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REVIEW ARTICLE

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A pilot study of brain injury in police officers: A source of mental health problems?

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Accessible summary

What is known on the subject?:

- Traumatic brain injury (TBI) has been linked to poor outcomes in terms of mental health, specifically, PTSD, depression and alcohol abuse.
- A lack of research evidence exists relevant to exploring the presence and implications of TBI in the police in the UK and globally, despite the elevated risk of physical and emotional trauma specific to policing.

What does the paper add to existing knowledge?:

- The rate of traumatic brain injury is highly prevalent in a small sample of police officers.
- Traumatic brain injury is a major source of post-concussion symptoms (physical, cognitive and emotional deficits) in police officers, which, in general, are associated with greater mental health difficulties and drinking alcohol to cope.

What are the implications for practice?:

- Traditional mental health treatments should be supplemented with elements of concussion care to address any cognitive, emotional and physical issues due to head injury.
- Interventions should be made more accessible to those suffering from a mild brain injury. This can be done through regular reminders of appointments, pictograms and by providing a concrete follow-up.

Abstract

Introduction: Police officers have a high risk of injury through assaults, road traffic incidents and attending domestic calls, with many officers developing post-traumatic stress disorder (PTSD) as a consequence. Traumatic brain injury (TBI) is a common injury in populations involved in conflict and has been extensively linked to mental health difficulties. However, current research has not explored the frequency and sequelae of TBI in police populations, despite the elevated risk of physical and emotional trauma specific to policing.

Aim: To explore self-reported TBI, PTSD, post-concussion symptoms, depression and drinking to cope in a small sample of UK police, to determine the frequency of these conditions and their relationships.

Method: Measures of TBI, mental health, and drinking alcohol to cope were administered to 54 police officers from a Midshire Police Constabulary.

Results: Mild TBI with loss of consciousness was reported by 38.9% of the sample. TBI was associated with increased post-concussion symptoms (PCS). PCS were associated with greater severity of PTSD, depression and drinking to cope.

Discussion: Exploring TBI in the police could identify a major factor contributing towards ongoing mental health difficulties in a population where, based on previous research, the implications of TBI should not be overlooked, highlighting the need for further research in this area.

Implications for Practice: This research spans to identify the importance of routine assessment and increasing awareness within mental health services. Mental health treatments should be made amenable to a population with potential memory, planning and impulse control deficits. Further work in mental health services is needed to understand the level of ongoing issues that are due to post-concussion symptoms and those that are due to other mental health difficulties, such as PTSD, thereby educating patients on the association between TBI and emotional difficulties. A graduated return-to-work plan should be developed to enable a safe transition back to work, whilst managing any ongoing symptoms.

KEYWORDS
acute mental health, public health, recovery, stress and coping, trauma

1 | INTRODUCTION

Traumatic brain injury (TBI), including mild forms, can cause significant and potentially long-lasting cognitive, emotional and behavioural impairments (Bigler, 2008). This includes a threefold risk of suicide in those suffering from any TBI (Fazel et al., 2014). TBI is a pivotal risk factor in the development of ongoing mental health problems, particularly post-traumatic stress disorder (PTSD). Historically, there were doubts over whether PTSD and TBI were mutually exclusive, due to people with TBI having poor memory of events; however, recent evidence has shown that both disorders are comorbid in the sense that TBI increases risk of PTSD over and above the rate found in the general population (Bryant, 2011; Kaplan et al., 2018). Moreover, depression and alcohol misuse have been frequently identified as comorbid outcomes in both TBI and PTSD (Corrigan & Cole, 2008). TBI prevalence is estimated at around 8% (Silver, Kramer, Greenwald & Weissman, 2001) and 12% (Frost et al., 2013) in a general population. However, certain occupations, such as the military, have higher risk of brain injury. As many as 23% of US veterans returning from war have been estimated to have suffered a TBI, compared to 4.4% (9.5% in combat personnel) in UK soldiers (Rona et al., 2012). Similarly, police officers are frequently involved in fast-changing, physical environments

Relevance Statement

Mental health nurses are required to follow guidelines and procedures for mental health treatments; however, unfortunately, many mental health treatments do not acknowledge traumatic brain injury (TBI) in the role of mental health conditions. TBI is a major factor in multiple forms of mental health problems and can cause various cognitive impairments, such as memory and planning deficits. These deficits should be considered in mental health treatments. This can be done through regular reminders of appointments, including visual aids, and by providing a concrete follow-up. We are bringing neuroscience into nursing through models of understanding a major common clinical condition, with the aim of impacting on protocols being used around PTSD management that need to take account of brain injury and occupational health.

including car chases and dealing with violent offenders. This may confer a high occupational risk for injury. PTSD is a well-established problem in police officers (University of Cambridge, 2019);

however, there has been a surprising lack of research evidence investigating the presence and influence of TBI and PTSD on other mental health issues in the police force. We explore whether TBI and PTSD may co-occur in a police population, and any concomitant disorders of depression and/or problematic alcohol use.

