Head Injury in Female Prisoners: Impact and Disability

and Clinical Research Portfolio

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Chapter One: Systematic Review

Outcomes Following Intimate Partner Violence-Related Head Injury in Women

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Prepared in accordance with manuscript guidelines for the Journal of Head Trauma Rehabilitation (Appendix 1.1).

Abstract

Background: Intimate partner violence (IPV) is associated with negative physical and psychological outcomes. Studies on emergency-room presentations suggest that the head is the most common injury location following IPV; however, there has been little research on the impact of head injury due to IPV (IPV-HI).

Aim: To systematically review empirical studies on (1) the emotional, cognitive, behavioural and quality of life-related outcomes following IPV-HI and (2) the types of HI prevalent in female IPV survivors.

Methods: Electronic databases were searched for published research on IPV-HI. Studies on the topic were hand-searched to identify further relevant research. All studies were assessed for risk of bias.

Results: Ten studies were included. They suggest a high prevalence of repeat mild HI in women who have experienced IPV-HI. These studies find several negative outcomes are associated with IPV-HI, including 'post-concussive syndrome', post-traumatic stress disorder, anxiety, depression and impaired cognitive functioning.

Conclusion: The high risk of bias across studies meant that a causal link between HI and negative outcomes could not be made. Further research using rigorous methodology is needed to establish the impact HI has on women who experience IPV.

Introduction

Intimate partner violence (IPV) is a global public health concern that disproportionately affects women (Garcia-Moreno, Jansen, Ellsberg, Heise, & Watts, 2006). IPV refers to physical, sexual or emotional violence perpetrated by an individual with whom the victim is in an intimate relationship (World Health Organisation, 2012). Prevalence estimates suggest that worldwide, 30% of women who have been in intimate relationships have experienced IPV (Devries et al., 2013). IPV is associated with long-lasting negative outcomes, including mental health problems, physical injury and chronic physical health problems (Campbell, 2002).

Head injury (HI) is a common consequence of IPV: studies of women presenting at emergency rooms with IPV injuries report that the head is the most common injury location (Wu, Huff, & Bhandari, 2010). The vast majority of HIs are mild and have no long-lasting consequences (Hessen, Nestvold, & Anderson, 2007). However, for some individuals, HI results in a range of negative outcomes including cognitive impairment, emotional and behavioural difficulties and disability in tasks of daily living (Konrad et al., 2011).

IPV is often chronic in nature (Thompson et al., 2006) and thus is likely to result in multiple HIs. Research has found that multiple HIs have cumulative effects that result in long-lasting impairment and disability (Karr, Areshenkoff, & Garcia-Barrera, 2014). IPV also results in significant psychological trauma (Woods, 2005). Research on HI in military populations has found that the cumulative effects of multiple HIs and the context of complex psychological trauma in which they occur can lead to severe and persistent post-concussive symptoms, mental health difficulties and cognitive impairment (MacDonald et al., 2015; Miller, Ivins, & Schwab, 2013). Women who experience IPV-HI may therefore be more likely to experience negative outcomes from HI because of (1) the likelihood of experiencing multiple HIs and (2) the trauma associated with IPV-HI.

It thus appears probable that IPV results in HIs, and that in turn these HIs result in negative outcomes for IPV survivors. However, very little research has yet directly investigated HI in women who have experienced IPV. Kwako et al. (2011) conducted a review of research on IPV-related HI (hereafter 'IPV-HI'), and found only four studies focusing on outcomes in women with IPV-HI (Corrigan, Wolfe, Mysiw, Jackson, & Bogner, 2003; Jackson,

Philp, Nuttall, & Diller, 2002; Monahan & O'Leary, 1999; Valera & Berenbaum, 2003). This review concluded that women with IPV-HI experience a high level of symptoms associated with 'Post-Concussive Syndrome' (PCS), including headaches, memory loss, anxiety, depression, dizziness and sleep disturbances. They also found evidence to suggest that severity and frequency of IPV-HI is associated with poorer cognitive functioning. In terms of the type of HI prevalent in IPV, Kwako et al. (2011) conclude from the findings of one study that multiple HIs are highly prevalent in IPV-HI.

However, the Kwako et al. (2011) review had a number of limitations. IPV is associated with a number of comorbid difficulties; most commonly, post-traumatic stress disorder (Woods, 2005). IPV-related comorbidities also have associations with the negative outcomes discussed in the Kwako et al. (2011) review (i.e. PCS symptoms and cognitive difficulties; Campbell, 2002; Twamley et al., 2009). It may be these comorbidities rather than HI *per se* that cause negative outcomes in IPV-HI. Kwako et al. (2011) do not present any data that account for the potential confounding effects of such co-morbidities, nor do they present any data that compare outcomes from IPV-HI with relevant control samples (e.g. women with IPV without HI or women with HI without IPV). Thus, although the review implies that IPV-HI leads to the negative outcomes listed above, it makes no attempt to establish the independence of the association between IPV-HI and these outcomes.

The Kwako et al. (2011) review is further limited in its search strategy: it searched only three databases and did not use alternative search terms for either IPV or 'traumatic brain injury'. Furthermore, it did not assess the quality of studies. Therefore, the conclusions of the review must be interpreted with caution, as the studies therein are likely to vary in terms of their methodological quality. Finally, it is based on a very small sample of studies ($N = 4$), which limits the generalisability of the review's findings. It is likely that further research on outcomes following IPV-HI has been published since the Kwako et al. (2011) review following growing interest in this area and a number of calls for research on the topic (e.g. Wong, Fong, Lai, & Tiwari, 2014).

Aim

The current review aimed to expand upon the Kwako et al. (2011) review by using an expanded search strategy, assessing study quality and answering questions that were not answered by Kwako et al. (such as whether or not the outcomes following IPV-HI are

independent of other potential causes of disability and impairment). The overarching aim was to establish the added burden that HI places on survivors of IPV.

Systematic Review Questions:

- What types of HI are prevalent in women who experience IPV (mild, moderate, severe and/or multiple)?
- What are the behavioural, cognitive, emotional and quality-of-life outcomes following IPV-HI?
- What is the functional disability associated with IPV-HI?
- How do outcomes following IPV-HI compare to outcomes in women following (1) IPV without HI and (2) HI from other causes?
- To what extent is HI an independent predictor of outcomes following IPV (i.e. when possible confounding factors, such as trauma and PTSD symptoms, are accounted for)?

Hypotheses:

1. IPV in women will result in a high prevalence of multiple-mild HIs.
2. IPV-HI will be associated with negative emotional, cognitive, behavioural and quality-of-life outcomes. It will also be associated with disability in everyday life.
3. These outcomes will be causally related to the HI and cannot be fully explained by the trauma of IPV.

Methods

Inclusion and Exclusion Criteria

To be included in this review, studies needed to:

- Be quantitative in design. Single case studies and qualitative studies were not included.
- Include analysis of women who sustained IPV-HI during adulthood.
- Report outcomes (behavioural, cognitive, emotional, quality-of-life or disability) following IPV-HI.
- Be published in the English language.

The following were excluded:

- Unpublished studies.
- Review papers.
- Studies that did not specify that HI was sustained via IPV.
- Studies that only reported outcomes due to strangulation. Although strangulation can result in hypoxic or anoxic brain injuries, the mechanism of injury is different to that caused by a blow to the head. This review uses the definition of head injury as 'an impact or forceful motion of the head' (Centres for Disease Control and Prevention, 2003; Corrigan & Bogner, 2007).

Search Strategy

The following databases were searched for research published by 12 May 2018: Medline, EMBASE, PsycINFO and CINAHL. All databases were searched from their start date (i.e. no limits were placed in relation to the publication year of studies): MEDLINE includes research dating from 1946, EMBASE includes research dating from 1947, PsycINFO includes historical journal records and therefore includes research dating from the 17th century and CINAHL includes research dating from 1981.

The search strategy was informed by previous reviews that have examined HI and/or IPV (Alhabib, Nur, & Jones, 2010; Kwako et al., 2011). A range of alternative search terms for HI and IPV were used (appendix 1.2). Author and subject heading terms for IPV/HI were

combined with the Boolean operator 'OR'. Search terms for IPV and HI were then combined with the Boolean operator 'AND', so that studies had to include a term for both IPV and HI to be included in the search.

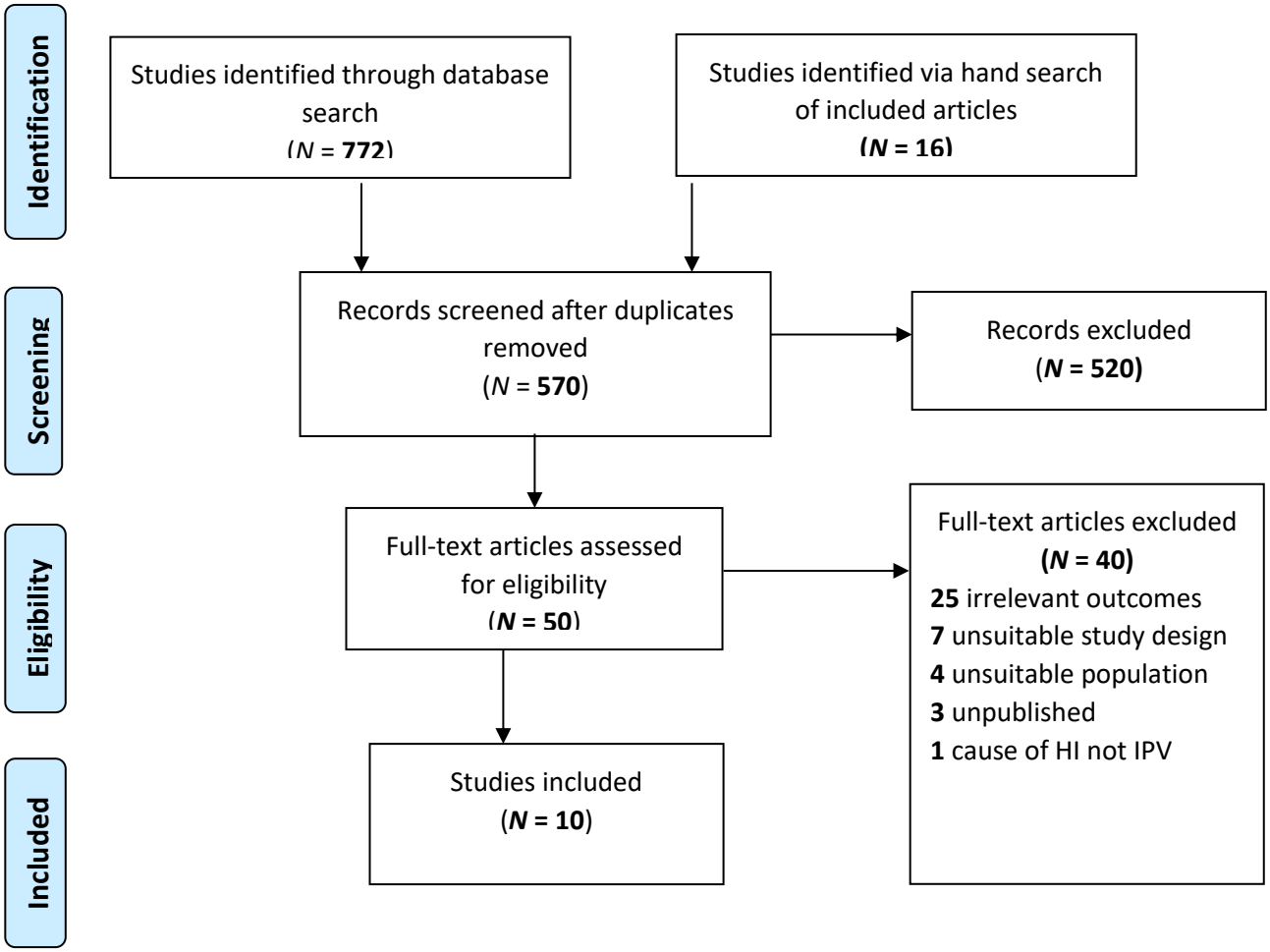

Figure 1. *Prisma Flow-Diagram of Search Strategy*

The search yielded a total of 788 results, of which 218 were duplicates (figure 1). The author screened the titles and abstracts of 570 results for relevance. Of these, 518 were not relevant to this review. The abstracts or full-texts for two titles could not be retrieved, either via database searches or university inter-library loans; as a result, the relevance of these titles to the review could not be determined. These titles were therefore excluded. The full texts of 50 studies were reviewed; 40 of these studies were excluded because they (1) did not report outcomes following IPV-HI (25 studies); (2) were not quantitative in design or were not empirical research articles (7 studies); (3) were not peer reviewed (3 studies); (4) did not sample adult women (4 studies); or (5) did not specify that HI was due to IPV (1 study). This left 10 studies for inclusion.

Quality-Rating

The quality-rating tool used was derived from criteria developed for use in epidemiological studies (Sanderson, Tatt, & Higgins, 2007) and modified for use in HI literature (Moynan & McMillan, 2017). This quality-rating tool was further adapted in line with the research questions of the current study. The quality-rating tool consisted of five domains which are summarised in table 1 (see appendix 1.3 for further information). Studies were rated independently by two raters. There was inter-rater concordance for 95/100 ratings (95%; appendix 1.4). Cohen's kappa for inter-rater reliability was 0.90. The five exceptions were resolved by discussion. Studies were rated as 'high' or 'low' in risk of bias (table 2). Where domain criteria were not reported, the domain was rated as 'not reported' (N/R).

Data Extraction

Data extraction was conducted using the headings from tables 2 and 3. For each paper, data relevant to each table heading was extracted. Extracted data for all papers are displayed in these tables (2 and 3).

Table 1. *Quality-Rating Tool*

1	**Methods for selecting study participants**	Inclusion and exclusion criteria are clear
2	**Methods for identifying IPV-HI**	i. Use of a validated HI assessment tool ii. Use of internationally recognised categories and definitions of HI iii. Use of internationally recognised IPV assessment methods and definitions
3	**Comparison of outcomes**	Comparison of IPV-HI outcomes with i. Women who have experienced IPV without HI; or ii. Women who have experienced HI from causes other than IPV
4	**Assessment of outcomes**	i. Use of validated outcome measures ii. Use of measures which are relevant to outcomes in HI
5	**Methods to control confounding**	Methods to control confounding factors and establish causality. Such factors may include: i. Past trauma and current PTSD symptoms ii. Substance abuse iii. Accounting for HI from causes other than IPV iv. Demographic variables These may be controlled for via design (e.g. prospective design or excluding individuals who have non-IPV HI) or statistically (via robust and appropriate statistical methods).

Results

Study Characteristics and Risk of Bias

Overall, 67/100 of study ratings were high in risk of bias (table 2). All studies were cross-sectional and used self-report methods to assess HI history (table 3). No study used a validated HI assessment method. Four studies used clinical interviews to assess HI (Corrigan et al., 2003; Monahan & O'Leary, 1999; Valera & Berenbaum, 2003; Valera & Kucyi, 2016); 3 studies used the non-validated HELPS HI screen (Gagnon & DePrince, 2017; Jackson et al., 2002; Zieman, Bridwell, & Cárdenas, 2017); two studies used the non-validated Veteran's Association HI screening tool (Iverson & Pogoda, 2015; Iverson, Dardis & Pogoda, 2017) and one study used questions from a physical abuse measure to assess HI (Campbell et al., 2017). Six studies used an internationally recognised definition of HI as an injury to the head resulting in alteration or loss of consciousness (Jackson et al., 2002; Monahan & O'Leary, 1999; Iverson & Pogoda, 2015; Iverson et al., 2017; Valera & Berenbaum, 2003; Valera & Kucyi, 2016). Five studies included anoxic and hypoxic injuries from strangulation in their definition of HI (see table 3).

