. Further, participants will not lose any payment that they receive for attending work if they attend the study during work time. Care will be taken to ensure that interview is as non-intrusive as possible, and data

will be anonymised at the point of collection to ensure that no personal information is compromised. To ensure data security once collected, it will be stored in a locked filing cabinet and will be kept for the required period of time in accordance with either NHS or University of Glasgow policy before it is destroyed. Submissions will be made to both the Scottish Prison Service and the NHS Research Ethics Committees, and an application will be made to the Privacy Advisory Committee of ISD for data from SMR-01.

Financial Issues

Costs will include that of printing and/or photocopying screening questionnaires and outcome measures. There will also be a cost involved in accessing information from the ISD, which we anticipate will be met by the NPHN.

Timetable

1st June 2016 - Applications to SPS and ISD

1st July - Application to NHS ethics

1st September 2016 to 30 April 2017 – Data collection and scoring

May- July 2017 - Data analysis and write up

July 2017 – Final project submitted

Practical Applications

This study aims to inform the decision-making process around which measure should be recommended as a screening tool to be used when indicated by initial triage in the SPS in Scotland. Providing that this study confirms the usefulness of one of these tools, it is anticipated that it will be used by NHS staff in prisons.

References

Armitage, S. (1946). Analysis of certain psychological tests used for the evaluation of brain damage. Psychological Monographs, 60(1), 1–277.

Bogner, J., & Corrigan, J. D. (2009). Reliability and predictive validity of the Ohio State University HI identification method with prisoners. *The Journal of head trauma rehabilitation*, *24*(4), 279-291.

Burgess, P. W., Alderman, N., Evans, J., Emslie, H., & Wilson, B. A. (1998). The ecological validity of tests of executive function. *Journal of the International Neuropsychological Society*, *4*(06), 547-558.

Burgess, P. W., & Shallice, T. (1997). The Hayling and Brixton Tests. Thurston, Suffolk: Thames Valley Test Company.

Bush, S. S., Ruff, R. M., Troster, A., Barth, J. T., Koffler, S. P., Pliskin, N. H., & Silver, C. H. (2005). NAN position paper: Symptom validity assessment: Practice issues and medical necessity. *Archives of Clinical Neuropsychology*, *20*(4), 419-426.

Coughlan, A.K. & Hollows, S.E. (1985). The Adult Memory and Information Processing Battery Test Manual. Psychology Department, University of Leeds, Leeds, UK.

Faul, F., Erdfelder, E., Lang, A.G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175-191.

Frost, R. B., Farrer, T. J., Primosch, M., & Hedges, D. W. (2013). Prevalence of traumatic brain injury in the general adult population: A meta-analysis. *Neuroepidemiology*, *40*(3), 154-159.

Green, P., Lees-Haley, P.R. & Allen, L.M. (2002). The Word Memory Test and validity of neuropsychological test scores. Journal of Forensic Neuropsychology, 2, 97–124

Hux, K., Schneider, T., & Bennett, K. (2009). Screening for traumatic brain injury. *Brain Injury*, *23*(1), 8-14.

Lezak, M. D. (2012). *Neuropsychological assessment*. Oxford University Press, USA.

McKinlay, A., Grace, R.C., McLellan, T., Roger, D., Clarbour, J. & MacFarlane, M.R. (2014). Predicting adult offending behaviour for individuals who experienced a Traumatic Brain Injury during childhood. *J Head Trauma Rehabil*, 29 **(6)**, 507-513.

McMillan, T. M., Weir, C. J., Ireland, A., & Stewart, E. (2013). The Glasgow Outcome at Discharge Scale: an inpatient assessment of disability after brain injury. *Journal of neurotrauma*, *30*(11), 970-974.

Miller, E. (1999). Head injury and offending. *The Journal of Forensic Psychiatry*, 10 **(1)**, 157-166.