1.1 | Traumatic brain injury

Traumatic brain injury (TBI) is the leading cause of death and disability in working-age adults (Fleminger & Ponsford, 2005), with 90% of all head injuries being classified as "mild" (Yates, Williams, Harris, Round, & Jenkins, 2006). Worldwide, more than 50 million people are estimated to suffer from a TBI each year (Maas et al., 2017). Common causes involve falls, sporting injuries, fights, assaults and road traffic accidents (Faul, Wald, Xu & Coronado, 2010), whereas blast-related TBI has become the most "signature" injury in the Iraq and Afghanistan wars (Levin & Robertson, 2013). TBIs are a subset of head injuries, in which brain damage is evident. Injuries can be focal, whereby direct impact produces lacerations or contusions of brain structures, typically within frontal and temporal regions, or diffuse, due to the stretching and shearing of white matter tracts throughout the entire brain—specifically caused by rotational injury at high speed (Caeyenberghs et al., 2014). Loss of consciousness (LOC) is often used to guide diagnosis and help determine level of impairment. Mild TBI typically involves LOC between 0 and 30 min, whereas moderate-to-severe TBI involves LOC of >30 min. Therefore, hospitalization, diagnosis and reporting are more likely in moderate–severe cases (Bruns & Hauser, 2003; Andriessen et al., 2011). Moderate and severe TBIs are associated with neuropsychological deficits, behavioural problems and poor social outcomes (Stambrook, Moore, Peters, Deviaene & Hawryluk, 1990). In milder injuries, subtle post-concussion symptoms (PCS) may be the main long-term problems (Bruns & Hauser, 2003). Symptoms include physical (e.g. headache, dizziness and nausea), cognitive (e.g. concentration and memory problems) and emotional (e.g. anxiety and irritability) impairments (McCrory et al., 2005). This is usual in <15% of cases—as symptoms typically resolve between 1 and 3 months (Walker & Tesco, 2013).

1.2 | TBI in the police

The police are likely to have an increased risk of injury due to the very dynamic situations that they are exposed to, for example, restraining non-compliant offenders, traffic pursuits and stops, and attending domestic calls (Crifasi, Pollack & Webster, 2016). In fact, 10,399 assaults with injury on constables were recorded across all forces in England and Wales in 2018/19 (Office for National Statistics, 2019), an increase of 27% compared to the previous year. Police officers may also have high rates of former occupational injury from the military, as many may have previous military backgrounds (Patterson, 2002). However, data are scant on TBI, as measured using "gold standard" scales (e.g. LOC). Nevertheless, there is evidence of injury patterns consistent with potential TBI.

One UK police study found 94 (42%) serious injuries (fractures, serious lacerations and bruising, concussion or trauma) to the face/head/neck (Brown, 1994). However, injury data were obtained from police crime files, which did not report on the clinical characteristics of TBI, such as LOC, PCS or even hospitalization. Several studies have used national injury databases to examine occupational injury rates in the police. For example, Crifasi et al. (2016) using the FBI's Law Enforcement Officers Killed and Assaulted database showed that between 1998 and 2013, 482 (61%) fatal and 505 (25%) non-fatal head, neck and throat injuries occurred in U.S. police. Similarly, Reichard & Jackson (2010) used data from the National Electronic Injury Surveillance System to examine occupational injuries across 67 U.S. emergency departments. Elevated levels of head injury were found in U.S. police forces relative to other blue light occupations (i.e. firefighters and emergency medical staff). Out of the three occupations, the police were the only occupation where head injuries were reported (n = 2,200) (4%). However, no specific risk ratio was calculated and, as such, national injury databases only provide vague descriptions of injury profiles, such as the location affected (i.e. the head), and do not report clinical indicators of severity. Therefore, the measures used in these studies report on head injury but are not standardized and sensitive to TBI; thus, it is unclear whether head injuries involved superficial laceration or actual damage to the brain.

We wish to emphasize, then, that TBI has only been marginally explored in the police in the UK and globally, which is a major omission in terms of potential factors that contribute towards low mood, poor occupational health and problematic alcohol use.

1.3 | PTSD in the police

PTSD is well established in police forces; indeed, we know from the literature that the incidence of duty-related PTSD has been found to range from 7% to 19% in Dutch and American police officers, versus a rate of 3.6% in the US general population and 3% in the United Kingdom, respectively (Marmar et al., 2006; McManus et al., 2009; National Institute of Mental Health, 2017). However, methodological differences may contribute towards varying estimates of PTSD. For example, these studies employed inconsistent assessment approaches (i.e. self-report measures vs diagnostic interviews). Diagnostic interviews have been found to substantially underestimate PTSD rates (Stevens, Fabra & Thies, 2013). Additionally, these studies included small sample sizes, specifically involving officers recently involved in critical incidents (e.g. fatal shootings); therefore, these samples are not representative of the general police population. Research into UK police officers is limited; however, (perhaps due to austerity), the police are attending more critical incidents without breaks in-between, and this is thought to create more pressure, having a negative impact on the mental health of frontline officers (Home Office, 2019). A recent study involving 16,857 UK police officers and staff across 22 forces found that 20% suffer from PTSD (University of Cambridge,

2019). However, no associations with specific risk factors were identified.

A plethora of risk factors is known to be associated with PTSD symptoms in police officers. For example, proximity (distance to the incident), type of incident, occupational stressors, neuroticism, introversion and poor coping skills have been shown to be associated with PTSD symptom severity (Klimley, Van Hasselt, & Stripling, 2018). However, the links between PTSD and TBI have not been systematically tested in the UK police force, despite an abundance of literature highlighting this association in the general population (Bryant, 2011) and in the military (Hoge et al., 2008).

1.4 | Developing PTSD After TBI

It has been found that TBI can complicate and exacerbate PTSD. mTBI and a short period of unconsciousness often lead to higher PTSD symptoms, compared to those without LOC, or even injury to the head (Mayou, Black, & Bryant, 2000). This may be due to various reasons. For example, those with TBI may still have "islands of memory" surrounding the traumatic event, which may enable re-experiencing of that event (Williams, Evans, Needham & Wilson, 2002). PTSD is more prevalent when memories of the traumatic event are connected to external attributions of blame, fear of death and loss of control (McMillan, Williams & Bryant, 2003). These factors could be particularly relevant in the police, as, quite often, they are the victims of unprovoked, unexpected and sometimes premeditated attacks (Brown, 1994).