All studies included in this review had independent samples (i.e. no study samples over-lapped). Sample sizes of women with IPV-HI ranged from 9 (Monahan et al., 1999) to 265 (Campbell et al., 2017). Only 4 studies included a comparison group (consisting either of women who had experienced IPV without HI or women who had never experienced IPV; Campbell et al., 2017, Iverson & Pogoda, 2015; Iverson et al., 2017; Monahan & O'Leary, 1999). No study included a comparison group of women with HI from causes other than IPV. Only one study excluded women with HI from non-IPV causes (Valera & Kucyi, 2016). No other study took account of the potential confounding effects of non-IPV-HI. Four studies statistically adjusted for other potential confounding factors (e.g. trauma and mental health; Campbell et al., 2017; Iverson & Pogoda, 2015; Iverson et al., 2017; Valera & Berenbaum, 2003).

Most (9/10) studies used adult female samples. One study (Zieman et al., 2017) included a small number of men (5.2%) and individuals who had sustained HI from individuals other than an intimate partner (18.3%). This study was included in this review because the vast majority of the sample were women with IPV-HI. Given the paucity of research in the area of IPV-HI, it was important to include all studies that have attempted to measure the impact of IPV-HI in women.

Table 2: *Risk of Bias Assessment*

Study	Selection of participants	Methods for identifying HI/IPV				Comparison of outcomes	Assessment of outcomes		Methods to control confounding	
	Clear inclusion/ exclusion criteria	HI definition	HI severity	HI assessment	IPV assessment method & definition	Suitable control group	Validated outcome measures	Measures relevant to outcomes in HI	Design	Statistically
1. Monahan & O'Leary (1999)	HIGH	LOW	HIGH	HIGH	HIGH	LOW	HIGH	LOW	HIGH	HIGH
2. Jackson et al. (2002)	HIGH	LOW	LOW	HIGH	HIGH	HIGH	HIGH	LOW	HIGH	HIGH
3. Corrigan et al. (2003)	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	LOW	HIGH	HIGH
4. Valera & Berenbaum (2003)	LOW	LOW	LOW	HIGH	LOW	HIGH	LOW	LOW	LOW	LOW
5. Iverson & Pogoda (2015)	HIGH	LOW	HIGH	HIGH	LOW	LOW	LOW	LOW	HIGH	LOW
6. Valera & Kucyi (2016)	LOW	LOW	NR	HIGH	LOW	HIGH	LOW	LOW	LOW	HIGH
7. Campbell et al. (2017)	LOW	HIGH	HIGH	HIGH	LOW	LOW	HIGH	LOW	HIGH	LOW
8. Gagnon & DePrince (2017)	LOW	HIGH	HIGH	HIGH	LOW	HIGH	HIGH	LOW	HIGH	HIGH
9. Iverson et al. (2017)	HIGH	LOW	HIGH	HIGH	LOW	LOW	HIGH	LOW	HIGH	LOW
10. Zieman et al. (2017)	LOW	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	LOW	HIGH	HIGH

Table 3: *Study Characteristics*

Study authors, year (country)	**Design**	**Sample**	**Measure and Definition of HI/IPV**	**Outcome measures**
1. Monahan & O'Leary 1999 (USA)	Cross-sectional self-report/ observational	Female shelter residents who experienced IPV *N*= 26. IPV-HI *N*= 9 Median age: 27 46% white; 38% African American; 15% other races	**HI/IPV**: Semi-structured interview	**PCS-related symptoms**: Semi-structured interview/social worker observations
2. Jackson, Philip, Nuttall & Diller 2002 (USA)	Cross-sectional self-report	Female shelter residents/attendees of community outreach programmes who experienced IPV *N*= 53. IPV-HI *N*= 49. Mean age: 30 (*SD*= 7) 60% African American; 28% Hispanic; 6% white; 6% other.	**HI:** HELPS screen (Picard, Scarisbrick & Paluck, 1991). **IPV:** NR	**PCS-related symptoms**: HELPS screen
3. Corrigan, Wolfe, Mysiw, Jackson & Bogner 2003 (USA)	Cross-sectional self-report	Females who attended emergency departments with IPV injuries *N*= 51. IPV-HI *N* unclear. Mean age: 34.8. 37% white; 41% black; 2% Asian.	**HI:** Semi-structured interview **IPV:** NR	**PCS-related symptoms**: Semi-structured interview.
4. Valera & Berenbaum 2003 (USA)	Cross-sectional self-report	Female shelter residents, attendees of substance use/relationship support groups *N*= 99. IPV-HI *N*=73. Includes strangulation (27%) Mean age: 31.2 (*SD*= 9) 58% white; 35% African American; 7% other races	**HI:** Semi-structured interview. **IPV**: CTS–2 and Severity of Violence against Women Scale.	**Cognitive impairment**: Trail Making Tests A and B; Digit Span; CVLT; Ruff Figural Fluency Test. **Mental Health**: CAPS-2; Mood and Anxiety Symptom Questionnaire (short form).
5. Iverson & Pogoda 2015 (USA)	Cross-sectional self-report	Female veterans with and without experiences of IPV *N*= 176. IPV-HI *N*= 33 Includes strangulation (63.6% of IPV-HI).	**HI:** VA HI screen. Modified to assess HI specifically by intimate partner **IPV:** CTS-2	**Mental Health:** CES-D; PCL **Quality of Life:** Medical Outcomes Study Short-Form 12 Item Health Survey.

Study authors, year (country)	Design	Sample	Measure and definition of HI/IPV	Outcome measures
6. Valera & Kucyi 2016 (USA)	Cross-sectional self-report	Female shelter residents/IPV programme attendees *N*= 20. All IPV-HI. Includes strangulation (25%) Mean age: 33.9 (*SD*= 11.6) 50% African American; 35% Caucasian; 5% Latina; 10% mixed race	**HI:** Semi-structured interview **IPV**: Modified CTS-2	**PCS:** Rivermead Post-Concussion Questionnaire **Cognition:** CVLT and Trails B
7. Campbell, Anderson, McFadgion, Gill, Zink, Patch, Callwood & Campbell 2017 (USA & US Virgin Islands)	Cross-sectional self-report	Females of African descent recruited from primary care waiting rooms. Median age: 27 *N*= 901. *N* never-abused controls: 358. *N* IPV no 'probable HI': 269; *N* IPV with 'probable HI': 265 IPV group includes strangulation (36.3%)	**HI:** MAPSAIS **IPV:** MAPSAIS	**PCS-related symptoms:** Assessed via MAPSAIS. **Control variables (data not reported):** 3 item Primary Care PTSD screen; CES-D-10
8. Gagnon & DePrince 2017 (USA)	Cross-sectional self-report	Females recruited from police reports of IPV *N*= 225. IPV-HI *N*= 180 47% Caucasian; 30% Black; 40% Hispanic; 11% Native American; 9% Other	**HI:** HELPS screen **IPV:** CTS-2	**PCS:** HELPS screen
9. Iverson, Dardis & Pogoda 2017 (USA)	Cross-sectional self-report	Female veterans who experienced IPV. *N*= 224. IPV-HI *N* = 63 (28 with 'current HI symptoms'; 35 'without current HI symptoms') Includes strangulation (57% of women with IPV-HI).	**HI** measured as per study 5. **IPV:** HARK screen.	**Mental health:** PCL-5 modified to ask if symptoms were due to an 'intimate relationship'
10. Zieman, Bridwell & Cardenas 2017 (USA)	Retrospective chart review	Domestic violence survivors referred to neurology clinic from IPV and homeless shelters. *N*= 115 with HI. Includes 6 males and 21 individuals who experienced non-IPV domestic violence (these groups are not mutually exclusive). IPV-HI *N*= 94 (unknown gender breakdown). Mean age: 37.9 (*SD*= 10.8)	**HI:** HELPS screen **IPV:** Hospital records	**PCS-related symptoms:** Hospital records

CTS–2 = Modified Conflict Tactics Scale; CVLT = California Verbal Learning Test; CAPS-2 = Clinician-Administered PTSD Scale for DSM IV; CES-D = Centre for Epidemiologic Studies Depression Scale; PCL = PTSD Checklist; MAPSAIS = Modified Miller Abuse Physical Symptoms and Injury Scale; PCL-5 = PTSD Checklist for DSM-5

Hypothesis 1: Does IPV in women result in a high prevalence of multiple-mild HIs?

Two studies reported information on HI severity. Valera and Berenbaum (2003) found that 73/99 female victims of IPV (74%) reported IPV-HI. The most common HI experienced by the sample was multiple-mild HI (44%), defined as more than one HI with a loss of consciousness (LOC) of 30 minutes or less. 24% had a single-mild HI, 7% had a single moderate-severe HI and 3% multiple moderate-severe HI. Overall, 51% of the sample reported multiple IPV-HI. Jackson et al. (2002) found that 92% of 53 women who had experienced IPV reported a mild HI. 32.1% of the total sample (or 35% of women with IPV-HI) had more than 20 IPV-HIs within the previous 5 years.

Valera and Kucyi (2016) reported that in a sample of 20 women with IPV-HI, 25% had experienced a single HI, while 75% had sustained three or more HIs. 55% had experienced over 20 IPV-HIs. Zieman et al. (2017) found that 87.8% of their sample of 115 individuals reported more than one HI and 92.1% reported 'too many HIs to quantify'. However, this finding should be interpreted with caution as this study included individuals other than women with IPV-HI.

Hypotheses 2 and 3: What are the behavioural, cognitive, emotional and quality-of-life outcomes following IPV-HI? Does IPV-HI result in more negative outcomes than IPV without HI or HI without IPV?

Post-Concussion Syndrome

Most studies assessed post-concussion syndrome (PCS)-related outcomes (7/10; table 3). PCS is defined by the ICD-10 as 'the organic and psychogenic disturbances observed after closed head injuries that include subjective physical complaints and cognitive, emotional, and behavioural changes.' Six of these studies had high ratings of bias (with between 5-9 domains rated as high in bias; table 2). Only one study used a validated measure of PCS (Valera & Berenbaum, 2003).

Table 4 shows the prevalence of PCS symptoms reported across these studies. The most frequent symptom reported was headaches (an average of 73.5% of women with IPV-HI), followed by dizziness (64.6%) and depressed mood (63.3%). However, there was high variation across studies: for example, the percentage of individuals reporting concentration difficulties ranged from 45% (Gagnon et al., 2017) to 92% (Zieman et al., 2017). This variation likely reflects the heterogeneity of PCS assessment methods used.

Corrigan et al. (2003) did not report individual symptoms, but reported that 67% of a sample of women with IPV-HI reported at least one PCS symptom. Iverson et al. (2017) also did not report on specific symptoms, but found that 44% of their sample of women with IPV-HI had 'current' PCS-related symptoms (memory problems, dizziness, irritability, headaches, sleep problems and light sensitivity). Valera and Kucyi (2016) reported that 89% of their sample had at least one PCS symptom and 63% had at least three symptoms.

Table 4. *Percentage of Sample with IPV-HI Reporting PCS-Related Symptoms*

Symptom	**1**	**2**	**3**	**4**	**5**	**6**	**Mean (*SD*)**
Headaches	77**	83	45	92	91[a]	53	73.5 (19.1)
Dizziness	77**	64	27	90	65*	--	64.6 (23.5)
Concentration difficulties	55**	77	29	76	63***	42	57 (19)
Memory difficulties	33*	72	34	--	48***	37	44.8 (16.3)
Problems following directions	22[a]	26	13	74	--	--	33.75 (27.4)
Expressive difficulties	--	66	33	73	--	--	57.3 (21.3)
Depressed mood	44[a]	--	--	88	--	58	63.3 (22.5)
Sleep problems	44[a]	--	--	90	--	37	57 (28.8)
Seizures	11[a]	--	--	--	6[a]	--	8.5 (3.5)

(1) Monahan & O'Leary (1999); (2) Jackson et al. (2002); (3) Gagnon & DePrince (2017); (4) Zieman et al. (2017); (5) Campbell et al. (2017); (6) Valera & Kucyi (2016)

[a] No significant difference found between IPV-HI and IPV control group

*$p < 0.05$; **$p < 0.01$; *** $p < 0.001$ (significant differences found between IPV-HI and IPV no HI groups)

Only two studies compared differences in PCS-related symptoms between women with IPV-HI and women who had experienced IPV without HI (Monahan & O'Leary, 1999; Campbell et al. 2017). Both found that dizziness, concentration difficulties and memory difficulties were more prevalent in women with IPV-HI. Monahan and O'Leary (1999) found that headaches were more prevalent in women with IPV-HI, while Campbell et al. (2017) did not find a significant difference in headache reports across groups. Neither Monahan and O'Leary (1999) nor Campbell et al. (2017) reported effect sizes for these analyses.

Campbell et al. (2017) explored associations between IPV-HI and overall frequency of PCS symptoms in a sample consisting of women with IPV-HI, women who had experienced IPV without HI and women with no history of IPV (*N*= 901). IPV-HI was significantly associated with PCS symptom frequency, independent of the presence of

PTSD (assessed via a three-item screen) and depression (*B* = 2.24, *95% CI:* 1.55-2.83; *p* <0.001). All covariates were significantly related to PCS symptoms in this model.

Mental Health

Three studies assessed mental health outcomes in women with IPV-HI (table 3). In general, these studies used validated outcome measures and had a lower risk of bias than those that assessed PCS symptoms. Iverson and Pogoda (2015) explored differences in PTSD severity between women with IPV-HI and women who had experienced IPV without HI. PTSD severity had a significant association with IPV-HI that was independent of the frequency of exposure to physical, sexual and psychological IPV events (as measured by the Conflict Tactics Scale Revised; CTS-2). In this model, IPV-HI was associated with a 15.59-point increase in PCL scores (*SE*= 3.21; $p < 0.001$). Valera and Berenbaum (2003) found that in a sample of women with IPV-HI, PTSD severity had a moderate positive correlation with a non-validated 'brain injury severity' score based on the recency, frequency and severity (mild or moderate-severe) of HI. This correlation remained significant when shared variance with the frequency of exposure to IPV events was removed ($r = 0.39$; $p < 0.01$).

Iverson et al. (2017) used a non-validated, modified version of the PTSD Checklist for DSM-5 that assessed PTSD symptoms specifically resulting from IPV. They found that women with IPV-HI who were currently experiencing PCS-related symptoms were 5.86 times more likely to meet criteria for PTSD (*95% CI*= 2.2 to 15.5) than individuals without IPV-HI. This model adjusted for past year IPV exposure and demographic factors. However, no association was found between IPV-HI without current PCS-related symptoms and PTSD.

