Persistent post-concussion symptoms and recovery in children and adolescents

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Thesis Portfolio Abstract

Background: Each year, 1.4 million people in England and Wales attend A & E departments with a head injury and up to 50% of those are children aged under 15. Concussion is classed as a traumatic brain injury and symptoms include confusion, dizziness, and mood changes. Usually, these resolve without the need for intervention, but some may experience Persistent Post-Concussion Symptoms (PPCS) for many months or even years.

Method: A systematic review and narrative synthesis explored psychological interventions for PPCS in children. An empirical study focused on adherence behaviour to child concussion guidelines and explored what factors may predict this behaviour in parents and teachers. A second empirical study sought to understand the practicality and acceptability of using a concussion education intervention with this population.

Results: Twenty-one studies were included in the systematic review. In the context of the literature, which was limited, highly heterogenous and of varying quality, psychoeducation and multimodal treatments using CBT show the best promise of improvements in PPCS and QOL. The empirical study found a sample of mostly white, well-educated, female participants had good knowledge of acute concussion symptoms and PPCS, but less knowledge for the recommended guidance that should be followed. Perceived barriers ($\beta = 0.459$), perceived susceptibility ($\beta = 0.536$) and concussion knowledge ($\beta = 0.601$) were found to be predictive of likely adherence by parents. The second empirical study found a short educational leaflet was an acceptable method for learning about concussion.

Conclusions: Findings suggest that effective psychological interventions are limited, and current evidence indicates multimodal interventions with a psychological component, psychoeducation and CBT may warrant further investigation. Parental adherence is predicted by perceived barriers, perceived susceptibility, and concussion knowledge. Educational interventions are a feasible and acceptable way for parents and teachers to learn about concussion recovery and may increase concussion knowledge

and adherence to guidelines. Implications and directions for future research were discussed.

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Chapter One:

Introduction to the Thesis Portfolio

Introduction to the Thesis Portfolio

Injury definition, aetiology and prevalence

Each year, 1.4 million people in England and Wales attend A & E departments with a head injury and between 33 and 50% of those are children aged 15 or under (NICE, 2014[a]). “Head injury” is a term commonly used to cover a broad spectrum of injuries from superficial head wounds to severe brain injury. A traumatic brain injury (TBI) usually results from a blow or jolt to the head and can range in severity from mild to severe. To determine the severity, several clinical indicators are used including abnormalities seen on a scan, level of consciousness and evidence of post-traumatic amnesia (PTA). PTA refers to a period of time in which an individual is alert and conscious but is in a state of confusion. They have trouble laying down new memories and may be behaving in an uncharacteristic manner. The Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974) is a practical assessment of an individual’s level of consciousness used worldwide and includes observation of eye, verbal, and motor responses to stimuli. It provides an overall impairment score where 13-15 is understood to represent a mild head injury, 9-12 is indicative of a moderate head injury and 3-8 is suggestive of a severe head injury. Using this criterion, a mild traumatic brain injury (mTBI) is typically, classified when there is a loss of consciousness lasting less than 30 minutes, the individual has a GCS of 13-15, and has a period of PTA lasting less than 24 hours (Sherer et al., 2008). Intracranial abnormalities such as haematomas and contusions may also be present, though this is not always the case for individuals diagnosed with mTBI. Research has shown that individuals with mTBI and intracranial abnormalities that are visible on medical imaging scans (sometimes referred to as complicated mTBI) and those without these abnormalities (sometimes referred to as uncomplicated mTBI), may have different recovery trajectories (Nelson et al., 2019; Van Der Naalt et al., 1999; Williams et al., 1990). Therefore, distinguishing between the two profiles of mTBI might be important both in research and clinical practice.

Concussion is a type of uncomplicated mTBI that is common in children and adolescents. Common causes of concussion are road traffic

accidents, falls, sports such as rugby and boxing, and physical abuse. Following a concussion, individuals may experience several acute symptoms such as confusion, headache, dizziness, fatigue, insomnia, mood changes, balance difficulties, poor attention and visual changes. Usually, acute concussion symptoms resolve spontaneously within a few days or weeks. Unfortunately, some individuals can continue to experience difficulties for many months or even years (Yeates et al., 2009). This is commonly referred to as Post-Concussion Syndrome (PCS) but it is debated whether these symptoms are a truly unique syndrome given the overlap in other physical and mental health presentations. Therefore, the term Persistent Post-Concussion Symptoms (PPCS) is now being used more frequently in the literature.

It is suggested that the prevalence of PPCS in adults is around 10-15% (NICE, 2014b) but the incidence is less clear for children and adolescents who sustain a concussion. One recent study (Fried et al., 2022) found the prevalence of PPCS in 8 to 15-year-olds to be as high as 25.3% in comparison to children with non-TBI injuries e.g., radial fractures, but further research is required to clarify rates within this population. PPCS can include a range of non-specific physical, emotional, and cognitive symptoms. The definition of PPCS in this thesis portfolio refers to children who have experienced concussion and have difficulties beyond the expected recovery time frame of four weeks for children (McCrory et al., 2017). Concussion and subsequent PPCS is often underrepresented in national statistics due to under-detection or individuals choosing to not seek medical support (Meehan et al., 2013; Rickards et al., 2020; Setnik & Bazarian, 2007). There is a growing body of literature interested in concussion and PPCS sparked by media attention often focused on sports-related injuries and the possible long-term consequences.

Controversy around the underlying causes and maintenance of PPCS mainly focuses on the extent to which symptoms are explained by biological and/or psychological origins (Rohling et al., 2011; Taylor et al., 2010). Whilst there are usually no visible changes on brain scans, there is evidence of physiological changes in the brain after concussion detected using biomarker tests (Giza & Hovda, 2001; Sekino et al., 1981; Varney et al., 1995). Other

than higher levels of proteins in the blood stream being associated to a longer duration of symptoms (Meier et al., 2020), the direct effect of these changes on specific symptoms is currently unclear. Some suggest that the persisting symptoms following concussion are often non-specific and can occur in other injuries such as traumatic orthopaedic injuries (Meares et al., 2011; Mickeviciene et al., 2004; Nacajauskaite et al., 2006), chronic pain (Smith-Seemiller et al., 2003), depression (Gunstad & Suhr, 2004; Iverson, 2006) and even in a healthy population (Chan, 2001; Hunt et al., 2016; Iverson & Lange, 2003; Voormolen et al., 2019; Wäljas et al., 2015). PPCS are subsequently considered by some to instead be largely impacted by a person's pre-morbid ability to adjust to significant events (including trauma), their current or historic mental well-being, their social and family circumstances, and/or their involvement with litigation (Zeldovich et al., 2020). Yeates et al. (2009) concluded that perhaps the two theories of PPCS (organic vs psychogenic) are not mutually exclusive and both injury characteristics and non-injury related variables are important in explaining PPCS and its maintenance after researching the trajectory of symptoms in children with mTBI. The definition of PPCS in this portfolio also assumes that PPCS "does not reflect a single pathophysiological entity, but describes a constellation of non-specific post-traumatic symptoms that may be linked to coexisting and/ or confounding factors, which do not necessarily reflect ongoing physiological injury to the brain", (McCrory et al., 2017, p. 5).

Rationale for the systematic review

Concussion is a common injury in children and adolescents and for individuals who go on to develop PPCS, it can have a significant impact on themself and their family. They recover slower than adults (McCrory et al., 2013) and may have problems participating in school, home and social life (Holmes et al., 2020; Yeates et al., 1999). Yeates et al. (2012) found that children with persisting somatic and cognitive symptoms three months post-injury had significantly worse health-related quality of life. Interestingly, even in children whose symptoms have resolved, deficits in health-related quality of life can remain for many months (Novak et al., 2016). Ongoing symptoms can also have wider implications for the family (Snedaker, 2013), future mental health of the child (Stazyk et al., 2017) and like other mTBI's

contributes to increased financial strain on the healthcare system (Humphreys et al., 2013; Te Ao et al., 2014). Therefore, understanding risk factors, producing evidence-based guidelines, and developing early interventions for concussion recovery is important.

In recent years, there has been an increase in concussion interventions that include a psychological component. This comes following the increasing evidence that suggests psychological factors play an important role in the development and maintenance of PPCS. This suggests there are potential psychological factors that can be targeted during interventions which may aid recovery. The systematic review in this portfolio will examine interventions available for PPCS in children that include a psychological component.

Rationale for the empirical paper

After a concussion, individuals should be offered evidence-based recommendations on what steps to take during recovery. The most recent concussion management guidance for children suggests an initial rest period of 24-48 hours followed by a gradual return to activity including returning to the classroom, returning to playing sports and returning to other activities at home (McCrory, 2017). A briefing paper by the National Institute for Health and Care Excellence (NICE) reported in 2014 that there was no evidence to indicate that advice given to patients in emergency departments who are diagnosed with concussion/mTBI is sufficiently detailed or consistent with best practice guidelines. This is problematic as evidence indicates that returning too early to activities whilst symptomatic can prolong recovery from the initial injury (NICE, 2014[b]). Additionally, literature has indicated that even when children are given recovery advice, their adherence to guidelines is variable which can result in poor outcomes and prolonged symptoms (DeMatteo et al., 2021; Gagnon et al., 2009; Hiployee et al., 2017; Moor et al., 2015; Taft & Ennion., 2021). It is recognised that families and school systems play an important part in supporting children to follow health care advice yet there is limited evidence available in the area of concussion. Therefore, the empirical paper in this portfolio explores the factors that impact parents and teachers' likelihood to adhere to concussion guidelines after child concussion.

The factors influencing adherence identified for exploration in the empirical paper were based on the Health Belief Model (HBM; Rosenstock (1974)). The HBM is extensively used in research to understand health behaviour and compliance with health recommendations (e.g. Al-Noumani et al., 2019; Dempster et al., 2018; Grimley et al., 2020; Lau et al., 2021; Ritchie et al., 2021; Zewdie et al., 2022). When the model was first developed there were four key constructs focused on internal cognitions: perceived severity, susceptibility, barriers, and benefits. Perceived severity relates to how serious an individual perceives the health condition to be in which they may consider the medical and social consequences of the illness. Perceived susceptibility refers to how likely the individual feels the risk of acquiring the condition may be and may depend on how vulnerable they perceive themselves/others to be. Perceived barriers refer to the obstacles a person perceives in performing a recommended health behaviour. Perceived benefits relate to the advantages someone sees in engaging in the health behaviour or how successful their engagement would be in reducing the threat of the condition. As the model developed, two new cognitive factors were added, perceived cues that trigger the decision to engage in health behaviour and perceived self-efficacy in implementing the health behaviour successfully. Additionally, individual factors have been highlighted to be important in determining health related behaviour such as demographic variables, psychological characteristics, and existing knowledge of the health condition (Chen et al., 2011; Dehghani-Tafti et al., 2015; Gillam, 1991). Using the HBM, it could be understood that parents and teachers' perceptions and knowledge about concussion recovery may influence their interactions with a child after concussion and impact their decision to engage with guidelines at home or school.

A key element of improving health behaviour, as identified in the HBM, is how much information individuals know about certain health conditions. Whilst there is literature exploring concussion knowledge and its impact on concussion detection and management, often related to sports-concussion (Bloodgood et al., 2013; Lin et al., 2015; Mannings et al., 2014; Sullivan et al., 2009), there is limited research investigating how educational interventions can be used to improve concussion knowledge and subsequent

health behaviours. Therefore, in addition to the main empirical study, a second empirical study was conducted to explore the acceptability and potential effect of using an educational concussion leaflet to improve knowledge and likely adherence behaviour. This information was gathered to inform a possible RCT which may robustly explore the impact of improving concussion knowledge on adherence to concussion guidelines and the prevalence of PPCS in children.

Thesis portfolio structure

This thesis portfolio aims to contribute to the literature on concussion recovery and PPCS in children. It begins with a systematic review examining psychological interventions for PPCS in children. This is followed by the empirical paper which explores factors that impact parents and teachers' likelihood to adhere to concussion guidelines after child concussion. An extended methodology and extended results chapter follows the empirical paper providing detail and findings that were unable to be included in the main papers. A further chapter is then presented to provide details and results of the second empirical study. Finally, an overall discussion chapter is provided which synthesises the findings from the systematic review and empirical study, evaluates the strengths and limitations of the thesis portfolio, and offers suggestions for future research.

Chapter Two:

Systematic Review

Prepared for the Journal of Head Trauma Rehabilitation.

Author guidelines (Appendix A) have been considered.

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Psychological Interventions for Children Following Concussion: A Systematic Review

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Abstract

Objective: This systematic review explores psychological interventions for Persistent Post-Concussion Symptoms (PPCS) in children.

Methods: Literature published until July 2021 was retrieved from MEDLINE, PsycINFO, Web of Science, NeuroBITE and CINAHL. Inclusion criteria were (1) sample with a mean age under 19 and PPCS (2) studies exploring psychological intervention or multimodal interventions that include a psychological component to treatment (3) any study design except single case (4) a measure of at least one of the following: PPCS, Quality of Life (QOL), anxiety or depression. Risk of bias was assessed using NHLBI quality tools. A narrative synthesis of results is presented.

Results: Twenty-one articles met the inclusion criteria. Only eleven studies were of good quality and low risk of bias. Interventions were highly heterogenous but typically included one or more of the following: psychoeducation, neuropsychological assessment, psychological therapy, or psychological skills-based exercises. Improvements in PPCS and QOL were evidenced across studies however, due to a variety of methodological limitations, these findings must be understood tentatively.

Conclusion: In the context of the literature which is limited and of low quality, psychoeducation as a standalone treatment, and active rehabilitation with CBT show the best promise of improvements in PPCS and QOL. Research on psychological interventions for children with PPCS is in its infancy and there are significant gaps that warrant further research to develop meaningful recommendations for treatment.