1.5 | PCS and PTSD

PTSD and TBI confer a multiplicative set of risks to well-being, each exacerbating the other (Mounce et al., 2013). In moderate–severe TBI, PTSD has been found to occur (Alway et al., 2016). In milder forms of TBI, PTSD can be a factor in facilitating post-concussion symptoms. MTBI often leads to post-concussion symptoms—which normally recover; however, the emotional trauma can lead to PTSD within that traumatic event. Consequently, survivors of events where there was both mTBI and acute stress disorder can have elevated symptoms of PCS, both "neurogenic" and "psychogenic," as both interact to increase the chronicity of symptoms (Mounce, 2011). This may be due to a multitude of factors that set the scene for emotional disorders to occur. Many stressors are common following TBI, such as pain and relationship conflict (Bryant, 2011). It may be that biological damage reduces the ability to deal with cumulative stress. For example, the neural networks that are responsible for top-down regulation of emotions are commonly damaged following a mTBI; specifically, the medial prefrontal cortex (mPFC) (Umile et al., 2002). Interestingly, underactivity in this region has also been implicated in PTSD sufferers during fear processing (Shin et al., 2005).

1.6 | Alcohol

TBI and PTSD share overlapping characteristics, which can increase the likelihood of alcohol abuse. For example, hyperarousal in response to stressful events characteristic of PTSD can increase social withdrawal and intensify negative affect (Corrigan & Cole, 2008). TBI can diminish the capacity to cope with these symptoms, thereby increasing the likelihood of alcohol consumption (Weil, Corrigan & Karelina, 2018). Alcohol misuse has been found to act as a coping strategy to deal with negative affect for some suffering PTSD (Debell et al., 2014) and TBI (Corrigan & Cole, 2008). In US veterans, the general population and community mental health clients, self-reported drinking to cope with negative affect mediates the relationship between distress/PTSD symptoms and problematic alcohol use. Furthermore, alcohol abuse may exacerbate PTSD over time creating a vicious circle (Read et al., 2014) perhaps via increased neuroinflammation producing poorer long-term executive functioning and psychosocial impairments after TBI (Weil, Corrigan & Karelina, 2016). Therefore, increased risk of alcohol use to cope with negative symptoms, following TBI, is a potentially modifiable factor that could be targeted to improve long-term outcomes.

Overall, a brief scoping exercise of the literature on head injury and/or head injury in police officers revealed no clear research studies relevant to identifying the prevalence and sequelae of TBI within police populations in the UK and globally. Given the high rates of TBI in populations with occupational histories such as the military, it is remarkable that there is a lack of research evidence on brain trauma in police officers. However, there is evidence to suggest that potential TBI is highly prevalent in police populations. This is an important area for research, given that brain trauma can complicate PTSD and is associated with increased rates of depression, alcohol abuse and a threefold risk of suicide (Fazel et al., 2014). All of which are relevant to mental health nursing in police officers, as a brain injury may be underlying the maintenance and severity of emotional disorders and alcohol problems. This study aims to address this gap in the literature.

The purpose of the current study was to measure self-reported TBI, PTSD, post-concussion symptoms, depression and drinking to cope in a small sample of UK police, to determine the frequency of these conditions and their relationships. This work will provide insight into the potential sequelae of TBI in UK police officers.

2 | METHODS

2.1 | Participants and design

This study used a cross-sectional, questionnaire-based survey design. Participants were police officers that were recruited using opportunity sampling from a Midshire Police Constabulary. All participants were currently employed within a police force in the UK. 150 police officers were invited to take part in the study by their commanding officer. 88 participants were recruited; however, 34

were excluded due to incomplete responses. Therefore, the total sample size was 54, i.e. a response rate of 36% from those approached. Recruited participants were from a range of frontline response roles, with the exception of police staff investigators (civilian investigator), who were former serving police officers. Participants had a mean age of 37.87 ($SD = 8.06$). The sample included various ranks and roles, which are presented in Table 1 alongside participant demographics. A significantly higher proportion of participants were ranked as police constable compared to other ranks ($\chi^2 = 17.556$, $df = 6$, $p = .007$) and were in response roles compared to non-response roles ($\chi^2 = 17.800$, $df = 3$, $p < .001$). The mean number of years worked in the police force was 12.74 ($SD = 7.64$), with a mean number of hours worked per week of 39.94 ($SD = 5.95$).

2.2 | Ethics

Ethical approval of this study was granted prior to data collection by the University of Exeter Department of Psychology Ethics Board. All participants were briefed, completed an online consent form to indicate their informed consent and were debriefed. Appropriate sources of support were provided in case participants felt uncomfortable with any of the topics addressed. Participants were also reminded that their responses would remain anonymous and were informed of their right to withdraw at any point during the study.

2.3 | Materials

2.3.1 | Traumatic brain injury (TBI)

The Ohio State University TBI Identification Method (OSU TBI-ID; Corrigan & Bogner, 2007) is a structured survey that is designed to identify lifetime history of TBI. The measure consists of 11 items that measure the presence of historical TBI, cause of TBI, length of loss of consciousness and age of first and last occurrence of LOC. The measure also assesses the presence of a period of repeated TBI and the age of first and last instance of post-concussion symptoms. The OSU TBI-ID has been found to have acceptable inter-rater and test–retest reliability, and construct validity (Corrigan & Bogner, 2007). The version used in this study followed Lequerica et al.'s (2018) validation of an online, self-administered version of the OSU TBI-ID.