Valera and Berenbaum (2003) used the validated Mood and Anxiety Symptom Questionnaire and found that all of its subscales (general distress, anxious arousal and anhedonic depression) were significantly correlated with the 'brain injury severity score' and remained so when shared variance with frequency of IPV exposure was removed (r = 0.25 to 0.28; $p < 0.05$). Iverson and Pogoda (2015) found that IPV-HI history was associated with significantly more severe depression scores, independent of frequency of IPV exposure ($B = 7.56$; $SE = 1.76$; $p < 0.001$).

Cognitive Outcomes

Two studies explored cognitive functioning in women with IPV-HI (Valera & Kucyi, 2016; Valera & Berenbaum, 2003); both were limited by the lack of a non IPV-HI comparison group. Valera and Berenbaum (2003) assessed processing speed and executive functioning (trails A and B), working memory (digit span), verbal learning and memory (the California Verbal Learning Test; CVLT) and figural fluency (Ruff Figural Fluency Test). The immediate and delayed CVLT tasks had significant negative correlations with the non-validated 'brain injury severity' score (based on recency, frequency and severity of IPV-HI). This correlation remained significant when shared variance with IPV frequency and PTSD symptom severity was removed (r = -0.24 to -0.38; p< 0.05). Trails B scores also had a negative correlation with the 'brain injury severity score' that remained significant when shared variance with IPV exposure was removed; however, the correlation was weaker and the p-value was above 0.05 once shared variance with PTSD symptom severity was removed (r = -0.20, p = 0.08). Digit span, trails A and figural fluency did not show significant correlations with brain injury severity.

Valera and Kucyi (2016) failed to replicate the significant correlation found previously between IPV-HI 'brain injury severity score' and trails B (r = -0.09, p = 0.71) or CVLT delayed (r = -0.23, p = 0.34) tasks. A correlation between CVLT verbal learning (immediate recall) and 'brain injury severity score' was found that was similar in magnitude to that found in Valera and Berenbaum but had a p-value of above 0.05 (2003; r = 0.40, p = 0.08) The small sample size in this study (N = 20) may have limited the power available to find significant associations. Potential confounding variables (e.g. trauma) were not controlled for in these analyses.

Disability and Quality of Life

No study directly assessed disability in women with IPV-HI. Iverson and Pogoda (2015) used the Medical Outcomes Study Short-Form 12 Item Health Survey and found that women with IPV-HI rated their physical health (mean difference = 9.85; p <0.01) and mental health (mean difference = 6.75; p <0.01) as significantly worse than a group of women with and without past experience of IPV. However, this analysis did not control for any potential confounding factors.

Discussion

Does HI Result in Worse Outcomes than IPV alone?

The IPV-HI literature has studied a limited range of outcomes: PCS-related symptoms, poor mental health and difficulties in cognitive functioning. The presence of these outcomes in women with IPV-HI is not surprising, given that they have also been found in the wider IPV population and in other populations that experience trauma (Dean, O'Neill, & Sterr, 2012; Twamley et al. 2009). A key aim of this review was to establish the added burden that HI places on survivors of IPV.

Studies of IPV-HI outcomes have mainly focused on PCS-related symptoms and have found a high rate of these symptoms in women with IPV-HI. Only two studies compared differences in PCS-symptom frequency between women with IPV-HI and IPV survivors without HI, and both of these studies found a greater prevalence of somatic and cognitive PCS symptoms in women with IPV-HI (Campbell et al., 2017; Monahan & O'Leary, 1999). However, these findings should be interpreted with caution, as both studies were rated as high in risk of bias in terms of their assessment of PCS.

There is much debate as to the validity of the concept of PCS (King, 2003). The term itself is falling out of use and no longer appears as a diagnostic category in DSM-5. This is partly because PCS symptoms are not specific to HI and are common in non-HI populations, such as individuals with depression, chronic pain and psychological trauma (Dean et al., 2012; Smith-Seemiller, Fow, Kant, & Franzen, 2003). There is much overlap between the symptoms of PCS and post-traumatic stress disorder (PTSD) in particular (Sumpter & McMillan, 2006). A high prevalence of PCS-like symptoms in women with IPV-HI may be caused by a high level of PTSD in this population rather than HI. Indeed, Iverson et al. (2017) found that PTSD severity was associated with IPV-HI, but only in women who were currently experiencing PCS-related symptoms. IPV-HI was not associated with PTSD severity in women who were not experiencing PCS symptoms. This highlights the difficulty of distinguishing between PTSD and PCS in samples of women who have experienced IPV.

Women with IPV-HI may report more PCS symptoms because they have experienced more severe psychological trauma. IPV that results in HI may be experienced as more traumatic and violent than IPV that does not result in HI. Thus, it may be the trauma

inherent in the nature of the HI-related assault – rather than the HI itself – which results in more severe trauma and therefore greater levels of PCS symptoms in this group. One study suggests that the association between PCS-symptoms and IPV-HI is independent of the presence of PTSD (as measured via a three-item screen; Campbell et al., 2017), but no study has yet accounted for how trauma severity or exposure may influence PCS-symptoms in IPV-HI. Although there is some evidence to suggest that PCS-symptoms may be more severe in women with IPV-HI, as yet there is no evidence that HI is the cause of these symptoms.

The reviewed research suggests that mental health outcomes – including PTSD, depression and anxiety – are more severe in women who have experienced IPV-HI. Unlike studies on PCS-related symptoms, studies examining these outcomes controlled for frequency of exposure to IPV trauma events. When compared to IPV survivors without HI, women with IPV-HI had significantly more severe PTSD and depression, irrespective of the frequency of exposure to IPV (Iverson & Pogoda, 2015). Within IPV-HI samples, the frequency, recency and severity of HI was associated with more severe PTSD, depression and anxiety, independent of IPV exposure (Valera & Berenbaum, 2003). Thus, these studies provide some evidence that IPV-HI results in negative mental health outcomes that cannot be fully explained by exposure to trauma.

There is some evidence that IPV-HI severity and frequency is associated with poorer cognitive function, independently of PTSD severity and the frequency of exposure to IPV events (Valera & Berenbaum, 2003; Valera & Kucyi, 2016). However, these studies were limited by their lack of a non-IPV-HI comparison group. Thus, although this research suggests that the severity of HI impacts on cognitive functioning, it does not provide evidence that outcomes following IPV-HI are any worse than those following IPV without HI.

No work has yet directly investigated disability in women with IPV-HI. However, when compared with women without IPV, women with IPV-HI have poorer subjective perceptions of physical and mental health (Iverson & Pogoda, 2015), which suggests that they experience a level of disability in their daily lives. Again, however, this research did not investigate how factors other than HI (such as trauma) might influence these perceptions.

IPV and Multiple-Mild HI

The reviewed studies suggest that multiple-mild HI is highly prevalent in women with IPV-HI. They found that 68-87% of women with IPV-HI had experienced more than one IPV-HI (Valera & Berenbaum, 2003, Valeri & Kucyi, 2016; Zieman et al., 2017) and that 35-55% had experienced more than 20 IPV HIs (Jackson et al., 2002; Valeri & Kucyi, 2016). They further report that between 94–100% of IPV-HIs are mild (Jackson et al., 2002; Valera & Berenbaum, 2003). The only study that reported on both the severity and number of HIs found that most women with IPV-HI (60%) had multiple-mild HI (defined as more than one mild HI; Valera & Berenbaum, 2003).

The findings of this review indicate that women with IPV-HI experience similar negative outcomes to other populations that incur multiple-mild HI. Research on athletes has shown that multiple-mild HI is associated with more persistent and severe PCS symptoms and poorer cognitive functioning than single-mild HI (Collins et al., 1999; Guskiewicz et al., 2003). Likewise, research on military populations has found that veterans with more than one mild HI have more persistent PCS-like symptoms and poorer mental health in terms of PTSD, depression and suicidality than veterans with a single HI (Bryan & Clemans, 2013; Miller et al., 2013). The literature on military HI has similar limitations to that on IPV-HI, in that it has not yet distinguished the causal role that HI (as opposed to trauma) plays on these outcomes (Brenner, Vanderploeg, & Terrio, 2009). However, the similarities between that literature and the findings of the current review suggest that victims of IPV may benefit from similar screening procedures and interventions that are available for veterans.

Limitations

Studies exploring IPV-HI were high in risk of bias. They were particularly limited by their use of non-validated HI assessment and outcomes measures. Most studies did not account for confounding factors such as HI from non-IPV causes, trauma severity/exposure and substance abuse. As a result, the potential causal role that IPV-HI plays in outcomes compared to IPV alone is unknown.

Half the studies in this review included anoxic or hypoxic brain injury from strangulation in their definition of IPV-HI; none of these studies reported separate results for anoxic/hypoxic injuries. It was therefore not possible to disentangle outcomes related to HI

and those related to strangulation. Future studies should provide separate data on outcomes following HI and those following anoxic/hypoxic injuries. One study in this review included some individuals that were male or who obtained a HI from an individual other than an intimate partner (Zieman et al., 2017). It was felt necessary to include this study in this review given the lack of studies on IPV-HI; however, the results of this study should be interpreted with caution as it is not possible to disentangle outcomes related solely to IPV-HI.

The search, screening and data extraction procedures for this review were not checked by a second reviewer; this increases the overall risk of bias in this review. This review did not include unpublished work. It may therefore be subject to publication bias, whereby studies with significant findings were over-sampled. Study authors were not contacted as part of this review: it may be that relevant data was collected by authors but not reported. Finally, this review was limited to women who are victims of IPV-HI. Outcomes relating to male victims of IPV is an understudied but important area of research.

Future Research

A key challenge for IPV-HI research is to identify outcomes resulting specifically from HI as opposed to trauma. Prospective research could help elucidate the causal role that IPV-HI plays in negative outcomes. Future work should also explore the potential cumulative effects of multiple IPV-HIs. Research that compares outcomes between women with IPV-HI and women who have sustained HI from other causes would provide insight into the unique clinical needs of women with IPV-HI. Finally, research on IPV-HI would benefit from exploring a wider range of HI-relevant outcomes. In particular, future work should investigate the disability and impairment that women with IPV-HI may experience in their daily lives.

Conclusions

Like the previous Kwako et al. (2011) review on IPV-HI, the current review finds (1) that most studies on IPV-HI have focussed on PCS-related outcomes and (2) that there is a high prevalence of these PCS symptoms amongst women who have experienced IPV-HI. However, this review calls into question the conclusions of the Kwako et al. (2011) review by illustrating that the research to date has not provided sufficient evidence that negative

outcomes result specifically from HI rather than the trauma caused by IPV. It is therefore not yet possible to establish the added burden that HI adds to women who experience IPV

Research to-date on IPV-HI is limited by the generally high risk of bias across studies published in the area. This limits the generalisability of the findings reported in this review. Nevertheless, the research in this review that has controlled for relevant co-morbid factors (such as PTSD) and which has compared outcomes from IPV-HI to outcomes following IPV without HI does provide some tentative evidence to suggest that women with IPV-HI may experience more negative outcomes than survivors of IPV without HI, particularly in terms of PTSD, depression and PCS-like symptoms. These outcomes are similar to those experienced by populations that incur multiple-mild HI in other contexts. Clinicians and others working with women who have experienced IPV should have an awareness of HI and its potential negative impact on this population.

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Chapter Two: Major Research Project

Head Injury in Female Prisoners: Impact and Disability

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Prepared in accordance with manuscript guidelines for the Journal of Head Trauma Rehabilitation (Appendix 1.1).

Plain English Summary

Background: Head injury is very common in female prisoners. In Scotland, female prisoners have much higher rates of head injury than either the general population or male prisoners (National Prison Healthcare Network; NPHN, 2016). Head injury can result in cognitive, behavioural and emotional problems and long-lasting disability in everyday life. There may be a need for specialist services within prisons for women with a history of head injury. However, very little research has been carried out on the needs of female prisoners with head injury.

Aim: To inform the Scottish Prison Service by investigating the impact of head injury on female prisoners.

Methods: 62 female prisoners from three Scottish Prisons took part in this study. Female prisoners who posed a risk of violence to researchers or who had a learning disability were not able to take part. Participants were asked to complete questionnaires on whether they ever had a head injury and on difficulties they experience in everyday life. They also completed some tests of their cognitive abilities and some measures of mental health problems like anxiety, depression and post-traumatic stress disorder (PTSD).

Findings: Overall, female prisoners had high levels of cognitive difficulties, mental health problems and disability. Prisoners who had a head injury at a young age had higher levels of disability and reported more problems with their planning and organisation abilities, emotions and behaviour than prisoners who were older when they had their first head injury. Prisoners who had experienced a moderate to severe head injury or a period of multiple head injuries (from domestic abuse, for example) had high levels of PTSD which in turn were associated with high levels of self-reported behavioural, organisational and emotional difficulties.

Conclusions and implications: Prison services should be aware of the high rate of head injury and cognitive problems amongst female prisoners. Prisoners who had a head injury in childhood may be particularly prone to difficulties later in life. High levels of PTSD in female prisoners with moderate-severe and multiple head injuries appear to have a negative impact on their day-to-day lives. Prison education programmes and interventions

for female prisoners with head injuries may be helpful. These interventions also need to address the traumatic ways in which the head injuries occurred.

Abstract

Background: Female prisoners are significantly more likely to have head injury (HI) than the general population. The rate of HI amongst female prisoners in Scotland is particularly high. Little research exists on HI in female offenders. As a result, the impact of HI on this small but vulnerable group in society is unknown. There may be an unmet need within prison services in terms of interventions for female prisoners with HI.

Aim: To investigate HI-related disability and impairment in the Scottish female prison population.

Methods: 62 female prisoners were recruited across three Scottish prisons. A self-report measure of HI was combined with measures of cognition, daily executive problems, psychological distress, post-traumatic stress disorder (PTSD) and HI-related disability.

Results: A history of moderate-severe HI (d = 1.06; *95% CI* = 0.20 to 1.91) or multiple-mild HI (d = 0.73, *95% CI* = 0.005 to 1.45) was associated with significantly greater self-reported dysexecutive difficulties. A greater proportion of individuals with moderate-to-severe HI (93.8%) were rated as 'disabled' compared to individuals with no or single mild HI (63.6%); χ^2 (1, N=27) = 3.9, p = 0.04, *Cramer's V* = 0.38. When controlling for potential confounding factors such as PTSD, substance use and demographic factors, these associations became non-significant and PTSD symptom severity was the only significant predictor of dysexecutive difficulties (B = 0.34; SE = 0.12; p = 0.005). Age at first HI had significant negative associations with disability level (*OR* = 1.10; *95% CI* = 1.02 - 1.19; p < 0.009) and self-reported dysexecutive problems (B = -0.52; SE = 0.18 p = 0.0061), independently of psychological distress, PTSD symptom severity, substance use history and demographic factors.

Conclusions: HI in childhood is associated with long-lasting executive difficulties and disability in female prisoners. PTSD appears to drive the association between moderate-severe/multiple-mild HI and dysexecutive difficulties. Trauma-informed education programmes regarding HI-related disability and executive difficulties may be useful for women in prison.