Key Words: persistent post-concussion symptoms, PCS, PPCS, paediatric, brain injury, post-concussion syndrome

Background

Injury prevalence, definition, and aetiology

Concussion is a type of traumatic brain injury (TBI) that is common in children and adolescents. Each year, 1.4 million people in England and Wales attend A & E departments with a head injury and between 33 and 50% of those are children aged 15 or under (1). Symptoms of concussion include confusion, headache, dizziness, insomnia, mood changes, and balance difficulties. Usually, symptoms of concussion resolve without the need for intervention, but some may experience ongoing symptoms for many months or even years (2). This is referred to as Persistent Post-Concussion Symptoms (PPCS) and in children is defined by difficulties persisting beyond the expected recovery time frame of four weeks (2). It also “does not reflect a single pathophysiological entity, but describes a constellation of non-specific post-traumatic symptoms that may be linked to coexisting and/ or confounding factors, which do not necessarily reflect ongoing physiological injury to the brain”, (2, p. 5). Kapadia et al. (3) suggests that PPCS tend to cluster into one of four main groups: vestibular-ocular (e.g., dizziness, balance and visual changes), autonomic (e.g., headaches, sleep disruption), cognitive (e.g., difficulties in memory, poor attention, feeling “foggy”) and emotional (e.g. feeling anxious, sad or irritable).

Understanding the aetiology of physical and mental illnesses is vital in developing effective treatments. One approach to understand PPCS is to consider it as a combination of physical and psychological variables. Using a biopsychosocial framework, McNally et al. (4) explained that concussion begins as “a biological event, and concomitant psychological factors, emotional reactions, and changes to the broader social system interact to drive persisting symptoms” (p.397). A recent systematic review (5) highlighted the importance of assessing mental health following concussion in children and integrating support to target psychosocial factors into standard treatments.

Interventions and Treatment for PPCS

Alongside increased media attention to concussion, there has been a growth in research exploring the management and treatment of concussion and PPCS. Over time, treatment guidance for concussion has shifted from rest until symptoms resolve to an active rehabilitation recommendation. Evidence showed that excessive rest could lead to increased symptomology (6). Literature now demonstrates the positive effects of exercise on general wellbeing, mood, sleep, cognition, and physical condition, all of which are common problems following a concussion, therefore gradual physical activity is now recommended during concussion recovery. Psychological factors, such as pre-existing anxiety and depression, have been shown to be associated with worse outcomes following concussion (7, 8). Additionally, cognitive factors such as attentional bias, expectations around recovery and misattributing other symptoms to concussion are also shown to have an impact on the presence of PPCS (9-11). Thus, there are compelling reasons why recommended interventions for PPCS should consider a core psychological component.

Psychological Interventions for PPCS in Adult Populations

Given the overlap in symptom presentation between PPCS and other conditions such as depression, anxiety and chronic fatigue syndrome (15-18) where CBT has been evidenced to be an effective treatment, it is unsurprising that CBT has also been of interest in the treatment of PPCS. Two systematic reviews (12, 13) and a protocol for a Cochrane review (14) have been published exploring psychological interventions for PPCS in adults. The completed reviews indicated that whilst the evidence is limited, of those evaluated, counselling and cognitive behaviour therapy (CBT) are the most useful interventions for PPCS in adults. However, more research is required as many of the studies included in the two systematic reviews (12, 13) were limited by small sample size, no long-term follow up to monitor symptomology, lack of randomised control trials and an inconsistency of how concussion and PPCS is classified (19-23).

Psychological Interventions for PPCS in Children and Adolescents

A systematic review was completed in 2017 to review treatment of PPCS in children but this focused on sports-concussion and largely reviewed medical and physical interventions (24). Treatments that have included a psychological component have mostly been conducted in the last few years and as such, there is currently no systematic review exploring psychological interventions for children with PPCS. The key components of such interventions have also not been reviewed. This present review will be important in exploring the evidence within this population and may help clinicians, commissioners and researchers with clinical decision making and will highlight avenues for future research.

Review Questions (RQ)

This review sought to answer the following questions:

1. What are the key components of psychological interventions for children after concussion with PPCS that have been empirically evaluated in published research?
2. How effective are these psychological interventions at reducing concussion symptoms and/or improving quality of life, anxiety and/or depression in children?

Methods

This systematic review was prepared according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (25). The study was prospectively registered at PROSPERO (CRD42021266220).

Search Strategy

The searches aimed to find all relevant peer-reviewed references relating to psychological interventions for children with PPCS/uncomplicated mild Traumatic Brain Injury (mTBI). The following electronic databases were searched in July 2021: MEDLINE, PsycINFO, Web of Science, NeuroBITE and CINAHL. The search strategy included key terms and Medical Subject Headings (MeSH): brain injury AND child AND intervention AND psychology AND outcomes (Figure 1). The search was set to exclude studies that mentioned “veteran”, “military”, “soldier”, and “servicemen” in the title of

abstract. There was no restriction of publication date and searches included all available studies until July 2021. Searches were limited to human research and English language journals. The full search strategy for MEDLINE is presented in Appendix B.

Box 1: Search terms and concepts

Concept 1: Brain injury	Concept 2: Child	Concept 3: Intervention
"mild traumatic brain injury"	child*	intervention*
"mild tbi"	paed*	therap*
mtbi	ped*	rehab*
concuss*	kid*	manage*
post-concuss*	adolesc*	treat*
postconcuss*	school-age*	strateg*
"post concuss*"	youth*	educat*
brain injuries, traumatic (MeSH)	teen*	support*
brain concussion (MeSH)	boy*	
	girl*	
	preteen*	
	pre-teen*	
Concept 4: outcomes	teen-age*	
"quality of life"	prepubescen*	
"well being"	pre-pubescen*	
well-being	pubescen*	
QoL		
symptom*		
skill*		
function*	Concept 5: Psychology	
abilit*	psych*	
outcome*	psychosocial outcomes (MeSH)	
recover*		

Figure 1. Box showing search terms and concepts

Eligibility Criteria

Eligibility criteria were determined using the PICO framework below.

Population

In this systematic review, we are interested in the milder end of the spectrum of mTBI which includes both concussion and uncomplicated mTBI. Where studies contained a mixture of TBI severity or Acquired Brain Injury (ABI), 90% of the sample was required to have a concussion/PPCS/uncomplicated mTBI diagnosis. If studies did not distinguish between complicated and uncomplicated mTBI, and there was no additional data available to categorise this (e.g., GCS or a clear statement that participants had no abnormalities on scans), the articles were excluded. Studies were included if

the age range and mean age was below 19. If a study had a mean age below 19 but the range was larger, then data for those under 19 were included if the data could be extracted or where at least 80% of data was aged under 19.

Intervention

Articles were included if a psychological intervention was described as the main intervention or where a multimodal intervention was used which included a psychological component to reduce symptomology associated with the concussion. The definition of 'psychological intervention' used for the purpose of this systematic review is "a relationship aimed at promoting a better adaptation of the individual to a given situation and thereby optimizing his or her personal resources in relation to autonomy, self-knowledge and self-help" (26) (p.1). This may include, but is not limited to, psychosocial interventions, psychoeducation, psychological therapy, cognitive skills-based work, and counselling.

Comparison

All studies were included if they offered a psychological intervention including comparison designs (e.g., treatment as usual (TAU), waiting-list control) as well as those with no control group. Research protocols were also included to answer review question one. Single case studies and single case experimental designs were excluded.

Outcomes

Studies were included if they reported quantitative data on concussion symptoms and/or psychosocial general quality of life and/or anxiety and/or depression and utilised a valid and reliable tool. Qualitative outcomes only were excluded.

Study Selection Process

After removal of duplicates, titles/abstracts were screened to determine eligibility by the main author (SC). A second reviewer (RM) screened a randomly generated 10% of the total to ensure consistent application of the

criteria resulting in an agreement rating of 89%. Ten percent of full texts were also reviewed using the same method resulting in an agreement rating of 95%. Any discrepancies were discussed between reviewers and agreed upon. A PRISMA flowchart detailing inclusion and exclusion of studies is presented in Figure 2.

Data Extraction and Management

The study characteristics (author, year of publication, country of study, study design), participants (sample size, gender, ethnicity, type of brain injury), outcomes (concussion, QOL and well-being measures) and main findings were extracted from the final studies, see Table 1.

The Template for Intervention Description and Replication (TIDieR) (27) checklist was used to summarise the intervention characteristics. The TIDieR checklist assists with the comparability of studies and supports others to replicate the intervention. The intervention characteristics extracted were: Why (theoretical rationale), What (procedures and materials), Who (intervention provider), How (mode of delivery e.g., face to face, online, individual, group), Where (location of delivery), When and How Much (duration and frequency), Tailoring (standardised or individualised intervention), Modifications (unforeseen adaptions to the intervention during the study), and How Well (fidelity, attrition and adherence).

Quality Assessment

Studies were assessed for study quality and associated risk of bias using the National Heart, Lung, and Blood Institute (NHLBI) quality assessment tools (28). The tool matching the study's design was used and each item was rated using yes and no depending on if the item is included in the study. A total rating was given of good, fair and poor which is determined by considering the risk each item contributes to the overall study. Guidance by the NHBLI suggest a "good" study has the least risk of bias and results are usually considered reliable, a "fair" study is susceptible to some bias but deemed not sufficient to invalidate its results and a "poor" study indicates significant risk of bias. Quality assessment ratings were then translated into risk of bias evaluations: low, medium or high risk of bias. Each study was

assessed independently by two reviewers, SC and RM, who had an agreement rating of 84% for quality rating. On the occasions where there were differences (N = 3), the outcome was discussed in relation to the guidance and agreed upon. Studies were not excluded based on methodological quality as the review objectives were to describe the components of published psychological interventions, as well as review the efficacy of interventions.

Data Synthesis and Analysis

Due to the wide heterogeneity of research designs (e.g., Randomised Control Trial (RCT), pre-post and other controlled designs) and types of intervention expected, it was determined that narrative synthesis using guidance from Popay et al. (29) would be the most appropriate method to summarise the research evidence.

Results

Study Selection

The initial search retrieved 3991 studies once duplicates were removed, see Figure 2 for PRISMA flow chart. After screening titles, abstracts, and full texts, 21 articles met the inclusion criteria. All 21 studies, including two protocol papers, were used to describe the intervention components as set out in review question one. Nineteen studies were reviewed to answer question two which required data to have been collected and evaluated. These 19 studies were further separated into two groups: 16 studies that aimed to reduce and treat PPCS symptomology and three studies that explicitly aimed to prevent the development of PPCS by offering early intervention within the first four weeks.

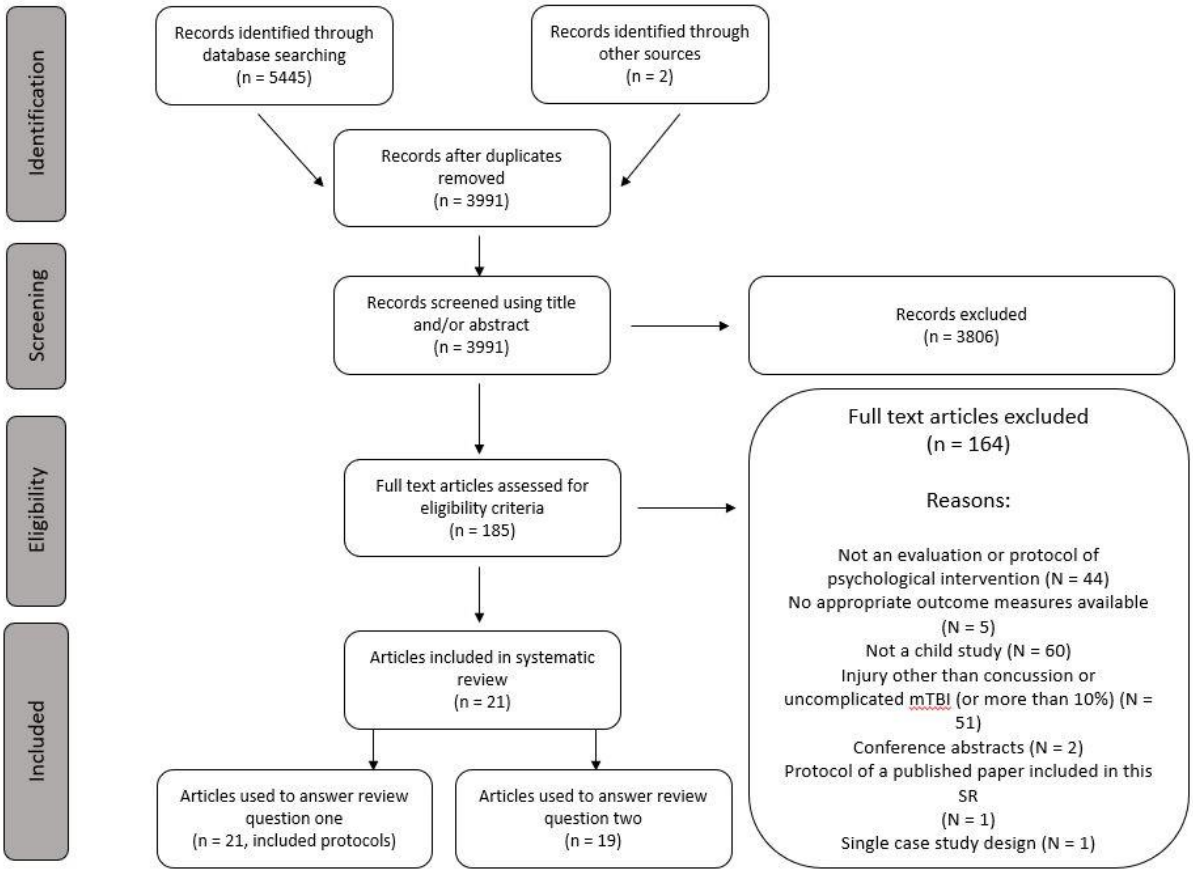

Figure 2. PRISMA chart (25)

Study Characteristics

The study characteristics are summarised in Table 1 which is organised by study design to assist with interpretation. All studies included were published between 2002 and 2021 with 72% of studies published in the last five years. Studies were conducted in Canada (N = 10), USA (N = 7), Australia (N = 3) and Netherlands (N = 1). The study designs were pre-post with no control group (N = 8), RCT (N = 10, including two protocols), other controlled, non-RCT design (N = 2) and case-series (N = 1).

Demographics

The total sample size across studies (excluding two protocols) was 1363 participants, 51.5% of whom identified as male, and the mean age was 13.9 years old. Nine-hundred and seven received an intervention and of those, 456 were assigned to a comparison group. Only seven reported sample ethnicity and reported participants identified from the following ethnic groups:

African American, Asian, Biracial, Black, Dominican, Hispanic, Latino, Pacific Islander, White or other. Most participants across the seven studies identified as White/Caucasian.