2.3.2 | Post-concussion symptoms

The Rivermead Post-concussion Symptoms Questionnaire (RPQ; King et al., 1995) consists of 14 items assessing the presence and severity of symptoms that are common in post-concussion syndromes, such as headaches, dizziness, irritability and difficulty concentrating. Responses are given on a 5-point Likert scale ranging from 0 = "Not at all" to 4 = "Severe". Possible scores range from 0 to 56, with higher

TABLE 1 Demographic characteristics of participants

Participants (n = 54)	Frequency	Percentage (%)
Gender		
Male	30	55.6
Female	22	40.7
Prefer not to say	2	3.7
Ethnicity		
White	52	96.3
Black or Black British	1	1.9
Other	1	1.8
Marital status		
Single	19	35.2
Married/Domestic Partnership	29	53.7
Divorced	1	1.9
Separated	1	1.9
Prefer not to say	1	1.9
Education (highest level)		
None	1	1.9
GCSE	7	13
A-level	12	22.2
Bachelor's degree	24	44.4
Master's degree	4	7.4
Other	6	11.1
Policing rank		
Uniform inspector	7	13
Uniform sergeant	7	13
Police constable	17	31.5
Detective police constable	8	14.8
Police staff investigator	2	3.7
Uniform police constable	9	7.4
Prefer not to say	4	16.7
Policing role		
Response	26	48.1
Investigation Hub	15	27.8
Neighbourhood	6	11.1
Prefer not to say	8	13

scores indicating more severe symptoms. The RPQ has been found to be a valid measure of PCS, with high reliability (King et al., 1995). Research has suggested a cut-off point of ≥16 to distinguish between those with and without post-concussion syndrome and has demonstrated a .97 sensitivity and .87 specificity at this threshold (Thompson et al., 2016).

2.3.3 | Post-traumatic stress disorder

The Trauma Screening Questionnaire (TSQ; Brewin et al., 2002) is a 10-item measure that assesses current levels of re-experiencing

and arousal PTSD symptoms that can occur after a traumatic event, such as upsetting dreams about the event and bodily reactions when reminded of the event. Each item assesses the frequency of symptoms experienced over the past week, ranging from 0 ("not at all") to 4 ("less than ten times"). Possible scores range from 0 to 40, with higher scores indicating more severe PTSD symptoms. The presence of 6 re-experiencing or arousal symptom items in any combination experienced at least twice was set as a threshold to indicate those who are likely to have clinically significant PTSD. The TSQ has been found to have good predictive and concurrent validity, as well as a sensitivity of .85, specificity of .89 and efficiency of .90 (Walters, Bisson & Shepherd, 2007).

2.3.4 | Depression

The Patient Health Questionnaire-8 (PHQ-8; Kroenke et al., 2009) consists of 8 items that ask the participant to rate how often in the past 2 weeks they have suffered from specific depressive symptoms. Responses are provided on a 4-point scale (0 = "Not at all" to 3 = "Nearly everyday"). Possible scores range from 0 to 24 with higher scores representing more severe depressive symptoms. Scores lower than 5 indicate no depressive symptoms. Scores of 5–9 represent mild depressive symptoms. Scores of 10 or higher indicate moderate depressive symptoms, the need for clinical assessment and possible treatment, whereas scores of 15 or higher indicate a high likelihood of depression and require medical treatment (Kroenke, Spitzer & Williams, 2001). Research has highlighted a two-factor structure of the PHQ-8 reflecting the emotional and somatic dimensions of depressive symptoms (Pressler et al., 2011) and has demonstrated a "good" internal consistency (Cronbach's α = .86) (Kroenke et al., 2009). Of the available measures, the PHQ-8 was chosen as it was brief, had a high clinical sensitivity and specificity (Kroenke et al., 2009) and captured the issues relevant to depression in this study.

2.3.5 | Drinking and drug motives

The Drinking Motives Checklist (DMC) (Hogarth et al., in prep) is an unpublished questionnaire that consists of 35 items measuring drinking and drug motives to cope with negative experiences. The measure consists of 7 subscales with 5 items each: depression, anxiety, stress, anger, isolation, physical and cognition. Each item consists of a "yes" and "no" response, with total scores reflecting the percentage of all items endorsed. Alternative measures were available, such as the Alcohol Use Disorders Identification test (AUDIT; Reinert & Allen, 2002); however, due to the preliminary nature of the study and due to the time pressure of the population, we opted for a short battery of tests, including a hybrid measure of alcohol and drug use.

2.4 | Procedure

Participants were recruited from a Midshire Police Constabulary. Staff were requested to take part in the study via email. A link to the online study was distributed to participants, who were prompted to respond over the course of three time points. It was explicitly stated that information provided would remain anonymous at all times. The online survey began by collecting informed consent, indicated using digital confirmation. Participants were then asked to generate a unique participant code, to ensure that their responses remained anonymous. Demographic questions regarding age, gender, ethnicity, education (highest level) and marital status were asked. Participants then completed questions on the OSU TBI-ID, RPQ, TSQ, PHQ-8 and DMC, respectively. Participants were then debriefed and thanked for their participation.

3 | RESULTS

3.1 | Analyses

Prior to analysis, all variables were examined for missing values, outliers and violations of the assumption of normality. Participants with missing data were excluded from analysis. Group differences in injury reporting between those with and without TBI were assessed with a chi-square test of independence as a post hoc method of controlling for injury reporting.

Mann–Whitney U tests were conducted to compare the difference in mental health variables (i.e. post-concussion symptoms, depression, PTSD and drinking to cope) between those with and without history of mTBI, as defined by loss of consciousness.

A chi-square test of independence was conducted to determine the relationship between TBI and post-concussion syndrome, and TBI and PTSD, using the aforementioned clinical thresholds.

A correlation matrix was conducted using Spearman's rho correlations to assess the relationships between post-concussion symptoms, PTSD, depression and drinking to cope, with point-biserial correlations being used to assess the association between TBI and mental health.

3.2 | Self-reported TBI

The mental ill health levels were high in this sample (means and standard deviations are displayed in Table 2). 16.7% of participants met criteria for PTSD (n = 9), and 39% met criteria for mild or more severe depression (n = 21) (Table 3). However, the primary concern in this study was TBI. We found that of the 54 respondents, 59.3% (n = 32) reported a lifetime history of being treated in an emergency room following an injury to their head or neck, and 20.4% (n = 11) reported a period of multiple, repeated blows or impacts to the head. The most common cause of head injury involved a fall or being hit by something (49.1%), followed by motor vehicle crashes (29.1%). A significantly

TABLE 2 Means and standard deviations for mental health across those with and without history of TBI

	Non-TBI (n = 33)		mTBI (n = 21)		p value
	Mean	SD	Mean	SD	
PCS	6.68	7.35	16.11	10.15	.002**
PTSD	5.63	7.03	11.33	14.0	.265
Depression	4.79	4.90	6.67	5.77	.065
DMC $_{Total}$	21.50	29.07	15.40	26.63	.467

*$p < .05$,
**$p < .01$,
***$p < .001$.