Introduction

Head injury (HI) is significantly more prevalent in prison populations than in the general population (Moynan & McMillan, 2018). A recent National Prisoner Healthcare Network (NPHN, 2016) report on Brain Injury and Offending found that the Scottish prison population was significantly more likely to have a history of hospitalised HI than demographically matched controls. Female prisoners in Scotland are particularly at risk of HI: the report found that being a female prisoner was associated with an even greater likelihood of HI (6 fold) than being a male prisoner (4.4 fold). This finding is surprising given that epidemiological studies in the general population report a much higher incidence of HI in males than in females (Corrigan, Selassie, & Orman, 2010). Following from this finding, a recommendation of the NPHN (2016) report was to investigate further HI in female prisoners.

A potential explanation for the increased prevalence of HI amongst female prisoners in Scotland is the high incidence of gender-based violence in this population. Female offenders are significantly more likely to have experienced childhood abuse and intimate partner violence (IPV) over their lifetime than the general population (Smith, Leve & Chamberlain, 2006). HI has been found to be a common consequence of such domestic abuse (Kwako et al., 2011). Indeed, Colantonio et al. (2014) investigated gender differences in the early life experiences of prisoners with and without HI, and found that female prisoners with HI experienced significantly more physical and sexual abuse than those without HI.

In the general HI population, over 90% of individuals have a single, mild HI and recover fully with no long-lasting negative outcomes (Tagliaferri, Compagnone, Korsic, Servadei, & Kraus, 2006**)**. However, a high incidence of HI resulting from childhood abuse and IPV could increase the risk of negative HI-related outcomes in female prisoners for two reasons. Firstly, a HI to the developing brain during childhood can result in more severe and long-lasting difficulties than HI in adulthood (Levin & Hanten, 2005). Secondly, the chronic nature of IPV and childhood abuse may result in multiple-mild HI. Research has found that multiple HIs have cumulative effects, resulting in greater long-term impairment

than single HI (Collins et al., 2002; Guskiewicz et al., 2005). As a result, female offenders may be more vulnerable to HI-related disability and impairment than other populations.

A higher prevalence of HI in female offenders highlights a need for the prison service to consider the impact of HI on these prisoners. Understanding the extent of disability associated with HI in the female prison population would facilitate prison service design and provision. As yet, however, no research has investigated disability in female prisoners with HI (Moynan & McMillan, 2018). Moderate-severe or multiple-mild HI can result in longstanding difficulties in cognitive, behavioural and emotional functioning (Guskiewicz et al., 2005; Langlois, Rutland-Brown, & Wald, 2006). Emotional difficulties following HI include mental health problems and difficulties regulating emotions. Cognitive difficulties encompass executive, attention and memory problems. The behavioural difficulties associated with HI include impulsivity, aggression and disinhibition, all of which are linked to offending and recidivism (Kenny & Lennings, 2007).

Traumatic experiences are also associated with disability and impairment in everyday life. Post-traumatic stress disorder (PTSD) and, in particular, complex PTSD resulting from prolonged periods of abuse have been found to cause emotional and behavioural dysregulation and cognitive impairments, particularly in relation to executive functioning, memory and new learning (Aupperle, Melrose, Stein, & Paulus, 2012; Schuitevoerder et al., 2013**)**. It may be that disability and impairment in female prisoners with HI results from the psychological trauma associated with abuse rather than HI *per se*. It is important to separate the effects of psychological trauma and HI on impairment and disability in order to inform interventions and supports for this population (i.e. whether these should be trauma or HI-focused).

The female prison population with HI is a vulnerable group in society that is at risk of being over-looked. This population is more likely to come from a marginalised demographic background, have experienced prior domestic and childhood abuse and have sustained HI as a result of this abuse. An understanding of the impact of HI on female prisoners is pivotal in terms of informing service need. The current study aimed to provide an in-depth exploration of the impact of HI on a sample drawn from the Scottish female prison population.

Aims

The primary aim of this study was to establish whether severity of impairment and disability in female prisoners with moderate-severe HI or multiple-mild HI differed from that in prisoners who had experienced no or single-mild HI. A secondary aim was to establish the association between age at first HI and disability and impairment.

Female prisoners with HI are likely to have co-morbid difficulties, such as PTSD and substance use problems (Colantonio et al., 2014). This study aimed to establish the association that HI had with impairment and disability independent of these factors.

Hypotheses

Impairment and disability are significantly greater in female prisoners with a history of at least one moderate-severe HI or a period of multiple-mild HI than in female prisoners reporting no moderate-severe or multiple-mild HI.

Specifically, individuals with moderate-severe or multiple-mild HI exhibit:

a. Poorer performance on cognitive testing. Specifically, moderate-severe or multiple-mild HI is associated with poorer performance in cognitive domains known to be impacted by HI (executive functioning, attention, memory and processing speed).
b. More self-reported dysexecutive problems
c. Greater disability in daily life

A secondary hypothesis is that the age at which prisoners first sustained a HI has associations with the above outcomes. Specifically, the younger an individual was when they first obtained a HI, the greater the level of disability and impairment.

Methods

Ethics

Ethical approval was granted from the West of Scotland NHS Research Ethics Committee (WoSREC; 17/WS/0230, appendix 2.1).

Participants

Participants were recruited from three Scottish prisons: HMP Cornton Vale (Scotland's only female-only prison), HMP Edinburgh and HMP Greenock. All three prisons house a mixture of long-term and short-term prisoners. Flyers advertising the study were distributed to all prisoners and posters were displayed in communal areas within prisons. The research was advertised as a general 'well-being study'; HI was not specifically mentioned in study advertisements (appendix 2.2). Prisoners who were interested in taking part were asked to give their name to a prison officer, who then passed it on to the research team.

Inclusion/Exclusion Criteria

To participate in this study, prisoners needed to be:

- Aged 16+
- Fluent in English
- Able to give informed consent

The exclusion criteria were as follows:

- Individuals with severe communication difficulties, a learning disability or severe neurological/mental health conditions
- Individuals deemed by prison personnel to pose a risk of violence to researchers

Procedure

This study was conducted in tandem with an epidemiological study on the prevalence of self-reported HI and trauma in the Scottish female prison population. Data were collected by three researchers. All researchers attended prison induction and Scottish Prison Service training.

Participants were given full details on what the study entailed and provided informed consent. They then completed a battery of self-report measures and cognitive tests. This took between 1-2 hours in total. Breaks were given where necessary. Prison officers who were the participants' personal officers were asked to complete measures on their view of participants' difficulties (see 'measures' section for more details).

A pilot of four participants was first conducted. Researchers observed each other administering all measures and double marked each other's measures, to ensure inter-rater reliability. Following the pilot, minor changes were made to the study protocol (three measures were removed to reduce participant burden and shorten the testing session). Pilot data was included in the final dataset.

Measures and Definitions

Head Injury

HI was assessed using the *Ohio State University Traumatic Brain Injury Identification Method* (OSU-TBI; Corrigan & Bogner, 2007). This self-report measure has been validated on female prison samples and is structured to aid recall of past HI (Bogner & Corrigan, 2009). HI is defined in the OSU-TBI as an injury to the head or neck that resulted in an alteration in consciousness (being dazed, having a memory gap or a loss of consciousness; LOC). Mild HI is categorised by the OSU-TBI as HI with no or less than 30 minutes LOC; moderate HI has LOC between 30 minutes–24 hours; and severe HI has LOC over 24 hours.

Multiple HI is defined by the OSU-TBI as a period of time in which an individual experienced repeated impacts to the head, even if without any apparent effect. Repeated HI is most likely to cause damage when HIs occur in close proximity; that is, if another HI occurs while an individual is still biologically recovering from a previous HI (Guskiewicz et al., 2005). Individuals are thought to generally recover well from mild HIs, provided they have time to recover (in other words, provided that they don't experience another HI for a number of months). Therefore, this study does not consider two HIs that occur at least a year apart as multiple HIs.

Disability and Impairment

Glasgow Outcome at Discharge Scale (GODS; McMillan, Weir, Ireland, & Stewart, 2013). This is a structured assessment of HI-related disability in several domains, including activities of daily living, relationships and independence in daily life. The GODS was adapted in order to make it relevant to life within prison (references to 'hospital', 'ward' or hospital staff were replaced with 'prison' or 'prison staff'). Both prisoners and prisoners' personal officers were asked to complete the GODS. Where there were discrepancies between prisoner and officer ratings, the more severe disability rating was used. This was to ensure consistency of decision making across researchers in terms of rating discrepancies.

Dysexecutive Questionnaire (DEX; Wilson, Evans, Alderman, Burgess, & Emslie, 1997). This is a validated 20-item self- and 20-item informant-report of executive dysfunction (the latter was completed by personal officers). It assesses the motivational, emotional, behavioural and cognitive difficulties associated with dysexecutive syndrome. Total scores range from 0–80, with higher scores indicating greater dysexecutive difficulties in everyday life.

Neuropsychological Tests:

Table 1 outlines the domains of cognitive function tested in this study. These domains were chosen as they have all found to be sensitive to HI (including mild HI; Belanger, Curtiss, Demery, Lebowitz & Vanderploeg, 2005). In addition, effort in psychological testing was also measured so that this could be controlled for in the analysis of cognitive test performance.

Table 1. *Domains of Cognitive Function Assessed.*

Cognitive Domain	Test	Test Description
Processing speed, attention and visual scanning	*Symbol Digit Modalities Test (SMDT; Smith, 1982)*	Participants were required to match symbols with corresponding numbers as per a key. The score is the total number correctly matched after 90 seconds.
	Trail Making Test A (Tombaugh, 2004)	Participants required to join in order numbered circles. The score is the time taken to complete the task.
Verbal memory and learning	*List Learning from The Adult Memory Information Processing Battery (AMIPB; Coughlan & Hollows 1985)*	A list of words is read and individuals are asked to remember as many as they can. The score is the number of words recalled across 5 trials.
Executive functioning-related domains (mental flexibility, response initiation and inhibition)	*Trail Making Test B (Tombaugh, 2004)*	Participants are required to join numbered and lettered circles distributed on a page in alternating and ascending order. The score is the number of seconds taken to complete the task
	Hayling Sentence Completion Test (Burgess & Shallice, 1997)	Participants were asked to complete sentences with a semantically sensible word (Part A) or a semantically nonsensical word (Part B). A scaled score (1 – 10) encapsulates the time taken to initiate a response in parts A and B as well as the number of errors made in responses to part B. Higher scores indicate better functioning.
Phonemic and category fluency (also sensitive to deficits in executive functioning)	*Benton's Controlled Oral Word Association Task (COWAT; Ruff, Light, Parker, & Levin, 1996)*	The COWAT category fluency task asks individuals to name as many animals as they can in one minute. The score is the total number of animals correctly named, minus any repetitions. The COWAT phonemic fluency task asks individuals to name as many words as they can beginning with the letters C, P and L. The score is the total number of words correctly named across all three letters, minus any repetitions, proper nouns (i.e. names of places or people) or incorrect/nonsensical words.
Effort	*Word Memory Test (Green, 2003)*	Participants were asked to memorize 20 semantically linked word-pairs, immediately recall the words and then recall the words after a 30-minute delay. The delayed recognition task is thought to be particularly sensitive; a score of less than 90% on this task is considered evidence of poor effort.

Psychological Distress and Trauma

The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) consists of depression and anxiety self-report scales. Scores range from 0-21 on each scale. A score of 11 or above indicates clinical levels of anxiety/depression.

PTSD Checklist for DSM-5 (PCL-5; Bovin et al., 2016): This is a 20-item self-report measure that assesses the DSM-5 symptoms of PTSD. It yields a total score between 0-80; higher scores indicate more severe PTSD symptoms. A cut-off score of 33 or above suggests the presence of PTSD.

The Traumatic Life Events Questionnaire (TLEQ; Kubany et al., 2000) assesses the occurrence and frequency of lifetime traumatic events, including intimate partner violence, childhood abuse and sexual abuse.

Participants were also asked to complete a demographic questionnaire (appendix 2.3). This included questions on age, socioeconomic background, offence history and substance use history.

Justification of Sample Size

As no research exists on HI-related disability in female prisoners, sample-specific power calculations could not be calculated. However, a meta-analysis on differences in cognitive functioning between individuals with and without HI in the general population computed effect sizes for the cognitive domains of interest in the present study: attention (incorporating Trail-Making), delayed memory (incorporating List Learning) and verbal/semantic fluency. The effect sizes found (Cohen's *d*) were 0.47, 0.69 and 0.77, respectively (Belanger et al., 2005). Using these effect sizes, it was estimated that between 22-57 participants per group would be required to detect significant differences at an alpha level of 0.05, with power of 0.80 (one-tailed). A one-tailed estimate was used as all hypotheses were specific in terms of the direction of difference (i.e. that HI predictors would be associated with worse outcomes in each measure). When the average of these effect sizes was used (d=.64), power calculations estimated that 31 participants per group would be required.

As this study was conducted in tandem with an epidemiological study on HI amongst female prisoners, female prisoners with HI were not specifically targeted for recruitment (as this would bias the representativeness of an epidemiological study). Self-reports of HI estimate a HI prevalence of 50-60% in prison samples (Moynan & McMillan, 2018). Therefore, using this estimate it was expected that a sample of at least 78 participants would be sufficient (i.e to allow for at least 31 individuals per HI group) .

Data Analysis

The sample was categorized as 'moderate-severe HI' (participants with at least one HI with LOC of 30 minutes–24 hours); 'multiple-mild HI' (participants with multiple-mild HI as defined by the OSU-TBI and no moderate-severe HI) and 'minimal HI' (no HI or mild HI without a period of repeated HI; Bogner & Corrigan, 2009).

Univariate analysis established between-group differences in outcome measures. Multivariate regression models then further investigated any significant differences by controlling for (1) psychological distress (anxiety, depression and PTSD symptoms), (2) demographic variables (age, years of education) and (3) previous alcohol and drug abuse. Effort was included as a covariate in models with cognitive test outcomes. Similar regression analysis was conducted with outcomes that had a significant correlation with age at first HI. Age at first HI was investigated rather than age at first LOC. This was because (1) individuals tend to find it difficult to recall whether or not they lost consciousness as a child (Bogner & Corrigan, 2009) and (2) age at first HI was found to be considerably younger than age at first HI with LOC, and this study's hypotheses were particularly interested in childhood HI.

Results

Participants

Sixty-two prisoners participated in the study. The sample ranged in age from 20 to 73; the median age was 34 years (table 2). Most participants (96.7%) were Caucasian. Four participants were transgender. On average, participants had 11 years of formal education. 53.2% of the sample reported attending mainstream school, while 45.2% either required one-to-one support at school or attended a school for children with special needs. Nearly a third of the sample (30.6%) reported that they had been unemployed in recent years.

Table 2. *Demographics*

Total sample size	62
Gender (N, %)	
Female	58 (93.6)
Transgender	4 (6.4)
Age (median, range)	34 (20–73)
Ethnicity (N, %)	
Caucasian	60 (96.7)
Mixed race	1 (1.6)
Asian	1 (1.6)
Years Education (mean, SD)	11 (2.2)
Type of Schooling (N, %)	
Mainstream	33 (53.2)
Mainstream with 1:1 support	7 (11.3)
Specialist school	21 (33.9)
Unknown	1 (1.6)
Most Recent Occupation (N, %)*	
Unemployed	19 (30.6)
Elementary	21 (33.9)
Sales/Customer Service	11 (17.7)
Skilled Trades/Caring/Leisure/Service	10 (16.13)
Managing Director/Senior	1 (1.6)

*Occupation categorised as per the International Standard Classification of Occupations (ISCO - 08)

Most participants reported a previous alcohol or substance use problem (79%) and 30.6% were currently prescribed methadone for opiate addiction (table 3). The majority reported multiple arrests (80.7%) and convictions (64.5%). Violent offences were most common.