All studies recruited participants who had experienced a concussion or mTBI. Three studies (49, 50, 56) aimed to prevent the development of PPCS meaning children were recruited shortly after injury and did not necessarily meet criteria for PPCS yet. For studies that recruited participants experiencing PPCS, the number of weeks with symptoms varied. Nine completed studies and two protocols stated including participants with a duration of PPCS longer than four weeks, four studies included duration longer than three weeks, two studies included duration longer than two weeks and one study included participants with PPCS lasting eight weeks or more.

Measures

All studies that measured PPCS used one or more of the following measures; Post-Concussion Symptom Scale (30, 31), N = 5), Post-Concussion Symptom Inventory Plus-Parent Report and Self Report (32), N = 3), Sports Concussion Assessment Tool-5 (SCAT-5; (33), N = 1), Health and Behaviour Inventory (34, 35), N = 7), SCAT-3 (36), N = 3), Post-Concussion Syndrome Checklist (37), N = 1), Post-Concussion Symptom Inventory (PCSI) Parent Assessment form (38), N = 1). One study (39) did not measure PPCS as it used secondary data to explore only mood-related changes after concussion. Nine studies used self-report measures for assessing PPCS, 10 used child and parent reports together, and one used parent report only. Fifteen studies (plus two protocol papers) measured general QOL, anxiety and/or depression. In total, there were 22 different outcome measures across studies to measure these variables.

Measures used were reliable and valid for the broad population studied, however, many studies reported the mean age rather than age ranges. Some measures (e.g., SCAT3; (36) and the Health Behaviour Inventory (34, 35) are validated with specific ages and therefore, the validity

of these measures may be reduced if the age range was much wider than the mean age reported.

Table 1.
General study characteristics and findings of all studies included in systematic review

Author(s), year and country	Study design	Type of injury	Intervention approach	Gender and age	Ethnicity	Concussion measure(s) and type of report	QOL, anxiety or mood measure(s)	Results	Quality rating and tool used
Chan et al. (40) Canada	RCT	Concussion with PPCS after 4 weeks	Multimodal using active rehabilitation	Control group: 8 females, 1 male, mean age = 15.1 (SD = 1.4) Intervention group: 6 females, 4 males, mean age = 15.9, (SD = 1.7)	Not specified	Post-Concussion Symptom Scale (30, 31) ♦ Child report only	Beck Youth Inventory-II (41), PROMIS emotional distress- depression (42)	• Linear mixed modelling was used to evaluate the effect of treatment on post-concussion symptoms. A linear mixed model with a random intercept and fixed effects for group (experimental vs control), time, and baseline PPCS score was used. • The effect for group was significant (Wald's t=2.15, P=.047). Group-by-time interaction and gender did not improve the model fit. The mean change on PPCS from baseline to follow-up was -24.7 (SD = 19.1) in the active rehabilitation group and -15.8 (SD = 12.5) in the TAU-only group, which is associated with a Cohen's d treatment effect size of .55 (group mean difference for pre-post change). • No inferential statistics were performed on QOL or mood measures. • These results indicate that there was a significant treatment effect on post-concussion symptoms.	Fair [b]
McCarty et al. (43) USA	RCT	Concussion with PPCS after 4 weeks	Multimodal with CBT	TAU group: 15 females, 9 males, mean age = 14.8 (SD = 1.7) Intervention group: 17 females, 8 males, mean age = 15.1, (SD = 1.6)	Overall sample: White = 75.5%, other = 14.3%, Asian or Pacific Islander = 8.2%, Hispanic/Latino = 8.2%, and Black = 2%	Health and Behaviour Inventory ♦ Child and parent report	PHQ-9 (44) ♦, PROMIS emotional distress- depression (42) ♦, Peds-QL generic (45) ♦	• Participants in the intervention group "had clinically and statistically significant improvements in post-concussive symptoms and health related QOL outcomes compared with controls. Statistically significant improvements in health-related QOL were demonstrated by both child and parent report. " • 78.3% of participants who received the intervention demonstrated >50% reduction in depressive symptoms compared with 45.8% of patients in the usual care group. • Adolescents who received collaborative care (i.e. intervention treatment) and their parents reported high levels of satisfaction with care.	Fair [b]

McCarty et al. (46) Canada	RCT	Concussion with PPCS after 4 weeks	Multimodal with CBT	TAU group: 64 females, 35 males, mean age = 14.7 (SD = 1.7) Intervention group: 60 females, 41 males, mean age = 14.8, (SD = 1.7)	Overall sample: White = 82%, Hispanic/Latino = 8.5%, Other = 3.5%., Asian = 3.5%, and Black = 2.5%.	Health and Behaviour Inventory ♦ Child and parent report	PHQ-9 (44) ♦, RCADS (47), GAD-7 (48), Peds-QL generic (45) ♦	• Those who received the collaborative care treatment had improved post concussive symptoms according to youth reports at 3 (Cohen's d = 0.26) and 12 months (Cohen's d = 0.32) compared to the TAU group. No differences were detected for parent report. • Adolescent reports indicated significant improvement in QOL at 12 months (Cohen's d = 0.29), but parent report did not. • The intervention group also reported more improvements in emotional functioning at 6 and 12 months compared to TAU, and the same for social functioning at 12 months. On the PHQ-9 and GAD-7 there were no differences between intervention and TAU groups. Despite this, the proportion of participants reporting suicidal ideation at the 12 month follow up significantly decreased in the treatment group compared to TAU. • Sleep quality also improved at all assessment time points for the intervention group.	Good [b]
Renaud et al. (58) Netherlands	RCT	Uncomplicated mTBI (GCS > 13)	Psycho-educational/ informative only	TAU group: 25 females, 39 males, mean age = 11.7 (SD = 3.5) Intervention group: 28 females, 32 males, mean age = 11.5, (SD = 3.3)	Not specified	Health and Behaviour Inventory Child and parent report	CASP-DLV (59, 60)♦, PedsQL (Dutch version; Engelen, Haentjens (61)), PedsQL-fatigue (62), Impact of Events Scale (63)	• Significant improvements were found for the intervention group compared to the TAU group at 6 months post-mTBI on the PedsQL-Fatigue (parent reported, p = .033, child reported, .023), IES (parent reported, p = .003, child reported, .007) and PedsQL-QOL (parent reported, p = .035, child reported, .003). Child reported PPCS was also significantly improved for the intervention group at 6 months (p = .037), but parent reports did not reflect this (p = .247). • The total CASP-DLV score improved significantly in both groups over time between 2 weeks and 6 months post-injury. Participation in activities improved in all settings e.g., at home, in the community and at school. • These findings indicate the intervention has the potential to reduce PCS symptoms and improve QOL after mTBI in children.	Good [b]
Tomfohr-Madsen et al. (64) Canada	RCT	Concussion with PPCS after 4 weeks	Psychological approach using CBT	TAU group: 9 females, 3 males, mean age = 14.9 (SD = 1.3) Intervention group: 9 females, 3 males, mean age = 15.2, (SD = 1.5)	Not specified	Health and Behaviour Inventory Child report only	PROMIS emotional distress- depression (42)	• At baseline, 8/12 in the intervention group and 10/12 in the TAU group reported their child was using medication to help sleep difficulties. At the post-treatment session, 3 of the intervention group were still using medication compared to 7 in the TAU group. • The intervention group demonstrated significant reductions in insomnia total scores compared with the TAU group at posttreatment that were maintained at the 1-month follow-up. • No significant effect of intervention was found for child reported depression and anxiety. • Self-reported PPCS significantly decreased over time for the intervention group. This, reflected a small to medium effect size of the intervention group compared with TAU but the difference between groups was not statistically significant.	Fair [b]
Gauvin-Lepage et al. (65) Canada	Quasi-experimental (non-randomised groups as proposed intervention already standard care at one site)	Concussion with PPCS after 4 weeks	Multimodal using active rehabilitation plus concussion education	TAU group: 22 females, 15 males, mean age = 13.2 (SD = 2.6) Intervention group: 5 females, 8 males, mean age = 14, (SD = 1.9)	Not specified	Post-Concussion Symptom Inventory Plus-Parent Report and Self Report (32) ♦ Child and parent report	Beck Youth Inventory-II (41), Child Behaviour Checklist (51), Peds-QL generic (45)	• Post-concussion symptoms decreased for both groups according to child and parent reports ($p < 0.01$) and was statistically significant across time points (baseline to two weeks, and two weeks to six weeks). • There was no significant interaction between group and time, or differences, between groups. • Youth in the intervention group presented with significantly higher QOL (p = 0.04) and scored significantly lower on the anger scale of the Beck Youth Inventory after 6 weeks (p =0.02) compared with the TAU group.	Fair [b]

Worthen-Chaudhari et al. (66) USA	Non RCT, open-labelled controlled trial	Concussion with PPCS after 3 weeks	Psychological approach using positive psychology	TAU group: 7 females, 2 males, mean age = 15 (SD = 2) Intervention group: 7 females, 3 males, mean age = 17, (SD = 2)	Not specified	SCAT3 ♦ Child report only	Center for Epidemiological Studies–Depression Child (67)	• 70% of enrolees used the app. • Concussion symptoms and optimism significantly improved for both the intervention group (p = 0.028) and the TAU group (p = 0.028). The effect size was slightly larger for the intervention group versus the TAU group (PPCS effect size r = 0.5 and optimism effect size r = 0.51). • There were no significant differences in depression scores between groups or between pre- and post-intervention.	Poor [b]
Cook et al. (68) USA	Pre-post, no control group	Concussion and PPCS after 2 weeks ("slow to recover" status)	Psychological approach using VR deep breathing	7 females, 8 males Mean age = 16.9 (SD = 3.2)	White = 80%, Black or African American = 6.7%, Dominican = 6.7%, and Other or unspecified = 6.7%	Post-Concussion Symptom Scale (30, 31) ♦ Child report only	Profile Of Mood States (POMS; (69)) ♦	• There was a significant decrease in stress, fatigue, tension, and confusion following the VR deep breathing exercise. PPCS was only measured at baseline to indicate the presence of symptoms. • There were no statistically significant differences in anger, depression, esteem related affect or vigour. • All participants completed the 5-minute exercise with no participant reporting significant discomfort. • 93.3% of participants reported the VR experience as positive or extremely positive. • The authors conclude, a VR-based deep breathing exercise for children, adolescents, and young adults who have persistent symptoms and are slow to recover following concussion has the potential to reduce stress, tension, fatigue and confusion.	Fair [c]
Dobney et al. (70) Canada	Pre-post, no control group	Concussion or mTBI with PPCS after 3 weeks	Multimodal using active rehabilitation	135 females, 142 males Mean age = 14.1 (SD = 2.3)	Not specified	Post-Concussion Symptom Scale (30, 31) ♦ Child report only	None reported	• T-tests (parametric and non-parametric) and linear regression were performed. Results indicated participation in an active rehabilitation program was associated with decreased post-concussion symptom severity compared to pre-intervention ($z = -7.35$, $p < .05$). It was also found that each symptom cluster, namely physical, cognitive, emotional and sleep related, was significantly lower at follow-up ($p < .05$). • A multiple linear regression established that sex and pre-intervention symptoms could statistically predict post-concussion symptoms at follow-up. Female sex was associated with an increased post-concussion symptom severity at follow-up.	Good [c]
Gagnon et al. (71) Canada	Pre-post, no control group	Concussion with PPCS after 4 weeks	Multimodal using active rehabilitation	3 females, 7 males Mean age = 16.3 years (SD = not reported)	Not specified	Post-Concussion Symptom Scale (30, 31) ♦ Child report only	Beck Depression Inventory-II (72), Paediatric Quality of Life Multidimensional Fatigue Scale (73)	• There was a large and statistically significant decrease in symptoms between initiation of the intervention and the 6-week follow-up assessment ($t = 3.79$; $P = 0.004$; $d = 1.83$). • Fatigue was a common complaint with 6 out of 10 reporting it at the outset of the study. Participants reported a significant decrease in fatigue after the intervention. • Depression scores, although in normal ranges, also significantly improved ($t = 3.26$; $P = 0.01$, $d = 0.48$). • Visual motor processing speed improved ($t = -2.81$; $P = 0.03$; $d = 0.54$) whilst other cognition composite scores remained similar between pre- and post-intervention. • Parental anxiety did not change.	Fair [c]
Hunt et al. (39)	Pre-post, no control group	Concussion with PPCS after 2 weeks	Multimodal using active rehabilitation plus	26 females, 14 males	Not specified	Not reported. This study involves secondary data	Beck Youth Inventory-II (41), ♦	• "Participants demonstrated significantly lower t-scores on the subscales of Anxiety [$t(39) = 2.84$, $p = .0070$], as well as Anger [$t(39) = 2.70$, $p = .010$] post-intervention, indicating positive changes on these subscales. Effect sizes were small to medium for both the	Good [c]

Canada			concussion education	Mean age =14.6 (SD = 2.1)		analysis from Reed, Greenspoon (74) in which only the protocol has currently been published.	Child Behaviour Checklist (51) ♦	anxiety (Cohen's d = 0.345) and anger (Cohen's d = 0.345) subscale." • Parent reported scores on the Child Behaviour Checklist were also significantly lower at week 6 on subscales of anxiety/depression (p = .011), somatic complaints (p = .002) and withdrawn/depressed (p = .046). • A regression model indicated that gender significantly predicted anger subscale scores at Week 6 with females demonstrating lower scores. This suggests females experienced greater reductions in anger post-intervention then males. • A 6-week active rehabilitation programme may reduce anxiety and anger in children following concussion though further research is needed to examine the effects compared to a control group.	
Kirkwood et al. (75) USA	Pre-post, no control group	mTBI (GCS >13) with PPCS after 8 weeks	Neuro-psychological assessment and concussion education	36 females, 44 males Mean age = 15 (SD = 2.2)	Caucasian = 59%, Hispanic = 21%, other = 20%	Health and Behaviour Inventory (34, 35) Child and parent report	Not specified	• There was a significant decrease in both child and parent reported HBI scores both at 1 week and 3 months following neuropsychological consultation (p <0.0001). •	Good [c]
McNally et al. (76) USA	Pre-post, no control group	Concussion or uncomplicated mTBI with PPCS after 3 weeks	Psychological approach using CBT	21 females, 10 males Mean Age = 15.9 (SD = 2)	White = 93.5% (no further specification)	SCAT3 (36) Child report only	Peds-QL 4.0 (77)	• A significant negative effect of time on SCAT-3 scores was found indicating symptoms improved over the course of treatment. Twenty-three out of thirty-one participants showed a reduction in symptoms of more than 50%. • For participants who had pre-intervention measures available, symptoms had remained stable until they began CBT. Once treatment had started, their symptoms began to decline. • Full attendance at school increased from 44.4% of participants at the start of treatment to 96.8% at the conclusion of treatment. • A significant effect was found between time and the PEDS-QL scores indicating a significant improvement in parent reported QOL during treatment. The domains of greatest magnitude were emotional and school functioning.	Good [c]
O'Neill et al. (78) USA	Pre-post, no control group	Concussion with PPCS after 4 weeks	Multimodal with CBT	41 females, 15 males Mean age = 15 (SD = 2.1)	White = 83.9%, African American = 7.2%, Hispanic =1.8%, Asian = 1.8%, Biracial = 5.3%	SCAT-5 (33) ♦ Child report only	Peds-QL (55)	• Approximately 93% of participants (n = 52) showed a reduction in symptom severity following multidisciplinary intervention (p < 0.01). • Logistic regression analyses did not reveal any significant predictors of treatment responders vs. non-responders. • A repeated measures ANOVA determined that SCAT5 symptom severity scores significantly declined across all three assessment time points (p < .001). Assessments took place at the initial visit, "mid-point" and final visit • Change in quality-of-life scores from pre- to post-intervention are not reported. • A multi-disciplinary approach is a promising treatment for persistent post-concussion symptoms in adolescents though further research is needed utilising a control group.	Good [c]