TABLE 3 Frequency of TBI and mental health issues

| Participants (n = 54)	Frequency	Percentage (%)
TBI		
No TBI	33	61.1
mTBI (LOC <5 min)	19	34.5
mTBI (LOC 5–30 min)	2	3.6
Occupational	6	28.6
Non-occupational	14	66.7
Post-concussion syndrome		
None	39	72.2
Post-concussion syndrome	15	27.8
PTSD		
No PTSD	45	83.3
PTSD	9	16.7
Depression		
None	26	48.1
Mild	13	24.1
Moderate	3	5.6
Severe	5	9.3

higher frequency of head injuries were suffered from falls or being hit by something compared to other events ($\chi^2 = 18.552$, $df = 3$, $p < .001$). Data are displayed in Figure 1. 57.4% of participants reported some form of mild TBI ($n = 31$). Of these, 18.5% ($n = 10$) may be classified as "possible TBI" as there was no reported LOC but associated PCS, whereas 38.9% of participants ($n = 21$) reported a history of mild TBI, as evidenced by loss of consciousness. Of these injuries, 28.6% ($n = 6$) were sustained during occupational policing activity and 66.7% ($n = 14$) were not. The mean age of first LOC was 20.28 ($SD = 8.93$) and the mean age of most recent LOC was 23.11 ($SD = 9.23$). The frequency of reported injuries did not differ significantly between those with and without history of mTBI (occupational: $\chi^2 = 2.498$, $df = 2$, ns; non-occupational: $\chi^2 = .003$, $df = 1$, $p =$ ns).

3.2.1 | Post-concussion syndrome

27.8% of participants ($n = 15$) met criteria for post-concussion syndrome, 80% of which ($n = 12$) had a history of mTBI. A chi-square test of independence was calculated to examine the relation between TBI and post-concussion syndrome. The relationship between these variables was significant ($\chi^2 = 12.178$, $df = 1$, $p < .001$, Cramer's V = .499). Participants with history of TBI were significantly more likely to suffer from post-concussion syndrome compared to those without TBI.

3.3 | Factors associated with post-concussion symptoms

In Table 4, a correlation matrix associates several variables investigated in a sample of police officers ($n = 54$). As illustrated, PTSD, depression, drinking to cope and TBI (as evidenced by LOC) were significantly associated with PCS. Figures 2–4 highlight the strength of the association between PCS and PTSD, depression and drinking to cope.
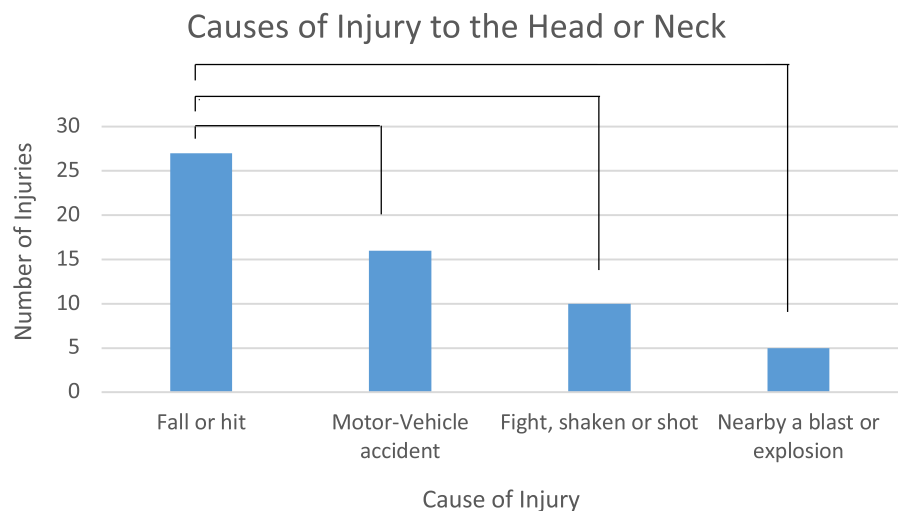
FIGURE 1 Most common causes of injuries to the head and neck

3.4 | Exploratory analysis

A chi-square test of independence was conducted to determine the relationship between the frequency of self-reported TBI and clinical threshold PTSD. The relationship between these variables was non-significant ($\chi^2 = 3.506$, $df = 1$, $p = .061$).

4 | DISCUSSION

We have identified that even in a small sample of police officers, history of brain injury is highly prevalent. Those with a history of mild TBI did not directly present with significantly higher levels of PTSD, depression or drinking to cope. However, those with a history of brain injury did report significantly higher levels of ongoing post-concussion symptoms, which, in general, were moderately associated with PTSD and drinking to cope, and strongly associated with depression. To our knowledge, no research studies to date have identified the frequency of mild traumatic brain injury within a sample of police officers and have demonstrated a range of physical, cognitive and emotional symptoms when compared to their non-head-injured counterparts.

In the current study, the prevalence of self-reported TBI across all severities was 57.4%. Of these, 18.5% ($n = 10$) may be classified as "possible TBI." For a TBI with LOC, the rate was 38.9%, all of which were mild ($n = 21$). 28.6% were suffered during occupational policing, and 66.7% were not. Repeated head injury was common. Those with self-reported mTBI, compared to those without TBI, had higher levels of ongoing post-concussion symptoms (PCS) and were more likely to suffer from post-concussion syndrome. In general, simple associations indicated that PCS were associated with greater severity of emotional difficulties, such as PTSD and depression, and greater adverse coping strategies, specifically, drinking alcohol to cope.