National Prisoner Healthcare Network (NPHN) (2015). Brain Injury and Offending (Draft Report for Consultation). NPHN.

Pitman, I., Haddlesey, C., Ramos, S. D., Oddy, M., & Fortescue, D. (2014). The association between neuropsychological performance and self-reported traumatic brain injury in a sample of adult male prisoners in the UK. *Neuropsychological rehabilitation*, (ahead-of-print), 1-17.

Schofield, P.W., Malacova, E., Preen, D.B., Este, C.D., Tate, R., Reekie, J., Wand, H. & Butler, T. (2015). Does traumatic brain injury lead to criminality? A whole-population retrospective cohort study using linked data. *PLoS ONE*, 10 **(7)**, 1-12.

Shiroma, E. J., Ferguson, P.L. & Pickelsimer, E.E. (2010). Prevalence of traumatic brain injury in an offender population: A meta-analysis, *Journal of Correctional Health Care* 16 (2), 147-159.

Snaith R, P., Zigmond A, S., Hospital Anxiety and Depression Scale (1994). *Acta Psychiatrica Scandinavica*, 67:361–370.

Smith, A. (1982). Symbol Digits Modalities Test. Western Psychological Services: Los Angeles.

Strauss, E., Sherman, E. M., & Spreen, O. (2006). *A compendium of neuropsychological tests: Administration, norms, and commentary*. Oxford University Press, USA.

Whelan-Goodinson R, Ponsford J, Schonberger M, (2009). Validity of the Hospital Anxiety and Depression Scale to assess depression and anxiety following traumatic brain injury as compared with the Structured Clinical Interview for DSM-IV. *Journal of Affective Disorders* .114:94–102.

Whitnall, L., McMillan, T. M., Murray, G. D., & Teasdale, G. M. (2006). Disability in young people and adults after head injury: 5–7 year follow up of a prospective cohort study. *Journal of Neurology, Neurosurgery & Psychiatry*,*77*(5), 640-645.

Wood, R. L., & Thomas, R. H. (2013). Impulsive and episodic disorders of aggressive behaviour following traumatic brain injury. *Brain injury*, *27*(3), 253-261.

Appendix I: Plain English Summary

Title: Validating the Brain Injury Screening Index (BISI) and the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID) as Screening Tools for Head Injury in a Scottish Prison Setting

Background

Head injury (HI) has been linked with offending. Accordingly, routine screening for HI in Scottish prisons has been recommended to give those with HI associated difficulties access to specialist assessment and care planning. This can potentially reduce future offending. However, there is a need to validate a screening tool for this purpose. To validate a tool is to establish that it accurately identifies what it is supposed to identify. Two screening tools have shown initial promise with prison populations in England and

America, namely the Brain Injury Screening Index (BISI) and the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID).

Aims and Questions

This study will look at the extent to which the BISI and the OSU TBI-ID are practical and accurate in identifying HI and associated disability in Scottish prisons. The following research questions will be examined:

1. When compared to hospital records, how well do the two screening tools identify HI in prisoners?
2. To what extent is disability shown in those who are identified as having a HI by the two screening tools?
3. How practical are the tools to administer in prison settings?

Methods

Participants

Participants will be recruited from the Scottish Prison Service (SPS), primarily HMP Shotts and Cornton Vale. Participants must be fluent in English.

Recruitment

It is anticipated that recruitment will take place from the National Induction Centre within HMP Shotts. Recruitment procedures for HMP Cornton Vale are to be confirmed.

Consent

An information sheet will be distributed to potential participants by the SPS, and if they wish to participate they will be asked to sign a consent form.

Design of study

Participants will be randomly split into two groups which will be screened with the BISI and the OSU TBI-ID, respectively. These groups will then be compared in terms of their hospital records of HI and their levels of HI associated difficulties.