Simpson et al. (79) USA	Pre-post, no control group	Concussion with PPCS after 4 weeks	Psychological approach using CBT	Intervention group 1: 14 females, 5 males, mean age = 14.1 (SD = 2.7) Intervention group 2: 8 females, 2 males, mean age = 14.8, (SD = 1.8)	Intervention group 1: Caucasian = 68.4%, Hispanic/Latino = 21.1%, and African American = 10.5% Intervention group 2: Caucasian = 81.8%, Hispanic/Latino = 9%, and African American = 9%	Health and Behaviour Inventory ♦, SCAT3 ♦ Child and parent report	Peds-QL generic (45), RCADS and RCADS-Parent (80)	• 76% of children enrolled in treatment reported missing school due to their concussion prior to treatment. Of those with attendance difficulties, 71% reported improved attendance by the end of treatment. • Child and parent reported PPCS significantly improved across treatment ($p < 0.0001$) and there were significant reductions in anxiety and depressive symptom in children reported by parents ($p = 0.0001$, $p = .0007$) and self-reported in children ($p = .001$, $p = .0003$). • Treatment was also associated with significant improvement in parent reported and self-reported health related QOL ($p < .0001$). • Participants who endorsed higher depressive symptoms pre-treatment had lower PCS change scores. In contrast, those with lower exercise/activity at baseline had greater PCS change with treatment.	Good [c]
Gagnon et al. (81) Canada	Case Series	Concussion with PPCS after 4 weeks	Multimodal using active rehabilitation	5 females, 11 males Mean age = 14.3 years (SD = not reported)	Not specified	Post-Concussion Symptom Scale (30, 31) ♦ Child report only	None reported	• The prevalence of children with PPCS attending a concussion clinic was 11.2%. • The mean PPCS score significantly decreased from 30.0 (SD = 20.8) at initial assessment to 6.7 (SD = 5.7) at discharge from the programme. • All children were able to resume their normal physical activity participation at the end of the programme. • A case example of a 13-year-old is reported who engaged well with the intervention and was symptom free 5 weeks after starting the intervention.	Fair [a]
Mortenson et al. (49) Canada	RCT **(prevention study)**	mTBI (GCS > 13) or concussion (PPCS not criterion as intervention aimed to reduce development of PPCS)	Psycho-educational/ informative only	TAU group: 12 females, 22 males, mean age = 12.6 (SD = not reported) Intervention group: 8 females, 24 males, mean age = 11.9, (SD = not reported)	Not specified	Post-Concussion Symptom Inventory (PCSI) Parent Assessment form (38) ♦ Parent report only	None reported for child well-being	• At one week after injury, 17 of the 32 participants in the intervention group reported 2 or more concussion symptoms, with 8 already returning to school despite this. The TAU group was not contacted for symptom reporting until 3 months so no comparison can be made. • At one month, 8 of the 32 children in the intervention group had ongoing symptoms, with 6 of those 8 returning to school. • At three months, 78% of the children in the intervention group and 73% of children in the TAU group reported improved symptoms on the PCSI. Six children in the intervention group and five in the control group continued to report significant and severe symptoms on the PCSI. • Whilst most children had recovered well, injury-related burden for families remained high (17/32 intervention families and 20/34 control families). • No significant difference was found between the intervention group and control group on number of PPCS symptoms reported by parents or parental perceived level of family stress at 3 months. No differences were found for gender and PPCS. • The study concludes that no trend towards a treatment effect was found. However, at-risk patients for PPCS were highlighted and eight children were identified during the study as requiring further support past 3 months.	Good [b]

Olsson et al. (50) Australia	RCT **(prevention study)**	Uncomplicated mTBI (PPCS not a criterion as intervention aimed to reduce development of PPCS)	Neuro-psychological assessment and concussion education	TAU group: 10 females, 10 males, mean age = 11.8 (SD = 2) Intervention group: 7 females, 22 males, mean age = 9.6, (SD = 2.3)	Not specified	Health and Behaviour Inventory Child and parent report	Child Behaviour Checklist (51), Child Depression Inventory – Short Form (52), Child PTSD Symptom Scale (53) Spence Child Anxiety Scale (54), Peds-QL (55)	• 18/25 families in the intervention group report accessing the educational resources. • The intervention and TAU groups did not differ significantly on any child or parent outcome measure. Both child and parents reported significant improvements in post-concussion symptoms in both groups over the initial 3 months. • Child reported anxiety scores significantly improved over the initial three months. Psychosocial functioning significantly improved at 3 months according to both child and parent reports. • Those in the intervention group did not demonstrate improvements in their mTBI knowledge relative to the knowledge of the usual care group.	Fair [b]
Ponsford et al. (56) Australia	RCT **(prevention study)**	Uncomplicated mTBI with GCS >13 and neuroimaging not warranted (PPCS not a criterion as intervention aimed to reduce development of PPCS)	Neuro-psychological assessment and concussion education	mTBI intervention group: 18 females, 43 males, mean age = 11 (SD =2.6) non-TBI intervention control group: 15 females, 30 males, mean age = 10.9 (SD = 2.6) mTBI non-intervention group: 11 females, 47 males, mean age = 11.4 (SD =3.2) non-TBI non-intervention control group: 17 females, 28 males, mean age = 12.3 (SD = 2.1)	Not specified	Post-Concussion Syndrome Checklist (37) Child and parent report	Child Behaviour Checklist (51), Rowe Behavioural Rating Inventory (57)	• Both non-intervention groups (including the control group) demonstrated higher scores on the Child Behaviour Checklist at 3 months. The mTBI non-intervention group indicated higher levels of anxiety, depression, somatic, social, cognitive, anger and delinquency than the mTBI intervention group. The mTBI non-intervention group also tended to report more problems on the Rowe BRI. • Parents of the mTBI non-intervention group also reported a “significantly greater overall frequency of PPCS at 3 months than the mTBI intervention group. Headaches, irritability, sleeping difficulties, and problems with judgment were commonly reported. The study does not explicitly report changes in PPCS between pre- and post-intervention, instead it focuses on differences between groups at post measurement. • At 3 months, there were no significant differences between the mTBI groups and the control groups on the Child Behaviour Checklist or the Rowe Behavioural Rating Inventory. • "The proportion of children with significant ongoing problems requiring referral for additional assistance was similar in the intervention (21%) and non-intervention (19%) groups. However, overall, it seemed that those who received the intervention were reporting fewer problems 3 months after injury".	Fair/Poor [b]
Anderson et al. (82) Australia	RCT **(protocol)**	Concussion with PPCS after 4 weeks	Multimodal with CBT	N/A (protocol)	N/A (protocol)	Post-Concussion Symptom Inventory Plus- Parent Report and Self Report (32) ♦ Child and parent report	Peds-QL (55), RCADS (47), PROMIS emotional distress- depression (42), SDQ (83)	• Planned analysis includes chi-square of the proportion of participants who are fully recovered at study completion. • Generalised linear models will be used to estimate 95% CIs. • Comparison of means will be conducted using independent sample t-tests or non-parametric equivalent.	N/A

Reed et al. (74) Canada	RCT **(protocol)**	Concussion with PPCS after 4 weeks	Multimodal using active rehabilitation	10-18 years (protocol)	N/A (protocol)	Post-Concussion Symptom Inventory Plus-Parent Report and Self Report (32) ♦ Child and parent report	Beck Youth Inventory-II (41), Child Behaviour Checklist (51), Peds-QL generic (45)	• T-tests between experimental and control groups will be used to examine patient characteristics including presenting post-concussion symptoms • Analysis of Variance with repeated measures will be used to compare changes in PPCS post-intervention and group effects.	N/A

Note: ♦ = indicates primary outcome measure, [a] = NHLBI Quality Assessment Tool for Case-Series Studies, [b] = NHLBI Quality Assessment of Controlled Intervention Studies, [c] = NHLBI Quality Assessment Tool for Before-After (pre-post) Studies With No Control Group

Intervention Characteristics Using TIDieR Checklist (RQ1)

All 21 studies were considered in this section to answer review question one and describe the components of the interventions. The full details of the intervention characteristics according to the TIDieR checklist are presented in Appendix D.

Why (Theoretical Framework)

One study referenced the biopsychosocial model as a rationale for the intervention (76) whilst seven other studies mentioned the importance of a cognitive behavioural approach to treating PPCS. One study based the intervention on positive psychology ideas (66). No other study explicitly reported an overarching theoretical framework but many of the studies highlighted the need for new interventions due to physical rest no longer being evidence based in the treatment of concussion. Several of the studies also acknowledged PPCS as a constellation of somatic, cognitive, and psychological symptoms, providing a rationale for using multimodal interventions to target the wide variation of PPCS profiles.

What (Intervention Type, Materials, and Procedures)

The intervention approach across studies can be broadly categorised into three types: multimodal, psychological, and psychoeducation/ information only. Multimodal interventions included a mixture of approaches. Five used active rehabilitation according to the protocol described by Gagnon et al. (71, 81) which includes aerobic training, co-ordination exercises, visualisation tasks aiming to promote positive experiences in relation to the physical exercise and an individualised home treatment programme to continue these components (40, 70, 71, 74, 81). Two further studies used the Gagnon et al. protocol but also included a specific education component (39, 65). Four other studies used a multimodal approach that involved CBT and one or more of the following: physiotherapy, care management, athletic training, psychopharmacological or neurology consultation (43, 46, 78, 82). Those studies highlighted varied use of relaxation strategies, sleep hygiene, cognitive strategies, activity pacing and positive thinking to manage symptoms. Eight studies used a psychological approach, three of those

delivered CBT (64, 76, 79), three used neuropsychological assessment in combination with concussion psychoeducation (50, 56, 75), one used a deep breathing virtual reality exercise (68) and one used positive psychology in a mobile app game (66). Two studies provided psychoeducation only as the intervention (49, 58).

Most studies (N =19) described the materials used in the interventions which included daily logbooks to record physical activity and participation in the intervention, written manuals for staff delivering interventions, physical equipment (e.g., heart rate monitors), neuropsychological testing kits, educational handouts and resources, online sleep diaries, mobile phone apps and virtual reality apparatus. All studies reported intervention procedures which usually included a description of the treatment components (e.g., module topics, timings) and the order of steps carried out.

Who (Intervention Provider)

For studies that involved active rehabilitation, a physiotherapist or occupational therapist delivered these components (N = 7). Psychological treatment was typically delivered by a licensed neuropsychologist, clinical psychologist or therapist, doctoral or post-doctoral level psychology trainees, or master's level trained mental health professionals. For other treatment aspects or where interventions did not require formal psychological assessment or therapy, other professions were used including research assistants, research co-ordinators, occupational therapists or "professionals experienced and education in child rehabilitation after mTBI". A neurologist or medical doctor was reported to be part of the active treatment team in three studies.

How (Use of Technology and Contact Type (Individual or Groups))

Six studies integrated the use of technology in the delivery of the intervention either through telephone, videoconferencing, mobile phone app or virtual reality (46, 49, 50, 64, 66, 68). Whilst most interventions were directly offered to the child with concussion, families were commonly present during parts of the intervention e.g., listening to psychoeducation material and assessment feedback, and observing the training of the physical exercise programme.

One study directed intervention at parents of the child with concussion and had no direct contact with the child (49).

Where (Location of Intervention)

Eight studies delivered intervention using a combination of in-person treatment (often at a hospital or university) and independent home treatment (in the patient's home). Seven studies solely offered treatment sessions in a clinical space, though it is assumed that homework tasks were set (e.g., reading, implementing strategies at home between sessions). One study delivered most of the intervention in clinic, but the final session was completed in the patient's home. One study delivered intervention using videoconferencing to 60% of participants and via a hybrid of telehealth and in-person sessions to 38%. Two studies used a combination of clinic visits and telephone calls and one study used telephone calls only to deliver intervention.

When and How Much (Duration and Number of Sessions)

The intervention dose ranged from daily treatment to weekly. Interventions could be a one-off session (50, 66, 75) or until symptoms were completely resolved (43, 82). The maximum number of sessions was dependent on tailoring and not consistently reported. Within the same treatment approach, number of sessions was varied e.g., a mean number of eight CBT sessions were delivered by McCarty et al. (43) and McCarty et al. (46) whereas O'Neill et al. (78) reported a mean number of two CBT sessions only provided to participants identified by the multidisciplinary team as requiring further support. If the study ended and patients were still symptomatic, some studies reported they would refer participants on for further support.

Tailoring and Modifications

Sixteen of the twenty-one studies offered individualised treatment based on clinical need. This usually was in response to the type or number of post-concussion symptoms being reported. No study reported modifications being made to the intervention during the study period. Two studies were protocol papers and therefore modifications may still be made.