The prevalence of TBI is much higher in this sample (38.9%) than in the general population (12%) (Frost et al., 2013). This pilot study indicates that TBI may be a significant problem in the police force.

TABLE 4 Correlation matrix between questionnaires for the whole sample ($n = 54$ Police Officers). Cronbach's alpha of scales in bold on the diagonal demonstrates excellent reliability

	RPQ	TSQ	PHQ-8	DMC
RPQ	**.92**			
TSQ	$r = .311$ $p = .034^{*}$	**.95**		
PHQ-8	$r = .597$ $p < .001^{***}$	$r = .408$ $p = .005^{**}$	**.91**	
DMC	$r = .309$ $p = .056$	$r = .163$ $p = .314$	$r = .371$ $p = .019^{*}$	**.97**
LOC	$r = .442$ $p = .001^{**}$	$r = .161$ $p = .269$	$r = .272$ $p = .064$	$r = -.115$ $p = .473$

$^{*}p < .05$,
$^{**}p < .01$,
$^{***}p < .001$.

Importantly, high impact mechanisms, such as falls and hits (e.g. in sports), motor vehicle accidents, violence, and being nearby an explosion, were common. Police officers self-reported TBIs across the spectrum of causes, which reflects exposure to a high degree of cumulative occupational and non-occupational risk factors, including previous military service. The majority of reported TBIs were suffered during non-occupational activities; however, the neuro-psychological effects of these injuries can spill over into policing activity. Single mTBIs tend not to produce lasting neuropsychological deficits and very often resolve over time. However, of particular concern, there is evidence of frequent and repeated mTBI. This has previously been associated with neuropsychological dysfunction, such as impaired attention, memory, executive function and emotional regulation (Bigler, 2008), that may be linked to irritability and poor concentration.

Participants with a history of self-reported TBI reported significantly higher levels of ongoing post-concussion symptoms compared to those without a history of TBI. There is debate in the literature over whether PCS are neurogenic or psychogenic. Many studies have shown the relationship between mTBI and PCS to disappear when controlling for symptoms of PTSD (Hoge et al., 2008). The current study was unable to control for symptoms of PTSD and depression due to a small sample size; however, there was evidence of a strong relationship between post-concussion symptoms and brain injury. PCS may indeed have a neurogenic underpinning, alongside psychogenic difficulties accounted for by PTSD and depression. PCS lack specificity to post-concussion syndrome and include overlapping symptomology with depression (Garden & Sullivan, 2010); this was highlighted by a strong correlation between the two variables. Measures of PCS are also found to have a high degree of false positives (Iverson & Lange, 2003); in the current study, individuals without history of mTBI were also found to have moderate levels of PCS. Therefore, it is unclear whether the increase in PCS in those with mTBI is actually due to mTBI or due to general stress and emotional malaise. Nevertheless, post-concussion symptoms may contain a neurogenic component, which may interact with psychogenic symptoms, thereby increasing the chronicity and complexity of emotional difficulties (Mounce, 2011). This points towards many police officers suffering in silence with the consequences of head injury and/or other factors in their lives. Police officers with a history of mTBI may therefore have persistent neurogenic deficits as a result of their injuries.

The relationship between post-concussion symptoms and PTSD is consistent with previous literature (Bryant, 2011; Mounce, 2011). On average, those with a history of brain injury presented with higher self-reported levels of PTSD compared to those without history of brain injury. Unfortunately, being a pilot study, this study lacked sufficient power to detect this effect. An a priori power analysis indicated that a drastically higher sample size was needed to achieve adequate power. However, the relationship between TBI and clinical threshold PTSD was approaching significance. This is a relationship that warrants further investigation. Research has shown that biological damage may diminish coping skills to deal with