Table 3. *Offence and Substance Use History*

Variable	N (%)
Previous Problematic Alcohol/Substance Use	49 (79)
Prescribed Methadone	19 (30.6)
Number of Arrests	
1	12 (19.3)
2-10	20 (32.2)
11+	30 (48.4)
Number of Convictions	
1	20 (32.3)
2-10	30 (48.4)
11+	10 (16.1)
Missing	2 (3.2)
Previous Offence Type	
Property	26 (41.9)
Violent	45 (72.6)
Sexual	3 (4.8)
Other	43 (69.3)

Head Injury and Abuse History

Most participants (88.7%) reported at least one HI and 77.4% reported multiple HI (table 4). Thirty-five reported a history of multiple-mild HI (56.4%). The average age at first HI was 11.3 years (*SD*= 8.4), and the average age at first HI with loss of consciousness (LOC) was 16.4 years (*SD*= 9).

Table 4. *Head Injury History*

Worst Injury	Multiple HI	No Multiple HI	Total N (%)
No HI	0	7	7 (11.3)
Mild (no LOC)	10	2	12 (19.3)
Mild (LOC >30 mins)	25	2	27 (43.5)
Moderate (30 mins–24hrs)	12	3	15 (24.2)
Severe (LOC >24 hrs)	1	0	1 (1.6)
Total N (%)	48 (77.4)	14 (22.6)	62 (100)

Over a third (35.5%) reported childhood physical abuse and 74.2% intimate partner violence (IPV; table 5). Of those reporting childhood physical abuse, 16/22 (73%) sustained a HI as a result. Similarly, 40/46 (87%) of those reporting IPV sustained a HI as a result and 38/46 (83%) reported multiple IPV-related HI. Over half (59.7%) experienced childhood sexual abuse and 48.4% sexual abuse in adulthood.

Table 5. *Abuse History and Resulting HI (N; %)*

Trauma type	Experienced	Repeated Trauma[c]	Any HI	Repeated HI[d]
Childhood Physical Abuse[a]	22 (35.5)	19 (30.6)	16 (25.8)	13 (20.9)
Intimate Partner Violence[a]	46 (74.2)	42 (67.7)	40 (64.5)	38 (61.3)
Childhood Sexual Abuse[b]	37 (59.7)	21 (33.9)	2 (3.2)	--
Adulthood Sexual Abuse[b]	30 (48.4)	16 (25.8)	6 (9.7)	--
Any of Above	56 (90.3)	44 (71)	41 (66.1)	43 (69.3)

Note. Dashes indicate no data available (TLEQ did not assess repeated HI)
[a] Assessed via TLEQ and OSU-TBI; $N = 62$
[b] Assessed via TLEQ only; $N = 60$
[c] Repeated trauma is defined as trauma experienced on more than three occasions over lifetime
[d] Assessed and defined solely by the OSU-TBI

Cognitive Impairment and Disability

Most participants (81.7%) were moderately or severely disabled on the GODS (table 6). Over half (58.1%) believed that HI was a causal factor in their disability: 6 participants attributed the cause of disability solely to HI and 30 to a mix of HI and other causes. Twenty-six participants attributed their disability to another injury or illness (incorporating mental illness).

Table 6. *Glasgow Outcome at Discharge Scale (GODS) Ratings by Cause*

GODS Category	Cause: HI	Cause: Other	Cause: Mix	Total N (%)
Upper Good Recovery	4	4	2	10 (16.2)
Lower Good Recovery	0	0	1	1 (1.6)
Upper Moderate Disability	0	9	7	16 (25.8)
Lower Moderate Disability	2	1	7	10 (16.1)
Upper Severe Disability	0	8	5	13 (21)
Lower Severe Disability	0	4	8	12 (19.3)
Total N (%)	6 (9.7)	26 (41.9)	30 (48.4)	62 (100)

Population norms were obtained for all outcome measures (table 7). Where possible, norms for individuals with similar demographic characteristics (age, gender and education level) as the sample were obtained. On average, the sample scored below population norms on all measures. The average self-report DEX score was above the cut-off of 28 for 'considerable' dysexecutive difficulties (Chan, 2001; Pedrero-Perez et al., 2011). The independent-rated DEX mean was less severe than the normed mean. The independent-rated and self-report versions of the DEX questionnaire were weakly correlated ($r = 0.25$; $p = 0.068$), indicating low concordance between prisoner and prison officer perceptions of dysexecutive difficulties (see appendix 2.6).

Table 7. *Cognitive Test, DEX, HADS and PCL-5 Sample Means and Norms*

Measure	*N*	Sample mean/median	Normed mean/median
Symbol Digit Modalities Test	60	43.2 (12)	49.6 (10.8)[a]
List Learning	59	40.7 (8.7)	52 (9.6)[b]
Trails A (median, range)	61	40.3 (17-96)	24.4 (8.7)[c]
Trails B (median, range)	57	88 (31-308)	50.7 (12.4)[c]
Hayling Total	58	4.8 (1.4)	6.1 (1.6)[d]
Word Memory Delayed (median, range)	60	92.5% (45-100)	98.6% (2.4)[e]
Category Fluency	60	18.2 (3.9)	19.8 (4.2)[f]
Verbal Fluency	59	32 (9.1)	36.5 (9.9)[g]
DEX-Self	59	33.4 (14.5)	22.1 (8.9)[h]
DEX-Independent (median, range)	56	16.5 (0-58)	20.6 (10.5)[h]
HADS-Anxiety	60	12.6 (4.7)	6[i]
HADS-Depression	60	9.3 (4.8)	3[i]
PCL-5	60	45.4 (19.1)	N/A

Note. DEX = Dysexecutive Questionnaire; HADS = Hospital Anxiety and Depression Scale; PCL-5 = PTSD checklist for DSM-5.
[a] Kiely, Butterworth, Watson, & Wooden (2014).[b] Coughlan & Hollows (1985)
[c] Tombaugh (2004)
[d] Burgess & Shallice (1997)
[e] Green (2003)
[f] Tombaugh, Kozak, & Rees (1999)
[g] Ruff et al. (1996)
[h] Chan (2001)
[i] 50th percentile of normed sample (Crawford, Henry, Crombie, & Taylor, 2001)

Psychological Distress and PTSD

The sample scored higher than population norms on HADS anxiety and depression measures (table 7). The average HADS-anxiety score (12.6) was over the cut-off of 11 for clinical caseness, while the HADS-depression score (9.3) was just under this cut-off (Crawford et al., 2001). PTSD self-ratings were high: the mean PCL-5 score of 45.4 was well above the clinical cut-off of 33 (Bovin et al., 2016).

Associations between Moderate-Severe/Multiple-Mild HI and Impairment and Disability

Univariate Analysis

Cognitive test scores did not differ significantly between either moderate-severe or multiple-mild HI compared to minimal HI groups ($p > 0.18$; see appendices 2.4 and 2.5). The independent-rated DEX also showed no significant difference between-groups. A significantly higher proportion of individuals in the moderate-severe HI group were disabled on the GODS (94% of individuals with moderate-severe HI compared to 64% of individuals with minimal HI; χ^2 (1, N=27) = 3.9, p = 0.04; *Cramers V* = 0.38). Multiple-

mild HI did not show an association with disability. Self-rated DEX, HADS-anxiety and PCL-5 scores were all significantly higher in the moderate-severe HI group ($p < 0.02$ in each case). The multiple-mild HI group had significantly higher PCL-5 scores (mean difference = 15.03*; SE* = 6.50*; t* = 2.31; *p* = 0.03; *d* = 0.80; *95% CI* [0.10, 1.49]) and higher DEX-self (mean difference = 11.25; *SE* = 5.53; *t* = 2.03, *p* = 0.05; *d* = 0.73; *95% CI* [0.01; 1.45]) and HADS anxiety scores (mean difference = 3.34; *SE* = 1.65; *t* = 2.02; *p* = 0.05; *d* = 0.70; *95% CI* [0.002; 1.39]) that were of borderline significance.

Multivariate Analysis

Multivariate regression models further explored outcomes that differed significantly across groups in univariate analysis. A forced-entry approach was used, whereby all covariates were entered simultaneously into the models. A linear regression was modelled with DEX self-report as outcome variable and HI category as the predictor. The HI category variable was a three category dummy variable which consisted of 'multiple-mild' and 'moderate-severe' HI categories and 'minimal HI' as the reference category. A logistic regression was modelled with GODS disability status as outcome and moderate-severe and multiple-mild HI (a three category dummy variable with 'minimal HI' as the reference category) as predictor. Demographic variables (age and years of education), psychological distress (HADS), PTSD (PCL-5) and history of substance use problems (a binary variable where 1 = history of drug/alcohol use) were covariates in these models. Post-hoc linear and logistic regression diagnostics were conducted and the models were not found to violate assumptions.

Table 8. *Linear Regression of Association between Moderate-Severe HI and Multiple-Mild HI Categories and Self-Reported Dysexecutive Difficulties*

Outcome: DEX-Self	***B***	***SE***	***p***	***Adj R^2***
				0.50
Multiple-Mild HI[a]	3.60	4.25	0.402	
Moderate-Severe HI[a]	-0.78	4.83	0.872	
Age	-0.03	0.14	0.859	
PCL-5	0.34	0.12	0.005	
HADS-Anxiety	0.72	0.52	0.173	
HADS-Depression	0.40	0.42	0.340	
Substance use	2.57	3.99	0.523	
Years Education	0.09	12.09	0.896	

Note. HADS = Hospital Anxiety and Depression Scale; PCL-5 = PTSD checklist for DSM-5.
[a] Dummy coded variable where reference category (0) = minimal HI, 1 = Multiple-Mild HI and 2 = Moderate-Severe HI.

Neither moderate-severe HI nor multiple-mild HI had significant associations with DEX self-scores when controlling for confounding factors (table 8). In this model, the only significant predictor of DEX self-scores was PCL-5 scores. This suggests that PTSD explains the relationship between HI history and self-reported dysexecutive problems. In this model, a one-point increase in PCL-5 scores resulted in an increase of 0.34 points in DEX self-scores (*SE* = 0.12*; p* = 0.005), holding all other variables at their reference values.

The association between moderate-severe HI and likelihood of being classed as 'disabled' was no longer significant once covariates were included in the model (table 9).

Table 9. *Logistic Regression of Association between Multiple-Mild and Moderate-Severe HI Categories and Disability*

Outcome: GODS disability[a]	***OR***	***95% CI***	***p***	**Pseudo R^2**
				0.56
Multiple-Mild HI[b]	3.14	0.05, 196.69	0.588	
Moderate-Severe HI[b]	4.76	0.04, 587.96	0.525	
Age	1.12	0.99, 1.25	0.051	
PCL-5	1.09	0.99, 1.20	0.092	
HADS-Anxiety	1.69	1.00, 2.85	0.049	
HADS-Depression	0.99	0.68, 1.42	0.942	
Substance use	0.28	0.01, 11.68	0.502	
Years Education	2.14	1.04, 4.37	0.038	

Note. GODS = Glasgow Outcome at Discharge Scale; HADS = Hospital Anxiety and Depression Scale; PCL-5 = PTSD checklist for DSM-5.
[a] Dichotomous variable where 0= not disabled and 1= disabled
[b] Dummy coded variable where reference category (0) = minimal HI, 1 = Multiple-Mild HI and 2 = Moderate-Severe HI.

Associations between Age at First HI and Disability/Impairment

Age at first HI had significant positive correlations with GODS ratings (a higher GODS category score corresponds to a better outcome; *r* = 0.34, *p* = 0.01) and negative correlations with the DEX self-report (*r* = -0.47; *p* = 0.003) and PCL-5 (*r* = -0.33; *p* = 0.016; see appendix 2.6). These associations were further investigated in multivariate regressions. Again, these models employed a forced-entry approach, whereby all covariates were entered simultaneously into the models. As GODS ratings are ordinal, they violate a key assumption of linear regression. Therefore, an ordered logistic model was used (table 10). Post-hoc tests indicated that the proportional odds assumption for ordered

logistic regression was met. In this model, younger age at first HI was found to be associated with greater disability, independently of covariates.

Table 10. *Ordered Logistic Regression of Association between Age at First HI and GODS Category*

Outcome: GODS Category[a]	***OR***	***95% CI***	***p***	**Pseudo R^2**
				0.17
Age First HI	1.10	1.02, 1.19	0.009	
PCL-5	0.96	0.91, 1.01	0.096	
HADS-Anxiety	0.72	0.57 0.90	0.005	
HADS-Depression	1.19	1.01, 1.40	0.034	
Substance Use	9.79	1.62, 59.06	0.013	
Years Education	0.90	0.67, 1.20	0.478	
Age	0.95	0.89, 1.02	0.147	

Note. GODS = Glasgow Outcome at Discharge Scale; HADS = Hospital Anxiety and Depression Scale; PCL-5 = PTSD checklist for DSM-5.

[a] Due to small cell sizes, the upper and lower 'good recovery' categories were combined. The GODS outcome variable therefore consisted of five ordinal categories (Lower and Upper Severe Disability, Lower and Upper Moderate Disability and Good Recovery).

Age at first HI remained a significant predictor of DEX self-scores, independently of covariates (table 11). In this model, a one-year increase in the age at which prisoners first sustained a HI resulted in a 0.52 decrease in DEX self-scores (*SE* = 0.18; *p* = 0.006), holding all other variables at their reference value.

Table 11. *Linear Regression of Association between Age at First HI and DEX Self-Rated Scores*

Outcome: DEX-Self	***B***	***SE***	***P***	**Adj R^2**
				0.50
Age First HI	-0.52	0.18	0.006	
PCL-5	0.15	0.13	0.256	
HADS - Anxiety	1.17	0.56	0.044	
HADS - Depression	0.27	0.40	0.504	
Alcohol/drug use	1.78	3.89	0.649	
Years Education	-0.20	0.63	0.753	
Age	-0.06	0.18	0.717	

Note. . DEX = Dysexecutive Questionnaire; HADS = Hospital Anxiety and Depression Scale; PCL-5 = PTSD checklist for DSM-5

Discussion

PTSD and Executive Difficulties in Moderate-Severe and Multiple-Mild HI

Moderate-severe HI was associated with disability, while both moderate-severe and multiple-mild HI were associated with greater self-reported dysexecutive problems in daily life. However, these associations were not independent of potential confounding variables. High levels of PTSD appeared to drive the relationship between moderate-severe/multiple-mild HI and self-reported dysexecutive problems. This is consistent with reported associations between PTSD severity and deficits in executive functioning (Aupperle et al., 2012). PTSD that results from the cause of HI in female prisoners (for example, domestic abuse) may impair executive functioning to a greater extent than the HI itself.