How Well (Attrition and Compliance)

Fourteen studies did not report on attrition rates or compliance. Intervention fidelity was reportedly measured by four studies (40, 58, 66, 82). A range of methods were used to measure fidelity including interventionalists recording deviations from intervention protocols after each session (58), reviewing video recordings of randomly selected treatment sessions (82) and monitoring app usage to indicate intervention dosage was met (66). One study indicated that fidelity was measured using a treatment manual, but no information is provided on how they measured how closely the manual was followed (40). Another study acknowledged the lack of a formal fidelity measure as a limitation but also reported that adherence to treatment components was closely monitored and documented in session notes by interventionalists (79).

Quality Assessment and Risk of Bias Assessment

The quality of the studies (not including protocols) ranged from poor to good using the National Heart, Lung, and Blood Institute (NHLBI) quality assessment tool (28). The quality assessment tool used for each study is reported in Table 1. The item-by-item assessment and the risk of bias ratings are reported in Appendix C. Nine studies were rated “good” with low risk of bias, eight studies were rated “fair” with medium risk of bias, and two studies were rated “poor” with high risk of bias (56, 66).

Narrative Synthesis of Intervention Effects on Outcomes (RQ2)

Nineteen studies were included in this synthesis to answer review question two. They were split into two groups; those that aimed to *prevent* PPCS development and those that aimed to *treat* PPCS. The effectiveness of the interventions are described whilst considering the study quality and risk of bias. The three prevention studies are synthesised first and then the remaining 16 studies have been grouped according to intervention approach.

Prevention studies

Three studies reported the intervention aim was to prevent PPCS and typically saw patients within the first four weeks of injury. Whilst participants

did not meet the criterion for a PPCS diagnosis, given the time between injury and first contact, a measure of PPCS was used pre-intervention to determine impact of the treatment. The element of psychoeducation was important across studies with all providing general psychoeducation around common symptoms, expected recovery timeframes, and offering general recommendations on returning to school and sports. Two studies (50, 56) used neuropsychological assessment as a baseline assessment and offered additional psychoeducation as the intervention. The other study (49) used psychoeducation as a standalone treatment. All three implemented an RCT design.

Ponsford et al. (56) did not explore within-groups PPCS pre- and post-intervention but found that parents of children in the mTBI non-intervention group reported significantly more symptoms at three months than the intervention group, particularly headaches, irritability, sleeping difficulties and problems with judgement making. The mTBI non-intervention group also had significantly higher scores in areas of anxiety and depression. Olsson et al. (50) reported that both the intervention group and TAU group had significant improvements in PPCS and psychosocial functioning according to parent and child reports. The treatment effect size for PPCS was small (Cohen's $d < 0.2$) and the authors report that a very large sample would be needed to detect statistically significant differences between groups. Self-reported anxiety and depression scores also significantly improved. Mortenson et al. (49) reported 78% of children in the intervention group and 73% of children in TAU group had improved self-reported PPCS at three months. There is no analysis presented to indicate if these improvements were significant at post-intervention within groups, or whether there was a significant difference in child reported PPCS between groups. It is stated that there were no significant differences between groups for parent reported PPCS at three months. The study did not include a measure on well-being or QOL.

One study was rated high risk (56), medium risk (50) and low risk (49) of bias. The two neuropsychological assessment studies (50, 56) had several methodological issues including no reports of blinding assessors to treatment groups who were reviewing outcomes, no indication of whether there was

high adherence to protocols, and no reports of whether participants were involved in other interventions at the same time as the study treatment. In addition, Ponsford et al. (56) did not use true randomisation of participants to intervention and control groups and instead assigned participants alternately. The study also used some neuropsychological assessments with no standardised data. The only RCT with low risk of bias (49) used psychoeducation as a standalone intervention and only conducted significance testing on parent reported PPCS finding no significant differences between the control and TAU group. Given the methodological limitations that have been outlined and a lack of significant findings, no conclusions can be drawn about the effectiveness of psychological interventions as preventative treatment for PPCS in children.

Treatment studies

Multimodal Interventions Using "Active Rehabilitation"

Six studies used active rehabilitation. All studies were conducted in Canada and had a shared rationale that the impact of concussion is multidimensional affecting both physical and mental health. Literature referenced in these studies commonly stated that prolonged rest can contribute to the maintenance of symptoms whereas physical activity can have a positive effect on many of the symptoms associated with concussion. Each study included a daily visualization/positive imagery task lasting between 5 and 10 minutes. This activity aimed to promote positive experiences in relation to the physical exercise and subsequently enhance engagement with the intervention. The experimental intervention lasted up to six weeks or until symptoms resolved.

One study (39) did not measure PPCS pre- and post-intervention, but the others reported a significant improvement in post-concussion related symptoms. Hunt et al. (39) and Dobney et al. (70) were both assessed to have low risk of bias, the four others were deemed to have medium risk due to small sample size (40, 71), lack of randomisation procedures (65), or poor methodology description (81). Additionally, only two of these had a control group (40, 65). Chan et al. (40) conducted a small RCT and found a

significant difference between groups reporting a medium effect size (Cohen's d = 0.55). In contrast, Gauvin-Lepage et al. (65) used a quasi-experimental design and found no significant differences in PPCS between the active rehabilitation group and standard care post-intervention. However, the study did not measure physical activity in the control group, therefore it is possible participants in the control group also participated in physical activity masking some of the effects of the intervention in the experimental group.

Four studies measured QOL, anxiety and/or depression. Chan et al. (40) completed no inferential statistics on these variables despite measuring them which limits the conclusions that can be drawn. Two studies (39, 71) indicated significant improvements in depression for within-groups post-intervention with small to medium effects. Gauvin-Lepage et al. (65) used a control group and reported a significant improvement in QOL (emotional functioning and social functioning) and anger for children in the experimental condition but no significant difference on depression or anxiety scores following intervention. Hunt et al. (39) also found a reduction in anger scores post-intervention with small to medium effects (Cohen's d = 0.35).

Three of the seven studies conducted analysis with gender as a variable to explore treatment outcomes. Chan et al. (40) found gender did not improve the model fit for PPCS between groups post-intervention. Dobney et al. (70) found female gender was associated with increased PPCS severity at post-intervention but had no control group to examine this association further and conclude if females are less responsive to the experimental intervention. Hunt et al. (39) completed regression analysis which indicated gender significantly predicted anger scores at the end of the intervention. Females were found to have lower scores suggesting they experienced greater reductions in anger post-intervention than males. Whilst this study was assessed to have low risk of bias for a pre-post intervention, no control group was included. Therefore, the reduction in anger scores may represent a pattern in females during concussion recovery rather than an effect of the intervention itself.

No study included a follow-up session other than the post-intervention appointment, usually taking place 6-weeks after intervention initiation. It is

therefore not known what the long-term effects of the intervention were or if symptom improvements result in functional improvements in everyday life (e.g., academic performance).

Multimodal Interventions Using Cognitive Behavioural Therapy

Three studies used this approach, and all were conducted in the USA (43, 46, 78). CBT in these studies was used to teach support the participant to modify unhelpful thoughts and behaviours and teach them new coping skills for managing ongoing symptoms. All reported PPCS symptom severity was significantly reduced post-intervention. Two papers (43, 46) used a control group and found the differences in PPCS were significantly different between groups post-intervention. However, McCarty et al. (43) had a very small sample size for the intervention group which limits the confidence in study findings and resulted in the assessors reviewing it as having medium risk of bias. The other two studies were deemed low risk of bias, but McCarty et al. (46) was the only study to conduct a follow-up. This took place at 12 months which revealed PPCS improvements continued for the treatment group with small to medium effects (Cohen's d = 0.32).

Two studies completed mood and QOL measures pre- and post-intervention and one study (78) measured QOL at pre-intervention only. McCarty et al. (43) found significant improvements in the intervention group for QOL on both parent and child reports, whereas McCarty et al. (46) only found improvements on child self-reports. The authors highlight that some QOL items, such as emotional symptoms, are likely to be difficult for parents to report. For depressive and anxiety symptoms, neither study found a significant difference between intervention and treatment as usual groups. However, McCarty et al. (43) did find that a higher percentage of children had a larger reduction in depressive symptoms compared to TAU and McCarty et al. (46) report that the proportion of children disclosing suicidal ideation at 12 months was significantly decreased for those in the intervention group compared to TAU.

Psychological Interventions Using Cognitive Behavioural Therapy

All three studies (64, 76, 79) were conducted in the USA or Canada and used manualised CBT. All three studies aimed to offer six sessions and covered the following modules: clinical interview and treatment familiarisation, psychoeducation, activity and sleep scheduling, relaxation training, cognitive restructuring and relapse prevention. Each study stated that whilst these were defined 'modules' of the treatment they were used flexibly and so each module may have been drawn upon multiple times throughout the six sessions. An individualised approach was used, and the number of sessions actually delivered was between two and seven. This means some of the modules may not have been required as is often the case in clinical practice. One study (64) specifically targeted insomnia as part of the PPCS profile and therefore included additional psychoeducation on insomnia. There was a shared rationale among studies that targeting symptoms using a psychological approach may help to reduce persisting symptoms after concussion. All three studies showed significant improvements in PPCS. One study (64) used a control group and found self-reported PPCS decreased post-intervention, with a small to medium effect, but was not statistically significant when compared to the TAU group.

Each study included a measure of QOL and/or mood however, different reporting methods were used e.g., self-report, parent only, or both. McNally et al. (76) used parent report only and found a significant improvement within-groups for QOL post-intervention particularly in emotional and school functioning domains. The authors report that no patient characteristic predicted change in QOL scores or post-concussion symptomology. Simpson et al. (79) found significant improvements within-groups for health-related QOL, anxiety and depression scores on both child and parent outcome measures. In comparison, Tomfohr-Madsen et al. (64) found no significant difference in depression and anxiety scores post-intervention but only measured these constructs using child self-report. The study also primarily aimed to reduce insomnia rather than a range of post-concussion symptoms and did find that insomnia scores significantly improved in the treatment group and the improvements were maintained at one-month follow-up.

McNally et al. (76) and Simpson et al. (79) were assessed to have low risk of bias however, it should be noted that Simpson et al had just over 20% attrition. Whilst high drop-out rates can impact study validity, the authors conducted analysis which revealed no significant differences in baseline characteristics of completers and non-completers of the intervention. Tomfohr-Madsen et al. (64) was deemed to have medium bias due to a very small intervention group sample size (N =12) impacting the robustness of the study findings. Whilst the evidence is sparse and the quality variable, there is some indication that CBT is effective in improving PPCS and parent reported QOL in children.

Psychological Interventions Using Other Psychological Skills/Approaches

Two studies used non-CBT psychological interventions, and both were conducted in the USA. Worthen-Chaudhari et al. (66) used a positive psychology approach within a mobile app and found PPCS and optimism scores improved for both the intervention and TAU group. Large effects were found for both PPCS and optimism (effect size r = 0.5 and 0.51, respectively) and these are reported to be slightly larger for the intervention group versus the TAU group but were not significantly different. No significant differences were found in depression scores between the intervention and active control group. The findings of this study must be understood tentatively due to poor methodology (e.g., non-randomisation of experimental vs active control groups, lack of blinding and a small sample size (N = 10)).

Cook et al. (68) used a virtual reality deep breathing exercise and aimed to determine if it was a tolerable intervention for children recovering from a concussion. Whilst a significant reduction in stress, fatigue, tension and confusion was found, the authors did not ask participants to repeat the formal measure of PPCS post-intervention. Therefore, no comparison pre- and post-intervention can be made for this measure. The authors found no significant differences within-groups for depression or anger scores post-intervention. The study was rated as having medium risk of bias due to also having several methodological issues including small sample size (N = 15),

no control group, lack of post-intervention measurements, cross-sectional design meaning the long-term effects of the intervention are not known, and not all eligible participants being recruited due to issues of available clinic space to complete the intervention during their hospital visit.

Therefore, there is no current evidence to demonstrate that the approaches used in these two studies have a statistically significant effect on PPCS or depression following intervention. A multitude of methodological limitations might account for these findings e.g., a small sample size may not have detected small to medium effects if present.

Psychological Interventions Using Neuropsychological Assessment

One study (75), conducted in the US, used neuropsychological assessment with recommendations as an intervention. Two other studies used neuropsychological assessment but provided this as part of a *preventative* intervention and have been described above (50, 56). Kirkwood et al. (75) provided families with individualised feedback and reported significant improvements in PPCS on both child and parent measures at one week and three months post-intervention. Whilst this study was rated low risk of bias, no control group was used meaning conclusions about the direct effect of neuropsychological assessment on symptomology is limited. It is also the only study found by this review to use this type of intervention and so, additional studies using more robust methodology with a control group are warranted given the improvements in PPCS reported in this study.

Psychological Interventions Using Psychoeducation Only

Two studies provided information and education as a standalone intervention however one was a prevention study (49) and is described separately with other prevention studies above. Renaud et al. (58) was conducted in the Netherlands and rated good quality and low risk of bias. The authors reported significant improvements for the intervention group compared to the TAU group at 6 months in PPCS and QOL, though no effect size is reported. It is documented that participation in activities also improved across settings e.g., at home, school, and in sports. This study provides promising results, but additional studies are required to replicate findings.

Summary of synthesis

Prevention

Only one study (49) was rated of good quality by both reviewers which used psychoeducation as a standalone treatment. Whilst this was an RCT, it lacked robust analysis including significance testing for child reported symptoms. It reported no significant difference between groups for parent reported symptoms and therefore, there is currently no published evidence to support the effectiveness of psychological interventions as preventative treatment for PPCS in children.

Treatment

In summary, all studies that were rated good during quality assessment reported improvements in PPCS. These findings were drawn from interventions using active rehabilitation with CBT (46, 78), CBT alone (76, 79), psychoeducation alone (49, 58), active rehabilitation with a visualisation task (70) and neuropsychological assessment with psychoeducation (75). These findings must be understood with caution as only two were RCTs using either active rehabilitation with CBT (46) or psychoeducation alone (58). Both reported conducting significance testing between groups to reveal significant differences to the TAU group post-intervention which is encouraging.

Two of the studies rated good quality examined and reported significant improvements in QOL post-intervention with CBT but did not have a control group meaning improvements could be a result of other factors such as natural recovery or maturational effects (76, 79). Two more studies, one which used a multimodal intervention with CBT (46) and one using psychoeducation only (58), also identified improvements in QOL and used a RCT design finding the differences were significant between groups. From these studies, there is some evidence to suggest QOL may improve following psychological intervention with the most robust evidence for active rehabilitation with CBT and psychoeducation as a standalone treatment. One of the RCTs also measured anxiety and depression (46) revealing no significant difference between the intervention and TAU group post-

intervention whilst two studies with no control group (39, 79) reported significant improvements in both. Whilst these improvements in mood are encouraging, given the lack of findings from the only study that employed an RCT design (46), no firm conclusions can be made about the effectiveness of psychological interventions for mood-related symptoms in PPCS.