FIGURE 2 Scatter plot highlighting the relationship between PCS and PTSD
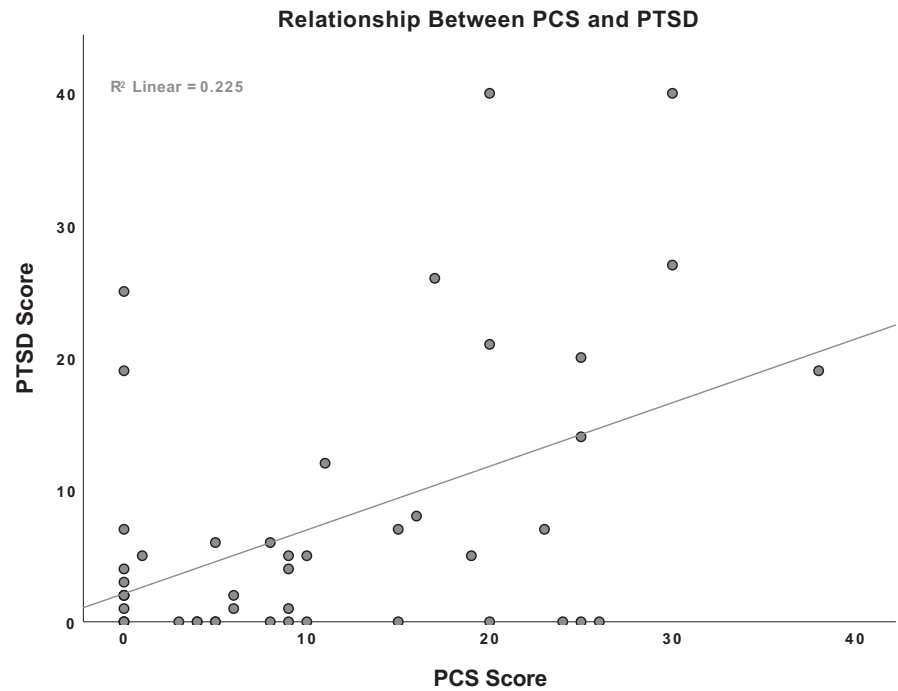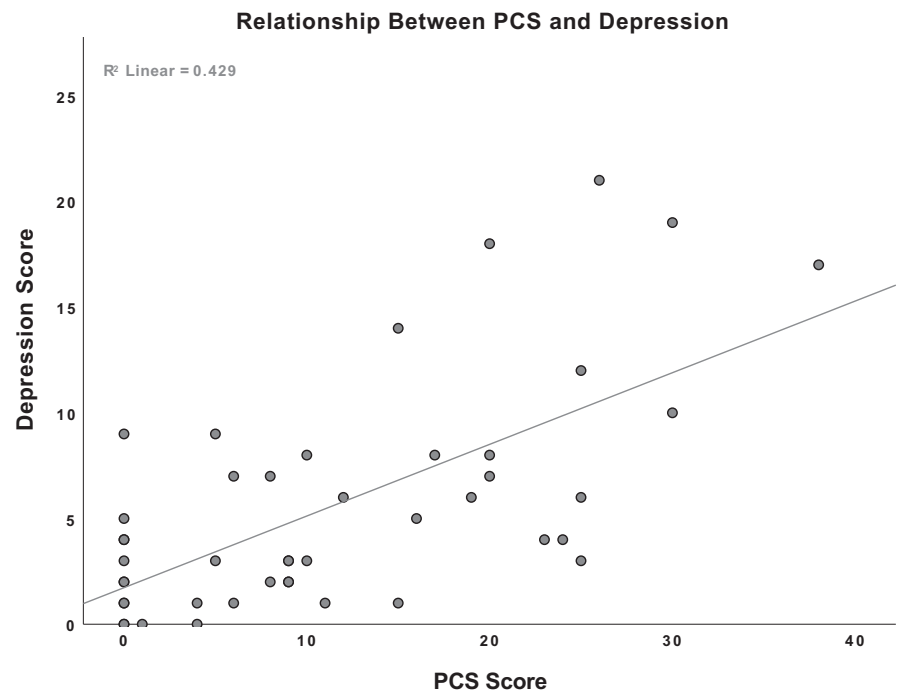
Relationship Between PCS and PTSD

R² Linear = 0.225

FIGURE 3 A scatter plot highlighting the relationship between PCS and depression

Relationship Between PCS and Depression

R² Linear = 0.429

situational stressors following TBI. It may be that suffering a mTBI can compromise crucial regions within the brain that are responsible for regulating emotions, such as the medial prefrontal cortex (Zhou et al., 2012). Such damage could predispose a vulnerability to PTSD and could maintain or exacerbate post-concussion symptoms. Many stressors are common after a mTBI, which, when combined with the stressful nature of policing, may increase vulnerability and perpetuate symptoms of PTSD. For some, neurological damage may be linked to outcome, whereas for others, psychological mechanisms may have a prominent role in the genesis and maintenance of symptoms.

Greater levels of post-concussion symptoms were associated with greater drinking to cope with negative experiences. This finding is consistent with literature highlighting frequent alcohol abuse as a coping mechanism in response to physical, cognitive and emotional difficulties (Corrigan & Cole, 2008). Alcohol abuse can lead to adverse biological and psychological consequences. For example, alcoholism may exacerbate the symptoms of PTSD by promoting avoidance behaviours (Read et al., 2014) and may perpetuate neuroinflammation and neurocognitive dysfunction in those with TBI (Weil, Corrigan & Karelina, 2016).). Although police officers may be temporarily masking their neurological and/or emotional issues

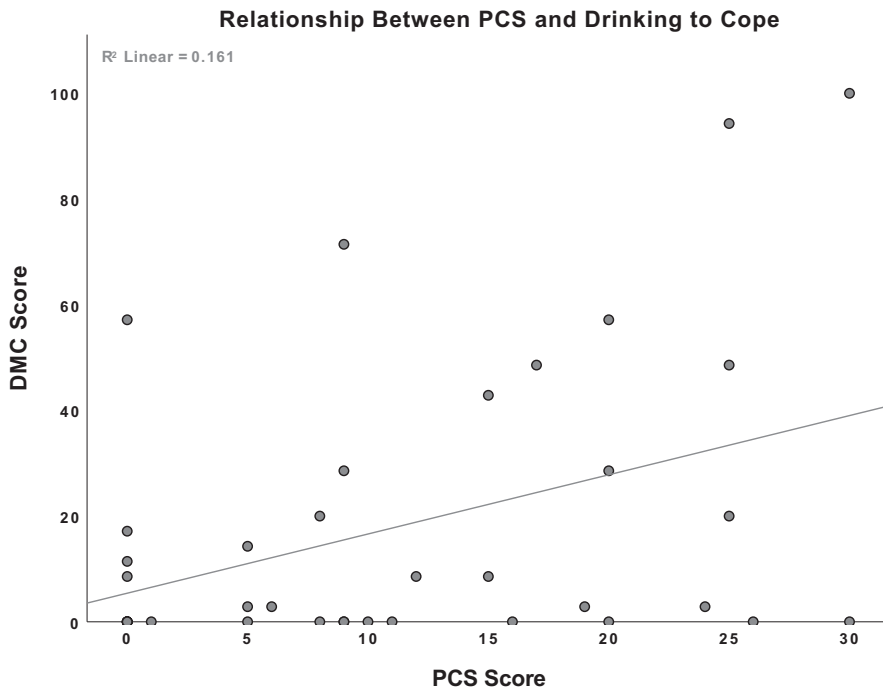**Relationship Between PCS and Drinking to Cope**

FIGURE 4 A scatter plot highlighting the relationship between PCS and drinking to cope

with alcohol, these behaviours can have serious, negative long-term consequences on their mental health and neuropsychological functioning.