However, there is considerable over-lap between symptoms of HI and PTSD (for example, cognitive and emotional difficulties). Assessment of PTSD with questionnaires on people with HI may not be accurate, as individuals do not differentiate between HI and trauma causes (Sumpter & McMillan, 2006). In completing the PTSD measure, prisoners may have referred at least in part to their HI-related symptoms. This study highlights how difficult it is to disentangle the effects of trauma and HI on female prisoners. In the current sample, HIs were most often sustained in the context of complex trauma and long-term abuse. Thus, HI and trauma appear to be inherently intertwined in the experience of female prisoners. Separating out the independent effects of either on outcomes was not possible in the current study. Future research with longitudinal designs should attempt to further understand the complex relationship between trauma, HI and disability and impairment in female prisoners.

Age of First HI, Disability and Executive Difficulties

Younger age of first HI was associated with greater disability and self-reported executive difficulties. These associations were independent of psychological distress (including PTSD), demographic factors and substance use history. This suggests that childhood HI has long-lasting consequences for female prisoners. This finding is in line with evidence reporting that childhood HI results in dysexecutive problems that negatively affect daily functioning in adulthood (Anderson, Brown, Newitt, & Hoile, 2011; Muscara, Catroppa, & Anderson, 2008). Outcomes following childhood HI are moderated by social factors, with social disadvantage and poor family functioning resulting in markedly worse outcomes

(Babikian, Merkley, Savage, Giza, & Levin, 2015). The social adversity that characterizes the childhood of many female prisoners could exacerbate the negative effects of early HI.

Self-reported Disability and Dysexecutive Problems in Female Prisoners

HI history had stronger associations with self-reports of dysexecutive problems and disability than other measures of impairment (e.g. neuropsychological tests). This could be because these self-report measures are particularly sensitive to the difficulties experienced by female prisoners. The DEX is a more encompassing measure of executive difficulties than other measures in this study because it incorporates cognitive, behavioural, motivational and emotional difficulties. The DEX and GODS have high ecological validity: both ask about an individual's functioning in the context of everyday life and therefore may be more accurate measures of real-world difficulties than cognitive tests (McMillan et al., 2013; Wilson et al., 1997).

Poor executive functioning is associated with several risk factors for offending, including impulsivity, aggression and difficulties with adapting behaviour in line with experience. Prisoners with executive difficulties may therefore be particularly prone to recidivism. Male prisoners with HI tend to offend at a younger age and have higher rates of re-offending than those without HI (Williams et al., 2010). In female prisoners, abuse-related HI is associated with incarceration for violent crimes (Brewer-Smyth, Burgess & Shults, 2004). Difficulties with executive function may be a vulnerability factor linking women with a history of HI, particularly in childhood, to offending and incarceration.

Limitations

Cross-sectional research on HI in prisoners is limited due to a high prevalence of co-morbidities, such as substance abuse and mental health difficulties. It was not possible to control for all potential confounding factors in the current study. This therefore makes an analysis of the unique role that HI plays on outcomes difficult. In particular, almost a third of the sample were prescribed methadone. The time at which individuals took methadone could have had an impact on results (i.e. if methadone was taken shortly before completing cognitive tests). Unfortunately, the timing of methadone administration and cognitive testing was not measured in this study; as a result, methadone administration was not controlled for in analysis.

This study relied largely on self-report measures, which may be unreliable due to memory difficulties associated with HI. Bogner and Corrigan (2009) found that the OSU-TBI was a reliable measure of single, moderate-severe and recent HI in prisoners. However, it was a less reliable measure of childhood and multiple HI, both of which were highly prevalent in the current sample. The multiple-mild HI group in this study might have been heterogeneous in terms of the number of HIs they had experienced; however, the OSU-TBI does not provide any information on this and no validated self-report measure of childhood and multiple HI has yet been developed.

This study was limited by its use of proxy measures. Self-reports of HI were not linked with medical records. Although prison officer perspectives were obtained, most officers had known prisoners briefly, calling into question the validity of their responses. This could explain the low concordance between prisoner and prison officer DEX reports. Finally, the sample size was below that estimated by power calculations. Small group sizes may have limited the ability to find statistically significant associations between multiple-mild/moderate-severe HI and outcome measures.

Implications

There has recently been a move towards trauma-informed care for female offenders (Miller & Najavits, 2012; Scottish Prison Service, 2015). Current findings suggest that trauma interventions should consider the impact of HI resulting from abuse, particularly in childhood. Trauma interventions for female prisoners need to consider executive difficulties associated with HI and PTSD and make relevant adaptations. Education aimed at improving awareness of trauma-related HI may benefit prisoners and prison staff. Such programmes could highlight the executive difficulties associated with HI and PTSD, and provide education around compensatory strategies. The high prevalence of self-rated disability also warrants attention: there is a need for the prison service to understand the nature of this disability and its implications for the quality of life of female prisoners.

Future directions

Longitudinal studies need to investigate how HI and trauma causally relate to impairment and disability in female prisoners. Specifically, work is needed on how PTSD and HI interact to negatively affect executive functioning. Future work should elucidate the role of

childhood HI in offending and recidivism. Finally, further research on the causes and nature of disability in female prisoners is required.

Conclusions

HI in childhood is associated with adulthood executive difficulties and disability in female prisoners, while high levels of PTSD appear to drive the association between moderate-severe/multiple-mild HI and dysexecutive difficulties. Trauma-informed education around HI-related disability and executive difficulties may be useful in female prisons.

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Appendix 1.1. Author Guidelines for Journal Head of 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.
  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.

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.

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.

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Appendix 1.2. Search Terms

Author title, abstract and keyword search terms (used across all 5 databases):	
IPV terms	("domestic" OR "partner" OR "intimate" OR "family" OR "gender based" OR "spous*" OR "relationship" OR "marital") within two words of ("violence" OR "abuse" OR "aggression")
	"IPV"
	"battered women" OR "battered female*"
Head injury terms	("head" OR "brain") within two words of ("inju*" OR "traum*" OR "damag*")
	"concuss*"
	"TBI"
Database specific subject/terms	
Medline	"domestic violence" OR "gender-based violence" OR "intimate partner violence" OR "spouse abuse"
	"brain injuries" OR "brain hemorrhage, traumatic" OR "brain stem hemorrhage, traumatic" OR "cerebral hemorrhage, traumatic" OR "brain injuries, diffuse" OR "diffuse axonal injury" OR "brain injuries, traumatic" OR "brain concussion" OR "brain contusion" OR "chronic traumatic encephalopathy" OR "brain injury, chronic" OR "epilepsy, post-traumatic" OR "head injuries, closed" OR "head injuries, penetrating" OR "skull fractures" OR "Post-Concussion Syndrome"
EMBASE	"domestic violence" OR "battered woman" OR "family violence" OR "partner violence"
	"brain injury" OR "head injury" OR "acquired brain injury" OR "brain concussion" OR "brain contusion" OR "brain damage" OR "brain stem injury" OR "cerebellum injury" OR "diffuse brain injury" OR "postconcussion syndrome" OR "traumatic brain injury" OR "brain injury assessment"

PsycINFO	"head injuries" OR "brain concussion" OR "traumatic brain injury" OR "brain damage"
	"domestic violence" OR "intimate partner violence" OR "partner abuse" OR "battered females"
CINHAL	"brain injuries" OR “brain concussion" OR "brain contusions" OR "chronic traumatic encephalopathy" OR "epilepsy, post-traumatic" OR "head injuries" OR "left hemisphere injuries" OR (MH "right hemisphere injuries" OR "brain damage, chronic" OR "postconcussion syndrome"
	"dating violence" OR "domestic violence" OR "intimate partner violence" OR "battered women"

Appendix 1.3. Further Guidance on Quality-Rating Tool

(1) *Definition of HI*:

   a. HI defined as injury to head accompanied by alteration in consciousness (i.e. LOC or dazed/memory gap etc).
   b. Categories of HI defined either by LOC (where mild < 30 mins, moderate = 30 mins – 24hrs, severe = 24+ hrs) or by GCS.
   c. The study should not use vague terms for head injury and should report LOC information.

(2) *Validated measures of HI:* either validated self-report or via hospital records with appropriate ICD codes etc.

(3) *Intimate Partner Violence (IPV)* defined as physical, sexual or emotional violence perpetrated by an individual with whom the victim is in an intimate relationship (World Health Organisation, 2012). Validated assessment method = any validated questionnaire/screen etc.

(4) *Methods to control confounding – design:* may include:

   a. Cross-referencing with medical records;
   b. Only sampling adult women (i.e. no men/children)
   c. A prospective design that attempts to establish causality
   d. Cross-referencing self-reports of HI/IPV with medical/police records
   e. Efforts should be made to isolate HI due to intimate partner violence. The study should exclude participants who have sustained HI from causes other than IPV. At the very least, HI from causes other than IPV should be measured and reported. If not, it is high in bias.

(5) *Methods to control confounding – statistical:* any statistical method that controls for confounding effect of trauma, substance use, demographic factors, HI due to other causes, etc

(6) *Outcome measures:*

   a. should use validated measure(s) of any emotional, cognitive, behavioural or quality-of-life outcome(s).
   b. If a measure is used that is not validated, some attempt at providing validity/reliability information should be reported (eg. a reliability estimate chronbach's alpha, factor analysis, correlation with other validated measures)

Appendix 1.4. Risk of Bias Ratings for Second Rater (*discrepancies in ratings are in italics*)

	Selection of participants	**Methods for identifying HI and IPV**				**Comparison of outcomes**	**Assessment of outcomes**		**Methods to control confounding**	
	Clear inclusion / exclusion criteria	**HI definition**	**HI severity**	**HI assessment**	**IPV assessment method & definition**	**Suitable control group**	**Validated outcome measures**	**Measures relevant to outcomes in HI**	**Design**	**Statistically**
1. Monahan & O'Leary (1999)	*LOW*	LOW	HIGH	HIGH	HIGH	LOW	HIGH	LOW	HIGH	HIGH
2. Jackson et al. (2002)	HIGH	LOW	LOW	HIGH	HIGH	HIGH	HIGH	LOW	HIGH	HIGH
3. Corrigan et al. (2001)	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	LOW	HIGH	HIGH
4. Valera & Berenbaum (2003)	LOW	LOW	LOW	HIGH	LOW	HIGH	LOW	LOW	LOW	LOW
5. Iverson & Pogoda (2015)	HIGH	LOW	HIGH	HIGH	LOW	LOW	LOW	LOW	HIGH	LOW
6. Iverson et al. (2017)	HIGH	LOW	HIGH	HIGH	LOW	LOW	HIGH	LOW	HIGH	LOW
7. Valera & Kucyi (2016)	*HIGH*	LOW	NR	HIGH	LOW	HIGH	LOW	LOW	LOW	*LOW*
8. Gagnon & DePrince (2016)	LOW	HIGH	HIGH	HIGH	LOW	HIGH	HIGH	LOW	HIGH	HIGH
9. Zieman et al. (2017)	LOW	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH
10. Campbell et al. (2017)	LOW	HIGH	HIGH	HIGH	LOW	*HIGH*	HIGH	*HIGH*	HIGH	LOW

Appendix 2.1. Research Ethics Committee Approval Letter

WoSRES
West of Scotland Research Ethics Service

NHS
Greater Glasgow and Clyde

Professor Tom McMillan
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Date 05 December 2017

Direct line 0141 232 1809
E-mail WoSREC5@ggc.scot.nhs.uk

Dear Professor McMillan

Study title: **Head Injury in Female Prisoners: Epidemiology, Impact and Disability**
REC reference: **17/WS/0230**
IRAS project ID: **230707**

Thank you for responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information was considered in correspondence by a Sub-Committee of the REC. A list of the Sub-Committee members is attached.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to make a request to postpone publication, please contact hra.studyregistration@nhs.net outlining the reasons for your request.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

The REC favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements. Each NHS organisation must

Appendix 2.2. Study Advertisement

RECRUITING

HEALTH &WELLBEING STUDY

We are trying to understand the needs of women in prison in Scotland. We want to know more about the health and well-being of women in prison in Scotland.

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

DO YOU HAVE ABOUT 90 MINUTES TO SPARE TO TALK TO A RESEARCHER ABOUT YOUR HEALTH AND WELL-BEING?

IF YOU ARE INTERESTED, PLEASE TALK TO A STAFF MEMBER OR WRITE YOUR DETAILS BELOW AND LEAVE IN THE BALLOT BOX

Appendix 2.3. Demographic Questionnaire

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 ***(where it significantly affected your functioning - family / job / social)***	Yes	No	
IF YES: how long did you have a problem for (in years)?			
IF YES: When was this?			
Were you ever treated for alcohol problems?	Yes	No	
IF YES: What kind of treatment?			
Previous problematic substance use ***(where it significantly affected your functioning - family / job / social)***	Yes	No	
IF YES: how long did you have a problem for (in years)?			
IF YES: When was this?			
Were you ever treated for drug problems?	Yes	No	
IF YES: What kind of treatment?			
Have you taken any alcohol in the past 24 hours?	Yes	No	
Have you taken any substances in the past 24 hours?	Yes	No	
What medicines are you currently prescribed? ***(inc. methadone)***			
IF PRESCRIBED METHADONE OR SLEEPING PILLS/BENZODIAZAPINE: What time did you take these last?			
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		
HI's occurred before or after 1994	Before		
	After		
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	

Previous psychiatric or physical health conditions

Have you currently or previously been diagnosed with any chronic physical or mental health conditions? (YES/NO) e.g. heart attack, stroke, depression, schizophrenia. (Include if the individual has experienced anxiety or depression but has not received a formal diagnosis)

Diagnosis	Past? (Y/N)	Currently? (Y/N)

Appendix 2.4. Moderate-Severe Head Injury Univariate Analysis

Outcome Measure Means (SD) and Tests of Differences in Means/Proportions for Participants with (1) Minimal HI and (2) Moderate–Severe HI.

Variable	Minimal HI (n = 11)	Mod – Sev HI (n = 16)	*d / V*	*95% CI*	t / χ^2	*p*
SDMT	41.5 (12.1)	43.9 (14)	0.18	-0.95, 0.60	0.45	0.65
List Learning	41.6 (12.6)	38.9 (7.7)	-0.27	-0.54, 1.07	-0.66	0.52
Trails A	45.6 (18.7)	46.4 (19.9)	0.04	-0.73, 0.81	0.11	0.92
Trails B	102.7 (60.6)	99.7 (68.2)	-0.04	-0.86, 0.77	-0.11	0.91
Hayling Total	5.1 (1.1)	4.5 (1.8)	-0.41	-1.21, 0.40	-1.01	0.32
COWAT Category	19.5 (5.3)	18.5 (4.1)	-0.21	-0.98, 0.57	-0.53	0.56
COWAT Verbal	33.4 (10)	32.6 (11.7)	-0.07	-0.87, 0.72	-0.18	0.86
Composite Cognitive Impairment[a]	0.69 (3.9)	0.13 (2.9)	-0.17	-1.01, 0.68	-0.38	0.71
Word Mem Delayed	35.9 (6.5)	36.6 (2.7)	0.15	-0.64, 0.94	0.38	0.71
Dex Self	23.9 (13.8)	35.9 (9.3)	1.06	0.20, 1.91	2.60*	0.01
Dex Independent	16.1 (18.6)	23.9 (17.9)	0.41	-0.28, 1.24	1.06	0.30
HADS anxiety	9.4 (5.6)	14.6 (3.2)	1.14	0.29, 1.97	2.88*	0.01
HADS depression	7.4 (4.1)	11 (5.2)	0.76	-0.04, 1.56	1.93†	0.07
PCL	31.1 (21.3)	54.1 (15)	1.29	0.42, 2.14	3.25***	0.00
GODS category	5.6 (2.2)	4.6 (1.2)	-0.65	-1.43, 0.14	-1.66	0.11
GODS disability[b]	63.6%	93.8%	0.38	N/A	3.92*	0.04

Note. N/A = confidence intervals for Cramer's *V* not available

[a] Composite Cognitive Impairment = sum of cognitive test Z-scores (SDMT, List Learning, Trails A & B, Hayling Total, Category & Verbal Fluency).