The best evidence currently available indicates psychological interventions using active rehabilitation with CBT or psychoeducation alone may be effective in improving PPCS and QOL but their effect on mood-related symptoms cannot currently be concluded. Further studies are warranted to strengthen findings and further explore the impact on mood related symptoms. CBT as a standalone treatment was also shown to improve PPCS and/or well-being but studies were not as robust in their methodology to draw reliable conclusions and may be of interest to explore further.

Discussion

This systematic review explored psychological interventions for children with persistent post-concussion symptoms. Twenty-one papers were identified that met review criteria with eleven rated low risk of bias and ten assessed as medium to high risk. The interventions were described using the TIDieR framework and summarised using narrative synthesis.

Psychological Interventions for Children after Concussion with PPCS

One of the aims of this review was to understand the psychological interventions available for children after concussion and the components of these. This review found that psychological interventions could be grouped into two subgroups of 1) prevention and 2) treatment for PPCS depending on when the intervention were offered after injury.

The heterogeneity of studies was large, and preventative treatments were limited to neuropsychological assessment with psychoeducation and psychoeducation as a standalone treatment. Interventions aiming to treat PPCS were categorised into multimodal interventions using active rehabilitation, multimodal interventions using CBT, CBT as a standalone

intervention, other psychological approach or skill, neuropsychological assessment with psychoeducation, and psychoeducation alone. The psychological components of interventions aiming to treat PPCS varied substantially from a short 5-minute exercise to an eight-week course of CBT. Studies that used a psychological therapy commonly aimed to increase well-being by supporting the individual to modify unhelpful thoughts and behaviours. Psychoeducation was used frequently across both prevention and treatment interventions and seeked to improve a child or family's knowledge and understanding of PPCS and in turn, empower them to feel more in control and have more realistic expectations about their recovery. Studies that used a multimodal approach, aimed to target the array of symptoms on an individual basis recognising how the profile of symptoms in PPCS interlink. Interventions were offered by several different professions from physiotherapists to occupational therapists to neuropsychologists to licensed therapists. Psychological therapy and psychological assessment were always completed by a trained professional, though psychoeducation was often offered by multidisciplinary team members.

Psychological Interventions for PPCS and their Effectiveness

The review shows that there are relatively few research studies of high quality exploring psychological interventions for PPCS in children. These are greatly varied in the approach taken and often require an individualised delivery depending on the needs of the child. A meta-analysis was not possible due to the heterogeneity of data and therefore, the overall reporting of the statistical effectiveness of interventions is limited; however, several tentative findings can be drawn.

In terms of *preventative* interventions for PPCS, there was just one RCT with low risk of bias (49) which indicated no significant findings in parent reported symptoms. The study lacked significance testing to explore child reported symptoms within and between groups. Further studies aimed at preventing PPCS are required to determine the effectiveness of psychological interventions.

All sixteen studies that explored *treatment* interventions and reported PPCS pre- and post-intervention described an improvement in scores. In fifteen studies the improvement post-intervention was statistically significant, however only two were RCT's with low risk of bias (46, 58). These two studies found significant evidence supporting the effectiveness of active rehabilitation with CBT and psychoeducation only. As mentioned, this conclusion should be interpreted with caution until further evidence replicating these findings is available and applies robust methodology.

This review also provides some insight into the impact of psychological interventions on QOL and mood. Whilst seven studies reported significant improvements in QOL post-intervention, only four were rated low risk of bias (46, 58, 76, 79). Two of these four implemented an RCT design and found evidence supporting the effectiveness of active rehabilitation with CBT (46) and psychoeducation only (58) for improving QOL. The other two studies had no control group but reported significant improvements in QOL using CBT (76, 79). The findings on anxiety and depression are less clear as not all studies reported the findings despite measuring these variables. The only RCT to measure anxiety and depression that was rated low risk of bias (46) in this review found no evidence of significant improvements having used active rehabilitation with CBT. Studies utilising less robust methodologies, but still deemed low risk of bias, revealed significant results using active rehabilitation with either CBT (79) or psychoeducation (39) and may warrant further exploration in the future. At present, there is no strong published evidence to indicate the effectiveness of psychological interventions for mood-related symptoms in PPCS due to the limited data available and the poor quality of studies that did measure these variables.

Strengths and Limitations

This is the first review to systematically describe and evaluate the evidence of effectiveness of psychological interventions for children experiencing PPCS. Whilst there are other reviews for adults in this area, it is important to understand the range and effectiveness of interventions within a child and adolescent population. This is due to their recovery after

concussion being different to adults (84), as well as the potential disruption to their physical, cognitive, and psychosocial development in early life. By summarising the range of different interventions using the TIDieR checklist, interested individuals can quickly view the key intervention components and consider the feasibility of using such these in clinical practice. To ensure this review was up-to-date, protocols were included to highlight to readers any relevant studies that should be monitored for publication.

This systematic review benefited from having a second independent assessor review at least 10% of the search results and complete quality assessment ratings on all studies that met the inclusion criteria. Whilst the review could have been strengthened by having a higher percentage of the search results screened to minimise author bias and risk of error, the two reviewers had a high agreement rate indicating judgement by the first author for the remaining studies was likely consistent. Due to the high volume of articles retrieved using the search strategy, articles were restricted to English Language and the search terms “veteran”, “military”, “soldier” and “servicemen” excluded from the abstracts. The author is aware that search limiters may introduce publication bias or have excluded some evidence that would have been useful in answering the review questions however considering the review was focused on children, it was felt excluding these search terms would not have a substantial impact.

Due to the wide heterogeneity of treatment approaches and a variety of study designs, a meta-analysis could not be conducted. This would have allowed a more robust synthesis of the effectiveness of interventions to be completed which may have enabled a more concise review of the literature. Whilst a narrative synthesis was performed instead, several methodological flaws still restrict the conclusions that can be drawn. Out of the nine studies (not including protocols) that were assessed in this review as good quality, no more than two used a similar intervention approach. Additionally, the studies included often used small sample sizes (intervention group $N < 30$) reducing the power of the study to detect significant results and increasing the margin of error. The diversity of the sample was also problematic in that 81% were published in either Canada or the USA and only a third reported

the ethnicity of samples. This reduces the applicability of findings across different cultures and ethnicities. Whilst the distribution of genders across combined studies was reasonably equal (51.5% male), some research highlights that the prevalence of PPCS may be higher in females (85-87) possibly due to underreporting by males (88). This may mean that the samples included are not reflective of the true population who experience PPCS, and the effect of the interventions reported may be biased.

Half of the studies did not use a control group and those that did, did not always account for confounding variables e.g., not measuring if the control group engaged in physical activity when active rehabilitation was the basis of treatment in the intervention group. A handful of studies did not complete post measures for all baseline variables making it difficult to conclude the effect of an intervention on certain variables (49, 56, 68). Another methodological concern across studies was the method used for reporting symptoms e.g., parent only, child only or both child and parent reports. As there is no 'test' to assess for PPCS, self-report and parent-report are frequently used. However, the reliability between these reporting methods is variable for PPCS (89-92) and psychosocial outcomes (93-95).

Another important consideration when interpreting the review findings is how studies classified PPCS. According to the 5th International Consensus Conference (ICC) on concussion in sport, PPCS in children occurs when symptoms persist longer than four weeks. Several of the studies recruited participants before this timeframe and consequently they would not have met criteria for PPCS according to the ICC guidance. In these cases, some participants may have continued to experience natural recovery and be symptom free by four weeks and therefore, improvements may not be fully explained by the intervention alone. Additionally, studies varied on how many persistent symptoms were required as a criterion with studies ranging from one persistent symptom to three symptoms being reported. Both of these diagnostic shortcomings are likely due to the lack of consistency of diagnostic criterion across manuals such as the ICD-10, DSM-IV, DSM-V and ICC (96).

Future Research

This review has revealed that the literature on psychological interventions for children with PPCS is limited but is of significant current interest with most papers being published in the last five years. Whilst research in this area is in its infancy, it is important to highlight the limitations in current publications so future research can be modified. One area that is crucial to streamline is the classification of PPCS in children across diagnostic guidelines and how studies use this as a criterion to allow for useful comparisons. This is not only important for research studies but also has direct importance for children and their families to ensure they are given accurate information and are able to access support.

Future research should also address the methodological concerns raised in this review and aim to conduct robust study designs such as RCTs, include a control group for comparison, utilise follow-up sessions to monitor long-terms effects of treatment, and consistently measure for any obvious confounding variables (i.e., if the intervention is delivering physical activity as the treatment, the level of physical activity should also be measured in the control group). When there is more research available, that has addressed these methodological issues, a comparison of treatments such as a comparative efficacy trial would be beneficial to help guide clinical decision making on concussion treatment. It will also be important for researchers to explore health economic data to allow services and commissioners to consider the feasibility of implementing certain interventions

There is already extensive literature exploring predictive factors of persistent symptoms in children such as personality traits, developmental stage, pre-existing diagnoses, and family functioning (97-99). What is less clear is the effectiveness of psychological interventions for those who present differently on these predictive factors. In particular, the role family play in the development of PPCS in children and their impact on the success of interventions may also be of interest given how reliant children are on their support system.

Conclusion

Current literature of psychological interventions for children with PPCS is highly heterogenous and dominated by studies completed in Northern America. Broadly, both prevention and treatment interventions aim to reduce psychological distress by promoting new coping strategies and knowledge about the condition to improve the individual's level of functioning and reduce symptomology. For treatment interventions, this may include treatment in the form of psychoeducation, neuropsychological assessment, psychological therapy, or psychological skills-based exercises. Often this is offered in combination with physical activity to provide individuals with a multidisciplinary and collaborative approach to recovery. With regards to the effectiveness of these interventions, only three studies aimed to 'prevent' symptoms and these were limited by poor methodology and analysis. Therefore, there is no robust evidence yet for the use of psychological interventions as a *preventative* intervention for PPCS. For *treatment* interventions, two RCT's with low risk of bias found significant evidence supporting the effectiveness of active rehabilitation with CBT and psychoeducation as a standalone treatment for persisting symptoms and QOL. However, the lack of high-quality studies due to methodological flaws means that the findings of the review are based on a very small number of studies and must be understood tentatively. The literature is in its infancy and there are significant gaps that warrant further research to reinforce findings. Future studies should aim to use robust study designs such as RCTs, improve the consistency of reporting methods and measures used, and recruit larger and more representative samples.

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Chapter Three:

Empirical Research Study

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Using the Health Belief Model to explore factors that impact adherence behaviour in parents and teachers after child concussion.

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Abstract

Current concussion management guidance for children suggests an initial rest period of 24-48 hours followed by a gradual return to activity. If concussion guidelines are not followed, then children may return to situations where they are not physically or cognitively ready and may put themselves at risk of a second head injury or experience persistent post-concussion symptoms (PPCS). Parents and teachers are in a position of responsibility over a child's wellbeing and therefore, it is important to understand their likelihood to adhere to implementing guidance. This study applied the Health Belief Model to examine what factors may predict their likely adherence to concussion guidelines. A survey was completed by 144 parents and 44 teachers which showed that a sample of mostly white, well-educated, female participants had good knowledge of acute concussion symptoms and PPCS, but less knowledge for the recommended guidance that should be followed. Perceived barriers (β = 0.459), perceived susceptibility (β = 0.536) and concussion knowledge (β = 0.601) were found to be predictive of likely adherence by parents. These findings extend previous research that has focused on sports-related concussion and non-UK samples and highlight areas where educational resources, guidelines and support can be modified to increase likely adherence, in turn improving the outcomes for children who experience concussion. Future research should aim to recruit a larger sample of teachers to determine predictors of their likely adherence, improve diversity of the recruited sample and consider the application of other health models to understanding this health behaviour.

Keywords: persistent post-concussion symptoms, PCS, PPCS, paediatric, brain injury, post-concussion syndrome, health belief model, adherence

Background

Symptoms of concussion can include confusion, headache, dizziness, mood changes, balance difficulties and poor attention in adults and children. Usually, symptoms of concussion resolve without the need for intervention, but some may experience ongoing symptoms. The National Institute for Health and Care Excellence (NICE) [1] states returning too early to school or to physical activities whilst a child is still symptomatic is associated with prolonged recovery. When a child experiences difficulties beyond the expected recovery time frame of four weeks [2], this is referred to as Persistent Post-Concussion Symptoms (PPCS). The current definition “does not reflect a single pathophysiological entity, but describes a constellation of non-specific post-traumatic symptoms that may be linked to coexisting and/ or confounding factors, which do not necessarily reflect ongoing physiological injury to the brain”, [2, p. 5].

Concussion management guidelines

Following a concussion there are several recommendations that should be followed to aid recovery. Current concussion management guidance for children suggests an initial rest period of 24-48 hours followed by a gradual return to activity including returning to the classroom, to playing sports and to other activities at home [2]. A systematic review [3] found few studies exploring the effectiveness of concussion guidance in a paediatric population, though the evidence that is available, supports the implementation of such recommendations.

Leaflets are a common way to communicate this guidance to families who access support, such as the leaflet by Lilley [4]. The “After Concussion, Return to Normality” (ACORN; Appendix E) leaflet was created in collaboration with the National Health Service (NHS) and Child Brain Injury Trust and uses a traffic light system to guide families through a three-stage recovery process. It encourages the child and their families to discuss recovery at each stage and seek agreement before moving to the next stage. Families would be expected to guide children to slowly increase their activity

at home (e.g., slowly increasing TV time, reading, and playing games), and liaise with schools to help them re-integrate (e.g., school attendance may need to be phased, homework tasks limited, and classroom environment adjustments made). Ensuring families are given correct and consistent advice by professionals is one of the first steps in supporting a child to recover from concussion. Following this, the implementation of health advice is commonly placed solely on families and schools as individuals are not routinely reviewed by medical professionals.