The rate of self-reported PTSD is in keeping with previous studies involving police officers. Indeed, the rate of PTSD supports the findings of previous literature. In this study, the rate of PTSD (16.7%) is within the reported range (between 7% and 20%) across the literature (Klimley, Van Hasselt & Stripling, 2018; University of Cambridge, 2019). In the current study, PTSD was measured using the TSQ, which has been found to have a good sensitivity and specificity (Brewin et al., 2002). However, the TSQ does not assess level of fear, helplessness or horror experienced by the individual; neither does it measure avoidance symptoms. Therefore, it may be that PTSD symptoms in this study are indeed more severe than reported.

These results should be considered in light of several limitations. First, this was a cross-sectional, opportunistic design which relied on subjective, retrospective accounts. This affects the generalizability of results and the reports may lack reliability due to the memory problems often associated with mTBI. However, the OSU TBI-ID is a validated and reliable measure of TBI identification (Corrigan & Bogner, 2007). Second, this was a pilot study with a limited sample size and did not include a matched control group for comparison of TBI prevalence. In addition, the response rate was low (36%), which further affects the representativeness of the sample and therefore the reliability of the results. Measures of PCS lack sensitivity and are known to inflate type 1 errors (Iverson & Lange, 2003). Therefore, we cannot know whether increased PCS are due to a difficulty in recovering from the symptoms of mTBI or, instead, due to baseline physical and mental health factors, such as emotional difficulties, stress and pain. However, a number of participants reporting symptoms of pain were very low. We did not have

a direct measure of neuropsychological functioning. This makes it difficult to know whether there is a link between TBI and neuro-cognitive dysfunction. Further, if there were impairments, it would not be possible to know whether TBI was causal of increasing risk of post-concussion symptoms or whether it acted as an incident leading to circumstantial factors associated with post-concussion symptoms. Lastly, the drug and alcohol measure used in this study is a non-standardized assessment, which causes uncertainty of measurement; therefore, the attribution between brain injury and drinking to cope is difficult to make. However, Cronbach's alpha for this measure in the current study demonstrated excellent internal consistency.

This study also has various strengths. The measures employed in this study have been proven to be both reliable and valid. There is a surprising lack of literature on injury rates within the UK police force, especially involving TBI and its relation to emotional difficulties. This pilot study shows that TBI is not trivial in the police and may be a very prevalent and significant issue, thus paving the way for more research to be conducted in the area.

4.1 | Implications

These findings could be considered in the management and rehabilitation of police officers. If TBI is a causal factor or a marker for other issues, it would be essential to have more of an active surveillance of these injuries that we know denude an individual's capacity to function in the long term. Police officers have a high risk of suffering from mental health problems and sickness leave in their lifetime (University of Cambridge, 2019); therefore, mental health nurses should routinely assess for TBI in police officers in the presence of

other comorbidities to increase awareness of it as a problem and identify any associated issues, thereby providing holistic care. Brain injury is known to be associated with an increased risk of suicide, depression and problematic alcohol use and can complicate PTSD (Fazel et al., 2014). Validated treatment programmes exist for PTSD; however, much work needs to be done to address cognitive, emotional and somatic issues due to head injury (i.e. fatigue, headaches, irritability and poor memory). Mental health treatments therefore need to be supplemented with elements of concussion care; however, this needs to be done carefully. Mental health nurses need to make interventions amenable to a population with potential impulse control, memory and planning deficits. This can be done through regular reminders of appointments, pictograms, making things visual and by providing a concrete follow-up. All of the head injuries in this study were mild, and the majority were sustained during non-occupational activities. Mental health nurses should help to identify the level of ongoing issues that are due to post-concussion symptoms and the extent that are caused by PTSD. More focus should be given to explaining this distinction to patients and educating them on the interconnection between TBI and an increased risk of emotional distress. A recovery plan should be put into place to enable a gradual return to work whilst managing symptoms. Police officers should be screened for history of TBI, sustained both occupationally or non-occupationally, and data gathering should be improved across the police force to manage assaults/trauma. This could help identify officers who are at risk of experiencing future mental health difficulties such as PTSD and depression. Post-concussion symptoms are a prevalent and debilitating issue in the police force; therefore, TBI and concussion resources should be applied to a psychological well-being toolkit to support those who have ongoing deficits resulting from TBI.

4.2 | Future research

These findings warrant the need for more detailed analyses of injuries in the police population, involving a larger sample of police officers from different UK forces. A larger study will allow the comparison of TBI across different ranks and roles to identify any subgroups of officers that may be more or less susceptible to mTBI. There is a need for more systematic research that addresses (a) the level of head injury, (b) the consequences of head injury, in terms of TBI, and (c) the effects of TBI on an individual's well-being. Such research should be carried out using standardized measures. As described in the introduction and used in this study, there are measures of TBI that are reliable, valid and sensitive. If a TBI has occurred, it needs to be identified so that recovery can be as complete as it can be. Future research should employ neuropsychological assessments in the police; from such testing, it may be possible to provide more targeted rehabilitation approaches. This can be supported by neuro-imaging studies, using diffusion tensor imaging, which would be useful to observe any microstructural abnormalities in the white matter tracts of police officers.

5 | CONCLUDING COMMENTS

The statement commonly attributed to Hippocrates that "no head injury is too serious to despair of, nor too trivial to ignore" emphasizes that any head injury permits sufficient care and attention. This needs to be approached and framed in a way that ensures that sufferers are aware that their lives are not restricted after a mTBI and any deficits are not permanent. Mental health nurses should regularly assess police officers for brain injury in the presence of other comorbidities and develop an individualized formulation to address any neurological and psychosocial issues that may be acting on the individual. Importantly, interventions should be tailored to a population with potential impulse control, memory and planning deficits and more focus should be given to educating individuals about the interconnection between brain injury and emotional difficulties. Head injury data need to be collected using gold standard measures, to ensure that recovery is maximal, and any risks are identified. A graduated return-to-work plan should be developed to enable a safe transition back to work whilst managing any ongoing symptoms.

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