[b]Proportion classed as 'disabled' by the GODS. Test statistic = chi squared. Effect size = Cramer's *V*. All others are independent sample t statistics/Cohen's *d* effect size.

† $p < 0.10$ * $p < 0.05$; *** $p < 0.001$

Appendix 2.5. Multiple-Mild Head Injury Univariate Analysis

Outcome Measure Means (SD) and Tests of Differences in Means/Proportions for Participants with (1) Minimal HI and (2) Multiple-Mild HI.

Variable	Minimal (n = 11)	Multiple-mild (n = 35)	*d / V*	*95% CI*	*t / χ^2*	*p*
SDMT	41.5 (12.1)	43.3 (11.3)	0.15	-0.53, 0.83	0.45	0.66
List Learning	41.6 (12.6)	41.2 (7.9)	-0.05	-0.75, 0.66	-0.13	0.90
Trails A	45.6 (18.7)	42 (18.8)	-0.19	-0.87, 0.49	-0.55	0.58
Trails B	102.7 (60.6)	101.8 (58.32)	-0.01	-0.72, 0.69	-0.04	0.97
Hayling Total	5.1 (1.1)	4.9 (1.4)	-0.12	-0.82, 0.59	-0.33	0.74
COWAT Category	19.5 (5.3)	17.6 (3.3)	-0.48	-1.16, 0.21	-1.4	0.18
COWAT Verbal	33.4 (10)	31.3 (7.6)	-0.25	-0.96, 0.45	-0.71	0.48
Composite Cognitive Impairment[a]	0.69 (3.9)	-0.05 (2.21)	-0.28	-1.01, 0.46	-0.74	0.46
Word Memory Delayed	35.9 (6.5)	36.3 (4)	0.09	-0.59, 0.76	0.25	0.80
Dex Self	23.9 (13.8)	35.1 (15.8)	0.73	0.005, 1.45	2.03†	0.05
Dex Ind	16.1 (18.6)	18.9 (14.4)	0.18	-0.53, 0.90	0.50	0.62
HADS anxiety	9.4 (5.6)	12.7 (4.3)	0.70	0.002, 1.39	2.02†	0.05
HADS depression	7.4 (4.1)	9.1 (4.8)	0.38	-0.30, 1.07	1.11	0.27
PCL	31.1 (21.3)	46.1 (17.9)	0.80	0.10, 1.50	2.31*	0.03
GODS category	5.6 (2.1)	5.3 (1.6)	-0.18	-0.86, 0.50	-0.53	0.60
GODS disability[b]	63.6%	82.9%	0.20	N/A	1.82	0.18

Note. N/A = confidence intervals for Cramer's *V* not available

[a] Composite Cognitive Impairment = sum of cognitive test Z-scores (SDMT, List Learning, Trails A & B, Hayling Total, Category & Verbal Fluency).

[b]Proportion classed as 'disabled' by the GODS. Test statistic = chi squared. Effect size = Cramer's *V*. All others are independent sample t statistics/Cohen's *d* effect size

† $p < 0.10$; * $p < 0.05$

Appendix 2.6. Correlation Matrix of Age at first HI and Outcome Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Age first HI	1														
2. Age first HI with LOC	**0.49*****	1													
3. GODS Category	**0.34****	0.19	1												
4. SDMT	-0.09	0.25	**0.29***	1											
5. List Learning	0.02	0.16	0.17	**0.38****	1										
6. Trails A	0.22	0.02	**-0.29***	**-0.72*****	**-0.36****	1									
7. Trails B	0.15	-0.03	**-0.24**†	**-0.67*****	**-0.23**†	**0.68*****	1								
8. Word Memory Delayed	0.11	0.02	**0.34****	**0.37****	0.14	**-0.33***	**-0.36****	1							
9. Hayling Total	**0.27**†	0.25	**0.40****	**0.36****	**0.22**†	**-0.38****	-0.17	**0.31***	1						
10. Category Fluency	0.01	0.26	**0.25**†	**0.32***	**0.27***	**-0.22**†	-0.19	-0.09	**0.31***	1					
11. Verbal Fluency	0.04	**0.35***	**0.22**†	**0.42****	**0.44*****	-0.20	-0.11	0.12	**0.28***	**0.44*****	1				
12. Dex Self	**-0.47*****	**-0.28**†	**-0.41****	-0.01	-0.06	0.11	0.05	-0.21	-0.22	-0.13	-0.11	1			
13. DEX other	-0.12	**-0.35***	-0.06	-0.12	-0.18	0.07	0.06	-0.16	**-0.34***	-0.09	-0.17	**0.25**†	1		
14. HADS Anxiety	-0.16	-0.14	**-0.40****	-0.09	-0.04	0.17	**0.28***	**-0.27***	**-0.29***	**-0.29***	-0.04	**0.64*****	0.14	1	
15. HADS Depression	**-0.23**†	-0.06	**-0.31***	-0.15	**-0.26***	**0.34****	0.20	-0.16	**-0.36****	**-0.24**†	-0.12	**0.64*****	0.05	**0.65*****	1
16. PCL-5	**-0.33***	-0.23	**-0.42*****	-0.11	-0.20	0.17	0.14	-0.16	**-0.32***	**-0.23**†	-0.12	**0.71*****	**0.27***	**0.74*****	**0.64*****

All correlations significant at the $p < 0.10$ level are highlighted in **bold.** $^{\dagger}p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Appendix 3. Research Proposal

Abstract

Background: A significantly higher rate of head injury (HI) has been found in the Scottish female prisoner population than in the general population (NPHN, 2016). Little research exists on HI in female offenders; as a result, there is no clear explanation for this high rate of HI, nor is the extent of HI-related disability in this small but vulnerable group in society known. There may be an unmet need within the prison service in terms of assessment and intervention for female prisoners with HI.

Aims: To inform service need by investigating the persisting effects of HI in a sample drawn from the female Scottish female prison population (housed at Cornton Vale, Polmont, Greenock, Edinburgh and Grampian prisons).

Methods: A quantitative survey of a sample from Scotland's female prison population will be undertaken. Self-reported measures of HI will be combined with medical records, a battery of neuropsychological measures and measures of HI-related disability.

Applications: This study can shed light on an under-researched population: female prisoners with HI. Profiling the extent of HI-related disability in female prisoners will provide valuable information regarding service need within the Scottish prison system.

Introduction

Head injury (HI) is significantly more prevalent in prison populations than in the general population (Farrer & Hedges, 2011; Shiroma, Ferguson & Pickelsimer, 2010). Preliminary findings from a recent study (McMillan et al.) in the recent National Prisoner Healthcare Network report on Brain Injury and Offending (2016) indicate that the Scottish prison population were 4.5 times more likely to have a history of HI than demographically matched controls (NPHN, 2016), and that women were 6 times more likely to have been hospitalised with a HI than matched controls. This finding is surprising, given that epidemiological studies in the general population report a much higher incidence of HI in males than in females (Corrigan, Selassie & Orman, 2010). Following from this, a recommendation of the NPHN (2016) report was to further investigate HI in female prisoners.

A potential explanation for the increased prevalence of HI found in female prisoners in Scotland is a high incidence of gender-based violence pre-dating their incarceration. The female prison population is significantly more likely to have experienced abuse over their lifetime than the general population (Brewer-Smyth**,** Burgess & Shults, 2004; Smith, Leve & Chamberlain, 2006), and HI has been found to be a common consequence of childhood abuse and domestic violence (Kyriacou et al., 1999; Kwako et al., 2011). Colantonio et al. (2014) investigated gender differences in the early life experiences of prisoners with and without HI, and found that female prisoners with HI experienced more early physical and sexual abuse than those without HI.

HI potentially increases the risk factors for offending and recidivism, including impulsivity and aggression (Williams et al., 2010). There may therefore be vulnerability factors linking women with a history of abuse and subsequent HI to offending and ultimate incarceration. Indeed, one study by Brewer-Smith (2004) has suggested a link between previous experiences of abuse-related HI in women and incarceration for violent crimes. Although psychological trauma and the experience of normative violence in which abuse occurs are both important factors underlying this link, this research suggests that that the effects of HI have an independent role to play in the offending behaviour of these women (Brewer-Smith, 2004).

A higher prevalence of HI in female offenders highlights a need for the prison service to explicitly consider the impact of HI on these prisoners. Understanding the extent of disability associated with HI would facilitate prison service planning for these women. As yet, however, no study has systematically investigated disability in prisoners (male or female) with HI (Moynan & McMillan, accepted). Severe or multiple head injuries can result in longstanding difficulties in cognitive, behavioural and emotional functioning (Langlois, Rutland-Brown & Wald, 2006). Emotional difficulties can include mental health problems, higher levels of psychological distress and difficulties regulating emotions; cognitive difficulties encompass executive, attentional and memory problems; while behavioural difficulties can include impulsivity, aggression and behavioural disinhibition (Durand et al., 2016; Ponsford et al., 2014).

In the absence of head injury, traumatic experiences in and of themselves may lead to disability in everyday life. Post-traumatic stress disorder (PTSD) and, in particular, complex PTSD resulting from prolonged periods of childhood and domestic abuse have been found to cause emotional and behavioural dysregulation, psychological distress, and cognitive impairments, particularly in relation to executive functioning, memory and new learning (Aupperle et al., 2012; Gould et al., 2012; Schuitevoerder et al., 2013). It could therefore be the case that disability and impairment found in prisoners with HI could be as a result of psychological trauma rather than HI *per se*. Knowing the cause of disability and impairment in prisoners is important in order to inform suitable interventions and supports for this population (ie. whether these should be trauma or HI-focused).

In the general HI population, over 90% of individuals have a single, mild HI and outcomes are usually good (Ettenhofer & Abeles, 2008; Tagliaferri, Compagnone, Korsic, Servadei & Kraus, 2006). This pattern may be the case for the prison population also (Moynan & McMillan, accepted). However, a high incidence of childhood and domestic abuse could affect the prevalence of HI-related disability in the female prison population for two reasons. Firstly, a HI to the developing brain during childhood can result in more severe and long-lasting difficulties than HIs sustained in adulthood (Levin & Hanten, 2005). Secondly, the sustained nature of childhood and domestic abuse may result in repeated mild HIs (Colantonio et al., 2014). Multiple mild HIs have been found to have cumulative effects, resulting in greater long-term impairment than single HI (Collins et al., 2002; Guskiewicz et al., 2005). Given the high rate of reported HI amongst female offenders and the factors that are likely to contribute to the severity of HI in this population, it is important that the prison health service is aware of the extent of HI-related impairment and disability in order to inform service design and provision for these prisoners.

The female prison population with HI is a vulnerable group in society that is at risk of being over-looked. This population is more likely to come from a marginalised

demographic background, be stigmatised, and have experienced prior domestic and childhood abuse. An understanding of the nature of HI in female prisoners in terms of impact and disability is pivotal in terms of (1) shedding light on this under-researched population and (2) informing service need. The current study aims to provide an in-depth exploration the impact of HI on the Scottish female prison population. Drawing on a sample of women from Scotland's prisons, this research will systematically investigate the impairment and extent of disability associated with HI in this population.

Aims and Hypotheses

Aims:

This study will explore the effects of HI in the Scottish female prison population. The primary aim is to establish whether severity of impairment and disability in female prisoners with HI differs from those with no HI. A secondary aim is to separate out the effects of HI from those of potential co-morbid conditions (eg. PTSD and substance abuse) on impairment and disability. Finally, this study aims to establish whether age of first head injury and number of head injuries predicts greater impairment/disability. These findings will inform service need for prisoners with HI.

The present study will be carried out in tandem with an epidemiological study on the same population conduced by a second Clinical Psychology trainee (see summary in Appendix A). This epidemiology study will identify potential participants with and without HI. It will also provide information on the number of HIs sustained, the severity and cause of HI, any loss of consciousness immediately following the HI, and the age at which the first HI was sustained. The findings of the epidemiology study will inform the present study, and vice-versa.

Hypothesis

Impairment and disability is significantly greater in female prisoners with a moderate-severe HI or with more than two mild HI than in female prisoners reporting no HI or less than three mild HI[*]

Specifically, individuals with HI will exhibit:

d. Poorer performance on cognitive testing
e. More self-reported dysexecutive problems
f. Greater psychological distress
g. More persisting symptoms associated with HI
h. Greater self-evaluated disability in daily life

Plan of Investigation

Participants

On a census day in August 2015, there were 425 females incarcerated in Scotland (NPHN, 2016). Women are incarcerated in the following prisons: HMP Cornton Vale, YOI

[*] Multiple HI is defined as a history of 3 or more HIs (Guskiewicz et al., 2005). Childhood HI is defined as a head injury sustained below the age of 16 (Levin & Hanten, 2005).

Polmont, HMP Edinburgh, HMP Greenock and HMP Grampian. This study will sample prisoners above the age of 16 incarcerated across all five prisons.

Identification of head injury in female prisoners: The parallel epidemiological study (appendix A) will identify female prisoners with and without a history of head injury.

Design

The following will be compared in female prisoners with and without HI:

(a) Cognitive impairment and functioning (as measured via neuropsychological tests)
(b) Disability (incorporating self-evaluated disability, post-concussive symptoms and dysexecutive symptoms)
(c) Psychological distress

In addition to exploring differences in the above between female prisoners with and without a history of HI, other factors that may further define those with HI-related disability will be explored. The degree to which age at first head injury predicts impairment and disability (as measured by a-c above) will be investigated, as will the differences in impairment/disability between three categories of individuals with (1) moderate-severe (hospitalised) head injury; (2) multiple mild HI (>=3; Guskiewicz et al., 2005); (3) <3 HI or no HI. These will be explored via regression models, by entering (1) age at 1st HI and (2) severity of head injury as predictor variables. The association between severity of disability/impairment and duration of loss of consciousness at the time of the HI will also be explored.

Confounding variables and comorbidities

Female prisoners with head injury are likely to have a number of co-morbid difficulties that may impact on their levels of impairment and disability; most notably, psychological trauma and drug and alcohol problems. As discussed, the events that lead to HI in female prisoners may also lead to psychological trauma (for example, domestic or childhood abuse). Indeed, HI and PTSD have been found to co-occur (Bryant, 2011; McMillan, Williams & Bryant, 2003). It is therefore important to separate out the effects of psychological trauma from those of HI on levels of impairment and disability. Likewise, substance abuse is common in those with HI (Taylor et al., 2003). While many individuals with HI develop PTSD or abuse substances, a large proportion do not (McMillan et al., 2003, Taylor et al., 2003). Thus, a representative sample of female prisoners should consist of individuals with HI but without PTSD/substance abuse, individuals with HI and comorbid PTSD/substance abuse, and individuals without HI but with PTSD/substance abuse. This study will separate out the effects of psychological trauma and substance abuse from those of HI on disability and impairment through multivariate and univariate regression models, which are outlined in greater detail in the 'data analysis' section.