Adherence to concussion recovery guidelines

If concussion guidelines are not followed, then children may return to situations where they are not physically or cognitively ready and may put themselves at risk of a second head injury which can cause more severe consequences. Research exploring adherence to concussion advice is currently limited. Existing studies have shown adherence by children can range between 30-90% [5-8]. Evidence has shown poor adherence is correlated with poorer outcomes and increased Persistent Post-Concussion Symptoms in children (PPCS) [9]. These findings emphasize the importance of adherence to concussion guidelines and highlight involvement from a child's support system, such as parents and teachers, may be beneficial. Parents can support a child at home whilst teachers play an important part in the child's return to school being able to monitor their learning, mood, and behaviour. Currently, there is a lack of literature exploring teacher and parental adherence to concussion guidance and where this is documented, much of this focuses on sports-related concussion and 'return to play' guidance. Mac Suibhne et al. [10] found 93% of parents were provided with 'return to play' guidance yet 84.2% of children were allowed by parents and schools to return to sports without a medical review and 11.3% of children returned to play prior to the recommended return to play advice. To support children to make a successful and safe recovery from concussion, understanding adherence behaviour by responsible adults is likely to be important.

Health Belief Model

The Health Belief Model (HBM; [11]; Appendix F) is a social cognitive model of health-related behaviour including compliance and adherence to medical advice. The HBM suggests an individual's beliefs about potential threat of an illness together with their beliefs about the effectiveness of the recommended behaviour predicts the likelihood of them adopting the behaviour. Perceived barriers is often the construct with the strongest predictive ability of health behaviour in the HBM [12] and refers to the obstacles a person perceives in performing a recommended health behaviour. The importance of individual factors has been highlighted in determining health related behaviour such as demographic variables, psychological characteristics, and existing knowledge of the health condition [13-15]. Indeed, children's knowledge of concussion guidelines has been shown to be predictive of their own adherence to recommendations [5]. The HBM has been used to explore concussion reporting behaviours in students [16] but not to examine adherence to recommended guidelines in parents or teachers.

Whilst the HBM has not been applied to this specific area, some of the variables within the model have been explored individually in the literature, though this typically relates to sports concussions. One study showed sports coaches in the US underestimate concussion recovery in children [17] whilst another showed parents who perceived a higher likelihood of their child sustaining a concussion were more likely to encourage concussion reporting [18]. Perceived barriers of implementing guidance by teachers includes the school environment, lack of communication from parents and student honesty [19-21]. Less is known empirically about parental perceived barriers, however, a systematic review indicated parental stress can be a barrier to good adherence irrespective of the child's medical condition [22]. A greater number of studies have explored knowledge of concussion in teachers and parents revealing both groups are more successful in identifying acute concussion symptoms than PPCS and RTN guidance for children [23-27]. Concussion knowledge has been shown to be impacted by a number of demographic variables including age, gender, parental income, years of education, years qualified as a teacher, personal experience of concussion,

socioeconomic status [28-34]. A recent study revealed that children's knowledge of concussion guidelines was significantly predictive of their own adherence to the recommendations [5] and therefore, exploring knowledge of guidelines in parent and teacher samples when examining adherence behaviours may be useful.

Study Aims

The present study addresses a gap in existing literature as studies to date have focused on sports-related injury only, been conducted outside the UK and have not applied health behaviour theories to understand adherence to concussion guidelines. The aim of this study was to determine whether the constructs of the HBM (perceived severity, perceived susceptibility, perceived barriers, perceived benefits, perceived cues to action and perceived self-efficacy) predict likely adherence to concussion guidelines by UK parents and teachers. Demographic variables, perceived stress, and concussion knowledge were measured to examine the effect on the HBM constructs in predicting adherence. It is hoped that by understanding adherence behaviour, along with knowledge and perceptions of concussion in parents and teachers, this study may contribute to the development of meaningful and targeted educational resources for families and schools, in turn improving the outcomes for children who experience concussion.

Research Questions (RQ)

1. What is the level of knowledge of teachers and parents on measures of acute concussion symptoms, persistent post-concussion symptoms and/or 'Return to Normality' (RTN) guidelines?
2. What percentage of parents and/or teachers obtain above 'neutral' scores on likely adherence to 'Return to Normality' guidelines after child concussion?
3. Do parents and teachers score differently on measures of child concussion knowledge, perceived severity, and perceived susceptibility?
4. Do constructs in the HBM predict likely adherence to 'Return to Normality' guidelines by teachers and/or parents?

Method

Design

This study was a quantitative, cross-sectional survey design. A second study was conducted with the same participants exploring feasibility and acceptability to help inform a future trial and these findings are reported separately.

Participants

Teachers and parents were recruited using convenience sampling. Participants were required to live in the UK, have access to technology to complete the online survey and did not require any specific concussion experience. Teachers were included if they were currently employed or had been previously employed in a state, private or special educational needs school supporting school-age children. Teachers could include qualified teachers or teaching support assistants and they were asked to self-report their qualification status in the survey. Parents were given options to self-identify as a “parent”, “guardian” or “other” to capture the realistic support systems of children. If participants identified as both a parent and teacher, they were asked to choose in which role they would like to participate. No other exclusion criteria were applied.

Materials

Ethical approval was obtained from the University of East Anglia Faculty of Medicine and Health Research Ethics Committee (application reference: 2020/21-058, Appendix G).

Survey development

As there was no published measure addressing the HBM variables for the target population in this thesis, a new survey was developed consisting of several new measures. A range of resources were reviewed to create appropriate measures for each variable of interest. To inform the survey development, stakeholders were consulted and included parents, teachers, and individuals with concussion experience either through supporting a family member or supporting a patient. The measures were piloted with 7

individuals (3 parents, 3 teachers and 1 postgraduate student) to review the timing, survey structure and wording. The survey was created using Qualtrics XM and had two versions (Appendix H and I) depending on whether the participant was a teacher or parent. The survey was designed to take no more than twenty minutes to maximise completion rate [35]. The following sections describe the measures that were included in the online survey.

Demographic information

Demographic information was gathered including gender, age, ethnicity, education, employment status, socioeconomic status, experience of first aid training, and direct or indirect concussion and/or traumatic brain injury experience.

Perceived Stress Scale (PSS)

The HBM suggests psychosocial variables are important in health behaviour outcomes. Perceived stress was chosen as a psychosocial variable given parental stress has been shown to be a barrier to parental adherence behaviour across child health conditions [22]. The PSS-10 ([36]; Appendix J) is a 10-item measure that uses a 5-point Likert scale where higher scores indicate higher levels of perceived stress (score range = 0 to 40). It has good internal reliability (r=0.86), two-day test-retest reliability of 0.85, good construct validity and has been shown to correlate with measures of health behaviour [37]. The PSS has been used widely in parent and teacher populations [38-43].

Knowledge of acute concussion, PPCS and RTN guidelines

Existing questionnaires measuring concussion knowledge were typically based on sports-related concussion (Rosenbaum Concussion Knowledge and Attitude Survey; RoCKAS [44], worded for a US population or were not aligned with current guidelines. Therefore, a new measure was created to assess a participant's health-related knowledge according to the HBM. Items were taken from existing measures where possible, and phrasing was changed to suit a UK population. Additionally, items were worded to be non-specific to sports-related injury and be applicable to parents and teachers

instead of sports coaches and return to play guidance only. The measure assessed knowledge of acute symptoms, persistent symptoms, and 'Return to Normality' guidelines. A score was produced for each of the three sections along with an overall concussion knowledge score calculated from the three subscales. Higher scores demonstrated higher knowledge across all measures (score range = 0 to 24).

Knowledge of acute symptoms and PPCS. Common symptoms of concussion (e.g., headaches and poor balance) and PPCS (e.g., irritability and disrupted sleep) were obtained from the NHS conditions website [45] and the Consensus statement on concussion in sport [2]. Distractor items (e.g., hearing voices and muscle weakness) were taken from other health conditions such as severe brain injury, mental health disorders and physical health problems. The draft measure was discussed with the research team (experienced neurophysiologist with expertise in mTBI, MG; consultant clinical neuropsychologist with expertise in child brain injury rehabilitation, FG) iteratively until there was agreement on symptom and distractor items. Each measure had 20 items (six correct and 14 distractor items). Participants were required to identify the six correct symptoms (score range = 0 to 6 correctly identified symptoms on each measure).

Knowledge of 'Return to Normality' guidelines. Items were possible activities taken from the guidance on the ACORN leaflet [4] (Appendix E) e.g. easy crafts, exams and playing competitive sports. Twelve items were presented with three time intervals ('straight away after concussion', 'between one and seven days after concussion' and 'between one and two weeks after concussion') according to the guidelines on the leaflet. Participants were asked to indicate at what time point they thought was the soonest a child should undertake each activity following a concussion and each item was designed to have one correct answer (score range = 0 to 12 correct answers).

Concussion perceptions

As indicated by the HBM, measures of perceived severity, susceptibility, barriers, benefits, cues to action and self-efficacy were included to explore

the relationship with likely adherence to concussion guidelines. No quantitative measure of concussion perceptions was identified from the literature to adequately assess these constructs within the target population. Existing measures were only partly applicable as they either focused on sports-related concussion or were directed to sports coaches (Sports Concussion Knowledge Scale, [46]; BAKPAC-TEACH, [47]), worded for a US population (BAKPAC-TEACH), or contained only one of the relevant HBM constructs (BAKPAC-TEACH; ROCKAS-ST [48]). Whilst the published measures could not be included in their current form, all were consulted to develop items on six new measures assessing each HBM perception specifically for this study. All were measured using a five-point Likert scale with perceived severity and susceptibility using strongly believe, believe, neither believe nor believe, disbelieve, strongly disbelieve, and, perceived barriers, benefits, cues to action and self-efficacy using strongly agree, agree, neutral, disagree and strongly disagree. Reverse scoring was utilised on some items to maintain concentration and avoid false positives that may have occurred if the participant selected one answer for all.

Perceived severity. Nine items measured this perception and included statements such as “A full recovery from concussion is typically complete within one week for children” and “Concussion is only serious if a child loses consciousness/blacks out”. Higher scores indicated higher severity of concussion perceived (score range = 9 to 45).

Perceived susceptibility. Six items measured this perception and included statements such as “Concussion is a common injury in children” and “Concussion can only occur if a child blacks out or loses consciousness”. Higher scores indicated higher susceptibility of concussion perceived (score range = 6 to 30).

Perceived barriers. There were separate versions for parents and teachers, both had eight items. Statements such as “If my child sustained a concussion, I would find it difficult to limit my child’s activities e.g., watching tv, video games, playing sports” were included on the parent version and “If a child in my class sustained a concussion, I would find it difficult to provide a

quiet workspace for them to learn" on the teacher version. Higher scores indicated fewer barriers to implementing concussion guidelines perceived (score range = 8 to 40).

Perceived benefits. There were separate versions in which the parent version had nine items and the teacher version had 11 items. Statements such as "My child could safely return to sports sooner" were included on the parent version and "I will need to make fewer classroom adjustments in the long run" on the teacher version. Higher scores indicated more benefits to implementing concussion guidelines perceived (parent score range = 9 to 45, teacher score range = 11 to 55).

Perceived cues to action. There were separate versions in which the parent version had five items and the teacher version had seven items. Statements such as "I would follow the recommended guidelines for child concussion if I was told about the long-term consequences of child concussion" were included on the parent version and "I would follow the recommended guidelines for child concussion if I was told to by a health professional" on the teacher version. Higher scores indicated more cues perceived that would prompt them to implement concussion guidelines (parent score range = 5 to 25, teacher score range = 7 to 35).

Perceived self-efficacy. There were separate versions in which both versions had five items. Statements such as "I would be able to identify when they were ready to return to school fulltime" were included on the parent version and "I would be able to identify when a child needed more breaks or quiet time" on the teacher version. Higher scores indicated higher self-efficacy to implementing concussion guidelines (score range = 5 to 25).

Likely adherence to concussion guidelines

The dependent variable (likely adherence to guidelines) was measured using vignettes with follow up questions relating to possible actions which participants rated in terms of their likelihood to complete. There were separate vignettes and different items for parents and teachers. Both scenarios described a situation where a child had experienced an injury and was recovering from a concussion. Vignette questionnaires have been

regularly used in research to measure behaviour and are thought to be a realistic alternative to standard survey questions thus increasing internal validity [49]. There were 14 items on this measure which were developed using the following resources: Return to Normality leaflet [4] and the CanChild Return to School/ Return to Activity Brochures [50]. Items included a mixture of recommended and non-recommended statements and reverse scoring was applied where appropriate. Items on the parent measure included statements such as “I would let James play in his football match tomorrow” (not recommended) and “I would try to minimise screen time for James over the next few days” (recommended), and on the teacher measure “I would offer one to one support for James in my classroom” (recommended) and “I would expect James to join in during physical education lessons” (not recommended). Items were rated using a 5-point Likert scale of very likely, likely, neutral, unlikely, and very unlikely. The score range was 14 to 70 where higher scores indicated higher adherence to the concussion guidelines. If a participant provided neutral responses across all 14 items, they would obtain a score of 42. The adherence outcome will be reported by calculating % of respondents achieving a score above 42 which on the basis of the Likert scale anchoring indicates ‘likely’ or ‘very likely’ to engage in actions which are consistent with guideline recommendations.

Procedure

Recruitment. The recruitment period was between April and December 2021. Teachers and parents were recruited using the same methods. Schools were randomly selected from http://schoolswebdirectory.co.uk/. Data was collected and analysed anonymously. Figure 3 shows a participants journey through the study.