Data collection

Participants will be screened with one screening tool or the other. Information will be recorded around the practical aspects of administering these for each participant (time taken to administer, whether or not extra clarification/explanation was required beyond the standardised questions, and the number of those able to complete it from those who were selected for inclusion). Questionnaires will then be used to determine level of disability and mental health difficulty, and neuropsychological tests will assess learning and memory. Following this, hospital records of HI will be accessed.

Key ethical issues

Care will be taken to ensure that assessment is as non-intrusive as possible, and data will be anonymised. Participants will be fully informed as to the nature of the study prior to written consent being taken. Participants will be informed that their participation is voluntary and will have no impact upon their custodial sentence.

Practical Applications and Dissemination

This study aims to inform the decision-making process around which screening tool should be used in Scottish prisons. Results will be presented and published in an academic journal.

References

Bogner, J., & Corrigan, J. D. (2009). Reliability and predictive validity of the Ohio State University HI identification method with prisoners. *The Journal of head trauma rehabilitation*, *24*(4), 279-29

Pitman, I., Haddlesey, C., Ramos, S. D., Oddy, M., & Fortescue, D. (2015). The association between neuropsychological performance and self-reported traumatic brain injury in a sample of adult male prisoners in the UK. *Neuropsychological rehabilitation*, *25*(5), 763-779. ***Word Count: 527***

Appendix II: Health and Safety for Researchers Form

WEST OF SCOTLAND/ UNIVERSITY OF GLASGOW

DOCTORATE IN CLINICAL PSYCHOLOGY

HEALTH AND SAFETY FOR RESEARCHERS

1. Title of Project	Validating the Brain Injury Screening Index (BISI) and the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID) as Screening Tools for Head Injury in a Scottish Prison Setting.
2. Trainee	Abigail Rorison
3. University Supervisor	Professor Tom McMillan and Dr Caroline Bruce
4. Other Supervisor(s)	N/A
5. Local Lead Clinician	To be confirmed
6. Participants: (age, group or sub-group, pre- or post-treatment, etc)	Participants will be male and female prisoners aged between 18-65 years old. Following screening participants will be allocated to a group: (mild, moderate or severity head injury, no head injury).
7. Procedures to be applied (eg, questionnaire, interview, etc)	Two screening tools will be administered • The Brain Injury Screening Index (BISI) • The Ohio State University Traumatic Brain Injury Identification Method – Short Form (OSU TBI-ID). Six outcome measures will be administered as follows: • The Glasgow Outcome at Discharge Scale (GODS) • The Hospital Anxiety and Depression Scale (HADS) • The Adult Memory and Information Processing Battery (AMIPB) - List Learning Sub-Test • The Symbol Digit Modalities Test (SDMT)

	• Trail Making Test (TMT) • Hayling Sentence Completion Test A test of effort will be administered: • Word Memory Test Additionally, information from the following will be collected, if available: • The Historical Clinical Risk Management (HCR-20) • Incident reports Finally, the following will be accessed to obtain records of head injuries which required hospital attendance/admission: • The Scottish Morbidity Records (SMR-01) Direct measures will be administered within the context of a semi-structured interview, which will also take into account demographic information.
8. Setting (where will procedures be carried out?) i) Details of all settings	Research will be conducted within the Scottish Prison Service (HMP Shotts and HMP Cornton Vale have agreed to take part). Research may also be conducted within HMP Polmont and HMP Barlinnie, subject to their agreement to partake as recruitment sites. Within HMP Shotts, research will take place within the National Integration Centre (NIC). It is likely that a room outside of the main prison area will be arranged for testing. Researchers will discuss security options. It is likely that prison officers will bring and retrieve participants for interview and testing. Researchers may have access to keys in some settings.
ii) Are home visits involved	No