Research Procedures

Participants will be asked to engage in one research session lasting approximately 45 – 60 minutes in length. Every effort will be made to keep participant burden to a minimum, and breaks will be given where necessary. Participants will be seen individually, in order to keep participant confidentiality and reduce distraction during cognitive testing.

Measures

Severity and aetiology of HI will be ascertained from Scottish Morbidity Records-01 (SMR-01, which date from 1981) and self-report data from the parallel epidemiological study using the *Ohio State University Traumatic Brain Injury Identification Method* (see appendix A). An application will be made to the Public Benefit and Privacy Panel for Health and Social Care of the ISD for data from SMR-01.

The effects of HI will be established via the following measures:

Disability and impairment:

*Rivermead Post-Concussion Questionnaire** (RPCQ; King, Crawford, Wenden, Moss, & Wade, 1995): A standardised checklist of HI symptoms, taking approximately 5 minutes to complete (see Appendix B).

Glasgow Outcome at Discharge Scale[*] (GODS; McMillan et al; Appendix C): This is a standardised, structured assessment of disability following HI in individuals who are not living in the community. It assesses HI-related disability in a number of domains, including activities of daily living, relationships and independence in daily life. Both prisoners and Scottish Prison Service (SPS) staff will be interviewed in order to complete the GODS. Administration time: 5-10 minutes

Dysexecutive Questionnaire (DEX; Wilson et al., 1996): A 20-item questionnaire on self-report of executive dysfunction. Approximate administration time: 5 minutes.

Neuropsychological tests: These will include tests of current cognitive functioning that will help establish cognitive disability. These will include:

Symbol Digit Modalities Test (Smith, 2013): A measure of information processing speed. Approximate administration time: 5 minutes.

Rey Auditory Learning Test (Rey, 1964): A measure of verbal learning (5 minutes).

Trail Making Test (Reitan, 1992): A measure of executive function (2-5 minutes).

Benton's Verbal Fluency Test (Lezak, 1995): A measure of semantic memory. (3-5 minutes).

Psychological distress: *The Hospital Anxiety and Depression Scale* (Zigmond & Snaith, 1983) will be used as self-report of anxiety and depression (3-5 minutes).

Control variables

[*] The symptoms covered by the RPCQ will be assessed in all participants (not just those reporting a history of head injury). This means that participants will be asked to report their subjective experience of each symptom whether or not they have had a head injury. Likewise, researchers will complete the GODS in relation to *all* participants.

Effort in neuropsychological testing: The *Word Memory Test* (Green, Lees-Haley & Allen, 2003) is a test of effort and will assess participants' level of effort in neuropsychological testing. It takes 5 minutes to complete.

Previous and present alcohol/drug abuse and dependence: These are likely to be confounding factors in studies of HI-related symptoms and disability. The World Health Organisation's Alcohol Use Disorders Identification Test (AUDIT) and the Drug Abuse Screening Tool (DAST-10; Skinner, 1982) will be used to assess these (5 minutes).

Psychological Trauma: To assess the presence of psychological trauma symptoms, the Traumatic Life Events Questionnaire (TLEQ; Kubany et al., 2000a) and Distressing Events Questionnaire (DEQ; Kubany, Leisen, Kaplan, & Kelly, 2000b) will be administered (5-10 minutes). The symptoms of post-traumatic stress disorder can over-lap with the symptoms of HI (for example, memory issues), this it is important to control for this in analyses.

A brief **demographic self-report** taking 2-5 minutes will be included.

Recruitment Procedures and Justification of Sample Size

Recruitment will be conducted through the NHS prison service in conjunction with the SPS, via prison officers and NHS clinicians working within the prison. Posters advertising the study will be placed in communal areas and prison halls. These will invite all interested participants to approach a prison officer to receive further information on the study (via an information sheet). Prisoners wishing to take part in the study will then be asked to give their name to a prison officer, who will then pass this on to the researchers involved. This strategy proved successful in a recent study of HI in male prisoners (McGinley, Walker & McMillan, manuscript in preparation). All prisoners who match the inclusion/exclusion criteria will be invited to take part.

Inclusion/Exclusion criteria: Participants must be fluent in English in order for all measures to be valid. Participants who are under the age of 16, unable to give informed consent or who have severe communication difficulties, current substance use, a severe neurological or mental health condition, or a learning disability will be excluded from the study. So too will individuals deemed by prison personnel to pose a risk of violence to researchers.

Sample size: This study and the related epidemiological study aim to recruit a sample of 100-200 participants. Self-reports of head injury estimate a prevalence of 50-60% (Farrer & Hedges, 2011; Moynan and McMillan, submitted). Thus, with a conservative estimate of 50%, about 50-100 individuals in the sample will report a history of HI.

A sample of individuals with and without head injury will therefore be recruited. Control participants will be matched as far as possible on demographic variables. As this study is exploratory in nature and no previous research exists on head injury-related disability in female prisoners, sample-specific power calculations cannot be calculated. However, a large literature exists on differences in cognitive impairment between those with and without head injury in the general population. A meta-analysis by Belanger and colleagues investigated differences in cognitive functioning between 1463 individuals with a history of mild head injury and 1191 control cases (Belanger, Curtiss, Demery, Lebowitz &

Vanderploeg, 2005). They computed effect sizes for the cognitive domains of interest in the present study: attention (incorporating the Trail-Making test), delayed memory (incorporating the Rey Auditory Learning test) and fluency (incorporating the Benton Verbal Fluency test). The effect sizes found (Cohen's *d*) were .47, .69 and .77, respectively.

Using the above range of effect sizes, for the present study it is estimated that between 22 – 57 participants per group will be required to detect significant differences at an alpha level of .05, with a power of .8 (one-tailed). If the average of the above effect sizes is used (d = .64), power analysis estimates that 31 participants per group will be required to detect a between-group difference. Therefore, it is expected that a sample of 100-200 participants (with a prevalence rate of HI between 50-60%) will be sufficient to detect differences in impairment and disability between groups, if they exist.

It is estimated that it will take approximately 25 study days to recruit the above sample (based on 2 DClinPsy trainees recruiting 4 participants each per day). A recent study on male prisoners recruited 85 participants in 17 study days (McGinlay, Walker and McMillan, manuscript in preparation). However, consideration will be given to the fact that more time may be needed to recruit from a female prison population, due to it being a smaller population spread across more sites and containing more individuals with complex trauma histories (who may be more reluctant to engage in a study on HI). Funding has been granted from the Scottish Government for a research assistant who will support recruitment and assessment in the study, which will reduce the time needed to recruit the full sample.

Settings and Equipment

Equipment needed: Psychometric scales and neuropsychological tests.

Setting: NHS clinic areas of the prisons in question. Prison personnel will staff these rooms at all times. All researchers involved in this study will attend inductions, follow prison safety procedures at all times, and attend SPS training events.

Data Analysis

Regression analysis will be employed. Multiple regression models will be developed that will establish associations between HI and current disability and impairment. Regression models will firstly explore differences in impairment/disability between female prisoners with and without a history of head injury. Further regression models will then explore the relationship between severity and number of HIs, age at first HI and impairment/disability. In these, Hi status (severe HI, multiple HI, <3 HI and no HI) will be included as a categorical variable, where the incremental effect of HI severity will be compared to no HI (the dummy variable).

Multiple regression also allows for models that can control for confounding variables. Using regression, this study will separate out the effects of HI on disability/impairment from those of (1) psychological trauma; (2) drug and alcohol abuse and (3) a lack of effort in neuropsychological testing. In order to do this, separate univariate models will firstly establish how much variance is accounted for by HI alone and the three confounding variables outlined above. Multivariate regression models will then be run to establish how

much of the variance in the association between HI and impairment/disability can be accounted for by psychological trauma, substance abuse and effort. Where appropriate, mediation and moderation analysis may be conducted to establish how psychological trauma or substance abuse may mediate or moderate the association between HI and impairment. Bonferroni corrections will be applied to account for multiple tests.

Health and Safety Issues

Researcher safety issues: Prison safety protocols will be followed at all times to ensure the safety of the researchers involved in this study. Researchers will also attend mandatory prison safety induction courses run by the SPS. Additionally, researchers will also have attended prison safety induction run by the SPS.

Participant safety issues: These are outlined below.

Ethical Issues

Consent: The female prison population is a vulnerable group in society, and many of these individuals will have experienced abuse by those in a position of power over them. There is a risk that some participants may feel pressured into taking part in the study in order to illustrate 'good behaviour'. This risk will be minimised by emphasising to all potential participants that their involvement is entirely voluntary: they may choose to discontinue the research at any time and taking/not taking part will not affect their treatment in prison or prison record in any way. To ensure literacy issues do not affect the consent process, each step of the consent form will also be given to participants orally, and the researcher will check that the participant has understood after each step. Prisoners will not be permitted to partake in the study if there are any doubts regarding their capacity to consent (capacity will be determined by participants' ability to understand the consent form and process).

Risk of distress/re-traumatising: This study will ask participants about prior HI and traumatic life events. In order to minimise the risk of causing distress, participants will not be asked to recount specific details regarding previous traumatic events/assaults. Instead, validated questionnaires such as the OSU HI-ID (Corrigan & Bogner, 2007) and TLEQ and DEQ (Kubany et al., 2000a) will be used. Scales such as these are designed to minimise re-traumatisation by asking yes/no questions (rather than detailed questions) in relation to traumatic events. The TLEQ has been used in previous studies of women in prison, and has not been found to re-traumatise individuals (Huang et al., 2008). However, this measure will be altered so as to cause minimal distress (while retaining the validity of the measure). The original TLEQ has 5 questions relating to sexual assault and abuse in adulthood and childhood; the TLEQ we will use now uses only one question regarding sexual assault and abuse. This means that all the domains of trauma measured by the TLEQ will remain in the adjusted measure, but that less detail will be required regarding the domain of sexual abuse. Ethical approval will be sought from both NHS and Scottish Prison Service ethics boards to assess trauma histories of female prisoners using this board. Furthermore, the use of this measure will be discussed in depth with prison personnel and

NHS clinical psychologists working with female offenders, prior to commencement of this study.

The researchers working on this study are both final year trainees in the Doctorate of Clinical Psychology programme at the University of Glasgow. They will therefore have the clinical skills necessary to sensitively assess trauma histories in this population using the above validated measure. All participants will be debriefed immediately following their participation in the study. In the unlikely event that participation in the study has caused significant distress, participants' GP and health care teams will be notified. During this de-brief participants will also be signposted to services available to them, should they require further support.

Uncovering underlying impairment: This research may uncover underlying psychological trauma, disability and cognitive impairment. This may have implications for the prison health service, as once these are uncovered in participants, the service may need to provide additional support for these individuals. Instead of making recommendations at the individual level, this research aims to provide service-level (aggregate) recommendations regarding the supports that may be useful for the prison population, following submission of the final research report. If current PTSD is uncovered, permission will be sought from the participant to inform the prison NHS service. However, any information uncovered that poses a serious risk of harm to participants or to others will over-ride consent (eg. disclosures of suicidality or discovery of a very severe cognitive impairment that puts the participant at risk) and will be shared with the prison health service immediately (this will be outlined clearly to participants during the initial consent procedure).

Participant burden and anonymity: To reduce participant burden, research sessions will be kept to a minimum (1 hour max), and only information necessary to answer the research hypotheses will be gathered. All data will be anonymised and participants' responses will be identified via a participant number. Paper responses will be stored in a locked filing cabinet at all times and anonymised electronic data will be kept in encrypted folders on NHS computers. Any identifying information will be kept at separate locations to participant data/responses. All data will be kept for the required period of time in accordance with NHS policy before it is destroyed.

Submissions will be made to the SPS and the NHS Research Ethics Committees.

Timetable

November 2016 – May 2017: Development and assessment of proposal

June – August 2017: Proposal review and submission to ethics committees;

Systematic review; review of study protocols in line with recommendations from ethics committee; final ethical approval

August – September 2017: SPS training and orientation in prisons

September – April 2018: Recruitment

May – July 2018: Write-up and analysis

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Proposal Appendix A

An epidemiological study of the female prison population in Scotland will be carried out alongside this study. The epidemiological study will use the same sample as the present study, but will answer different research questions. In short, the epidemiological study will establish the incidence, aetiology and types of HI present in the Scottish female prison population. It will achieve this via data linkage with Scottish Morbidity Records-01 (SMR-01, providing information on any hospitalisations for HI) and *The Ohio State University Traumatic Brain Injury Identification Method* (a validated self-report measure of HI; Corrigan & Bogner, 2007). The psychological co-morbidities present in female prisoners with HI will also be measured (eg. mental health problems, history of substance and alcohol abuse). Two researchers will therefore be jointly involved in the testing and recruiting of participants: both researchers will collect data for both studies.

Proposal Appendix B

Plain English Summary
Title:
Head Injury in Female Prisoners: Impact and Disability

Background:

A large proportion of female prisoners have a history of head injury (Moynan & McMillan, 2018). In Scotland, female prisoners have much higher rates of head injury than either the general population or the male prison population (NPHN, 2016). We have very little knowledge of the impact of head injury on female prisoners. There may be an unmet need within prisons in terms of appropriate services for women with head injury.

Aim:

To inform prison services by investigating the impact of head injury on female prisoners.

Methods:

100-200 female prisoners from the following prisons will be recruited: Cornton Vale, Polmont, Greenock, Edinburgh and Grampian prisons.

Prisoners over the age of 16 will be asked to take part. Those who have a learning disability or a severe neurological condition will not be able to take part. Neither will those who are deemed to pose a risk of violence to researchers.

Prison staff will provide prisoners with an information sheet on the study and invite them to take part. Posters advertising the research will also be placed in communal areas of prisons. Prisoners who wish to take part will be given a time to meet with a researcher, who will go through in detail what is involved.

Participants will be asked to complete questionnaires on whether they have had a head injury, difficulties they have completing daily tasks and relevant physical/psychological symptoms they experience. They will also be asked to complete some tests of their cognitive abilities.

Overall, the research will take participants between 45-60 minutes to complete. Every effort will be made to keep this time to a minimum, and breaks will be given where necessary.

Ethical Issues:

Female prisoners are a vulnerable group in society: many will have experienced abuse from those in a position of power. Some may feel pressured into taking part in order to illustrate ‘good behaviour’. These risks will be minimised by emphasising that involvement is voluntary and that not taking part will not affect their prison record in any way. A history of head injury and cognitive difficulties may also impair an individual’s ability to consent to research. Prisoners will not be able to take part if there are any doubts regarding their capacity to consent.

All data will be anonymised and kept for the required period of time in accordance with NHS policy before being destroyed. Paper responses will be stored in locked filing cabinets and electronic data will be kept in encrypted folders on NHS computers.

Study Impacts:

Knowledge of head injury-related disability in female prisoners will provide information on the kinds of head-injury services the Scottish prison system needs (e.g. whether prisons should routinely assess head injury in prisoners and whether specialist services should be set up to help these individuals with their difficulties).

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