9. Potential Risk Factors Considered (for researcher and participant safety): i) Participants	Participants: Whilst there are no direct risks for participants, it is possible that discussions of their head injuries may cause some discomfort and distress. Additionally, the involvement of participants in the criminal justice system means

ii) Procedures iii) Settings	that they may pose a potential risk to researchers. Furthermore, it is likely that some participants will demonstrate impulsive, irritable and aggressive traits that are associated with head injury. Procedures: Testing and interview with each participant will take approximately 1 hour. It is hoped that this will not differ much from Clinical Psychology interviews and is unlikely to raise risk issues. Participants may become frustrated if struggling to complete tests. Settings: Owing to the nature of the population, this research will take place highly secure settings wherein a large volume of high risk individuals reside.
10. . 10. Actions to minimise risk (refer to 9) i) Participants ii) Procedures iii) Settings	Participants: If participants experience distress relating to the testing process, researchers have some degree of clinical training, and will use their clinical skills to address this within the interview. Prison officers will also be informed if this occurs. Participants posing increased risk of harm will be excluded from the study. Guidance on this will be sought from prison officers. Whilst in the prison, prison officers will be aware of researchers whereabouts at all times, and will be on hand to manage any risks that are presented to researchers. Researchers will have training from the prison service to manage disclosure, maintain boundaries and to maximise breakaway skills. Procedures: Testing will take place in a safe area separate from the main prison to reduce risks. Researchers will use therapeutic skills throughout the testing process. Researchers will ensure that they give ongoing reminders to participants that they are free to withdraw from the study at any time. Settings: Prison officer support will reduce the likelihood of risk and increase the safety of researchers. Researchers may have a key to be able to navigate to safety if risk of harm arises.

Appendix III: Research Costs Form

University of Glasgow | College of Medical, Veterinary & Life Sciences

RESEARCH EQUIPMENT, CONSUMABLES AND EXPENSES

Trainee : Abigail Rorison

Year of Course: 2016 **Intake Year**: 2014.

Please refer to latest stationary costs list (available from student support team)

Item	Details and Amount Required	Cost or Specify if to Request to Borrow from Department
Stationary	1 ream white paper	Subtotal: £2.18
Postage	N/A	Subtotal: 0
Photocopying and Laser Printing	200 sheets	Subtotal: £20.00
Equipment and Software	N/A	Subtotal: 0
Measures	The following measures being used are free to access or are available through the University: • The Brain Injury	

	Screening Index (BISI) • The Ohio State University Traumatic Brain Injury Identification Method – Short Form (OSU TBI-ID). • The Glasgow Outcome at Discharge Scale (GODS) • The Hospital Anxiety and Depression Scale (HADS) • The Adult Memory and Information Processing Battery (AMIPB) - List Learning Sub-Test • The Symbol Digit Modalities Test (SDMT) • Trail Making Test (TMT) • Hayling Sentence Completion Test • Word Memory Test	Subtotal: 0
Miscellaneous	The Scottish Morbidity Records (SMR-01) will be accessed to obtain records of head injuries which required hospital attendance/admission. This involves an application to the ISD, the cost of which (approx £2000) Professor Tom McMillan anticipates will be funded via the NPHN. Travel costs: Shotts Prison: (from home 23.5 miles, from Gartnaval 20.6 miles). Cornton Vale Prison: (from home 36 miles, from Gartnaval 32.6 miles). Barlinnie Prison: (from home 8.9 miles, from Gartnaval 6.1 miles) Polmont YOI and prison: (from home 35.1 miles, from Gartnaval 29.9 miles).	Subtotal: 0 **£240** (15 journeys to and from Shotts or Cornton Vale/Polmont), @ 30pence per mile.

		It is likely data collection will take between 20-30 days (approximately 5 participants per day based on 100-150 participants). This will be split between two data collectors.
Total		£262.18

For any request over £200 please provide further justification for all items that contribute to a high total cost estimate. Please also provide justification if costing for an honorarium.

Given that this project requires a prison sample, frequent travel to HMP Shotts, HMP Cornton Vale, and possibly HMYOI Polmont will be required. Given the locations of these respective prisons and the target sample size, travel will be fairly extensive and thus costs are estimated as above.