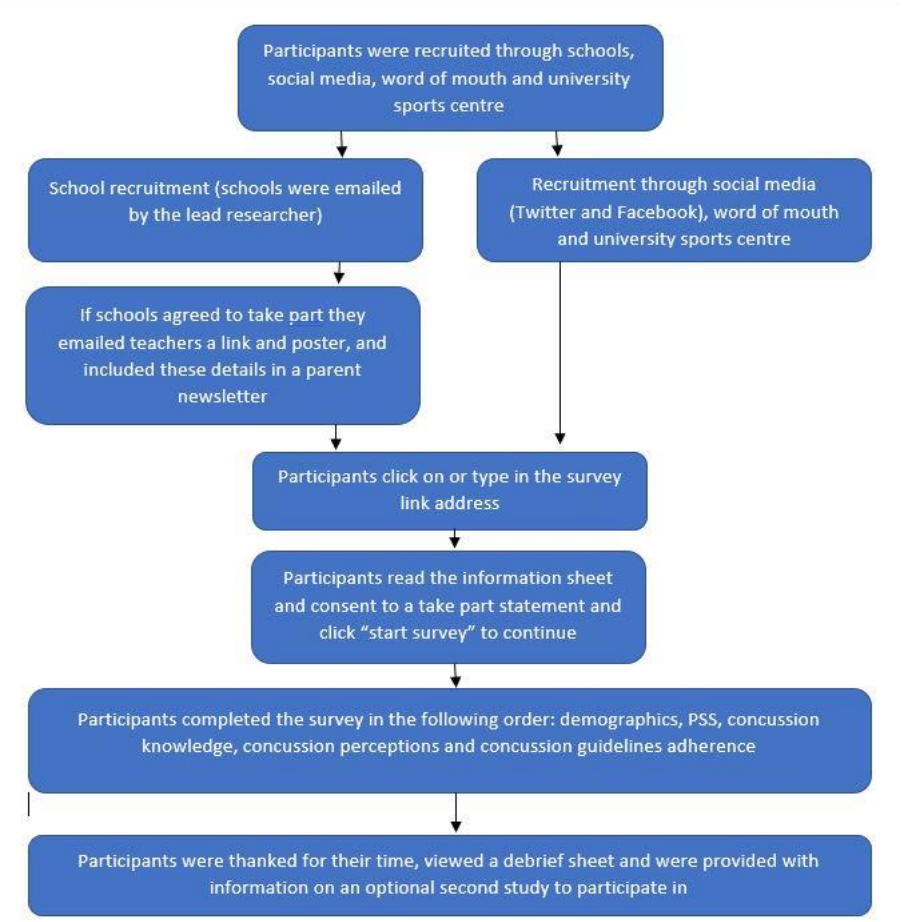

Figure 3. A flow diagram of a participant's journey

Data Analysis

Data analysis was completed using SPSS version 28. Datasets were removed if less than 20% complete to limit missing data. Descriptive statistics were used to analyse sample characteristics and key variables (RQ1 and RQ2). Data were checked to see if they met the assumptions for parametric testing. This included checking for normality using visual graphs (histograms and Q-Q plots), skewness and kurtosis (both between 1 and -1), and boxplots for outliers. Independent samples t-tests were used to look for differences between groups on concussion knowledge, perceived severity and perceived susceptibility (RQ3). Levene's test of equality of variances was also checked for this analysis. Associations between the dependent variable and other HBM variables were conducted using a series of Pearson (r) and Spearman (r_s) correlations. For Pearson correlations, normality of the key variables was assessed using the above method and scatterplots were

checked for a linear relationship between variables. All statistical tests were conducted with an alpha level of 0.05. Corrections for multiple comparisons were also employed [51].

Multiple linear regression was used to determine if the HBM constructs predict adherence to RTN guidance (RQ4). Prior to conducting this, with likely adherence as the dependent variable, the relevant assumptions were tested and are reported in the results. A minimum sample size of 139 was determined using GPower3 to detect medium effects with 80% statistical power, 5% alpha level and up to 15 predictors. The variables were entered into the regression according to the literature, with original HBM variables (perceived severity, perceived susceptibility, perceived barriers, and perceived benefits) entered in model one and then the most recent additions to the model, self-efficacy, and cues to action, added in the second model. Concussion knowledge and demographic variables (age, highest educational qualification, socioeconomic status, and perceived stress) were added in model three. Categorical variables of interest were transformed using dummy coding to make them suitable for regression analysis. Age was coded into the following categories: 16-34 (D1), 35-44 (D2), 45-54 (D3) and 55+ (D4). Education level was coded into the following categories: secondary school or less (D1), further education (D2), bachelor's degree (D3) and master's degree or above (D4).

Given some of the measures used in this study were newly developed, internal consistency was calculated to understand possible impact of this on the main analysis.

Results

Sample characteristics

Figure 4 shows responses recorded, removed, and analysed. There were 177 entirely complete datasets giving a survey completion rate of 76%.

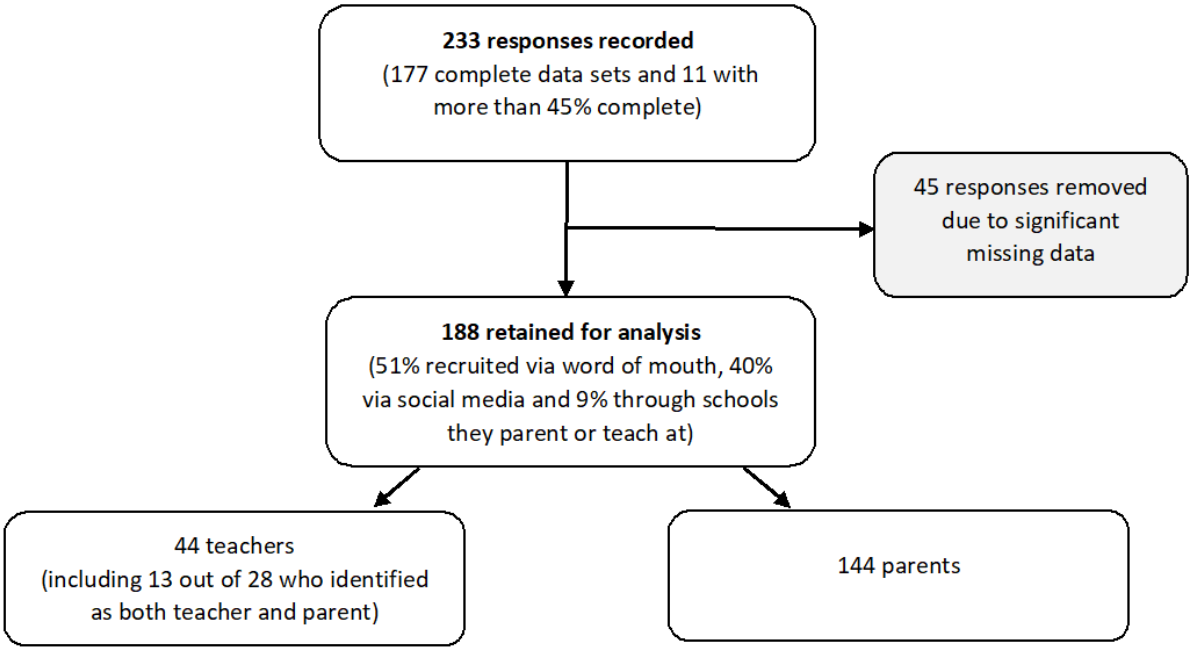

Figure 4. Total survey responses recorded, removed, and analysed

Table 2 presents the sample characteristics indicating 89.9% of the sample identified as female. Whilst there was a mixture of ethnicities reported, 94.1% of the sample identified as white. One hundred percent of teachers and 84% of parents who completed the study had completed further qualifications after secondary school. One teacher reported being a student whilst all other teachers were currently employed and 81.9% of parents reported being employed.

Table 2

Sample characteristics

	Total Sample (N = 188)	Teachers (N = 44)	Parents (N = 144)
Age, N (%)			
16-24	5 (2.6)	4 (9.1)	1 (0.7)
25-34	52 (27.5)	18 (40.9)	34 (23.6)
35-44	85 (45.0)	13 (29.5)	72 (50.0)
45-54	38 (20.1)	5 (11.4)	33 (22.9)
55-64	7 (3.7)	4 (9.1)	3 (2.1)
65+	1 (0.5)	0	1 (0.7)
Females, N (%)	169 (89.9)	37 (84.1)	132 (91.7)
Ethnicity, N (%)			
Asian	4 (2.1)	1 (2.3)	3 (2.1)
Mixed/Multiple ethnic	3 (1.6)	1 (2.3)	2 (1.4)

	Total Sample (N = 188)	Teachers (N = 44)	Parents (N = 144)
White	177 (94.1)	42 (95.5)	135 (93.8)
Other	3 (1.6)	0	3 (2.1)
Prefer not to say	1 (0.5)	0	1 (0.7)
Highest qualification, N (%)			
No qualifications	4 (2.1)	0	4 (2.8)
Secondary school	19 (10.1)	0	19 (13.2)
Further education	33 (17.6)	4 (9.1)	29 (20.1)
Bachelor's level	79 (42.0)	35 (79.6)	44 (30.6)
Masters level or above	53 (28.2)	5 (11.4)	48 (33.3)
Employment, N (%)			
Full-time	78 (41.5)	28 (63.6)	50 (34.7)
Part-time	65 (34.6)	13 (25.6)	52 (36.1)
Self-employed FT	7 (3.7)	0	7 (4.9)
Self-employed PT	9 (4.8)	0	9 (6.25)
Retired	2 (1.1)	0	1 (0.7)
Homemaker	16 (8.5)	0	15 (10.4)
Student	8 (4.3)	1 (2.3)	7 (4.9)
Unable to work/ unemployed	3 (1.6)	0	3 (2.1)

Note. FT = Full-time, PT = Part-time,

Forty-five (24%) participants lived in the least deprived areas of the UK and only 8 (4%) participants lived in the most deprived areas of the UK. The indices of multiple deprivation deciles based on postcodes participants provided indicated a heavy skew in data towards participants living in the least deprived areas (Appendix K).

Five (3%) participants, including two teachers both of whom reported they were first aiders, had not heard of the term concussion. One-hundred and sixty-five (88%) participants reported they were not aware of the symptoms of PPCS. One hundred and twelve (60%) participants were first aid trained (Table 3) and 38 (20%) had received formal training about concussion.

Table 3

Concussion and brain injury experience

	Total Sample (N = 188)	Teachers (N = 44)	Parents (N = 144)
First aider, N = Yes, (%)	112 (59.6)	23 (52.3)	89 (61.8)
Concussion experience, N (%)			

	Total Sample (N = 188)	Teachers (N = 44)	Parents (N = 144)
Indirect, Yes	66 (35.1)	11 (25.0)	55 (38.2)
Direct, Yes	38 (20.2)	12 (27.3)	26 (18.1)
Direct, Unsure	7 (3.7)	0	7 (4.9)
Moderate-Severe Brain Injury experience, N (%)			
Indirect, Yes	33 (17.6)	12 (27.3)	21 (14.6)
Direct, Yes	4 (2.1)	1 (2.8)	3 (2.1)
Direct, Unsure	2 (1.1)	0	2 (1.4)

Note. Direct experience refers to sustaining injury to self, Indirect experience refers to a close family member or friend sustaining injury.

One hundred and thirty (90%) parents identified as mothers in this study, 12 (8%) as fathers and two (2%) as stepmothers. One hundred and twenty-seven (88%) parents reported their children attended state school for most of their education, 10 (7%) attended private school and 7 (5%) were home schooled. Thirty-five (80%) teachers reported having over five years teaching experience and all had worked as a teacher in the last ten years. Table 4 shows that all teachers were currently working in state schools except one. Nine (20%) teachers had supported a child with a suspected concussion at school and six (14%) had supported a child return to school after a concussion. Thirty-six (82%) teachers were not aware if their school had any guidelines about supporting a child return to school following a concussion.

Table 4

Teacher specific characteristics

	Teachers (N = 44)
Type of school, N (%)	
State	43 (97.7)
Private	1 (2.3)
Supported a child with suspected concussion, N = Yes (%)	9 (20.5)
Supported a child return to school after concussion, N = Yes (%)	6 (13.6)
Aware of school guidelines, N = Yes (%)	8 (18.2)

Internal consistency

Internal consistency was calculated for the measures that were developed in this study to explore HBM variables. Cronbach's alpha was used with parent data revealing poor internal consistency for measures of perceived severity = 0.586, perceived susceptibility = 0.543, cues to action = 0.691 and perceived self-efficacy (0.428). The measures of perceived benefits (0.740) and perceived barriers (0.746) were found to have fair internal consistency according to common guidelines [52].

RQ 1: What is the level of knowledge of teachers and parents on measures of acute concussion symptoms, persistent post-concussion symptoms and/or 'Return to Normality' guidelines?

All participants identified at least three out of six symptoms correctly for acute concussion and 96% identified at least four symptoms correctly. For PPCS, 95% identified at least four out of six symptoms correctly and for RTN, 89% of participants identified between five and nine out of 12 activities and corresponding recommended timescales correctly. Table 5 indicates the frequency of scores for each subscale. For PPCS, the most frequently and correctly identified symptoms were headaches (N = 180), poor concentration (N = 185) and mood changes (N = 178) and the least correctly identified were disrupted sleep (N = 156), inability to keep up with schoolwork (N = 129) and difficulties with social interaction (N = 75).

Table 5

Frequency of scores for concussion knowledge subscales

		Total Sample (N = 188)	Teachers (N = 44)	Parents (N = 144)
Acute concussion symptoms score, N (%)				
	1	0	0	0
	2	0	0	0
	3	8 (4.3)	0	8 (5.6)
	4	32 (17.0)	9 (20.5)	23 (16.0)
	5	95 (50.5)	24 (54.5)	71 (49.3)
	6	53 (28.2)	11 (25.0)	42 (29.2)
PPCS score, N (%)				
	1	0	0	0

		Total Sample (N = 188)	Teachers (N = 44)	Parents (N = 144)
	2	2 (1.1)	1 (2.3)	1 (0.7)
	3	8 (4.3)	2 (4.5)	6 (4.2)
	4	52 (27.7)	13 (29.5)	39 (27.1)
	5	89 (47.3)	17 (38.6)	72 (50.0)
	6	37 (19.7)	11 (25.0)	26 (18.1)
RTN score, N (%)				
	1	0	0	0
	2	0	0	0
	3	2 (1.1)	0	2 (1.4)
	4	10 (5.3)	2 (4.5)	8 (5.6)
	5	29 (15.4)	5 (11.4)	24 (16.7)
	6	33 (17.6)	7 (15.9)	26 (18.1)
	7	47 (25.0)	10 (22.7)	37 (25.7)
	8	38 (20.2)	13 (29.5)	25 (17.4)
	9	21 (11.2)	5 (11.4)	16 (11.1)
	10	6 (3.2)	2 (4.5)	4 (2.8)
	11	2 (1.1)	0	2 (1.4)
	12	0	0	0

RQ 2: What percentage of parents and/or teachers obtain scores above 'neutral' scores on likely adherence to 'Return to Normality' guidelines after child concussion?

One hundred and forty-two parents and 41 teachers completed the vignette-based questions exploring likely adherence. Figure 5 shows the frequency of scores obtained, where higher scores indicate closer adherence. For parents, the spread of scores follows a normal distribution where the mean score was 51.32 (SD = 6.58) and the range of scores were 34 - 67. Fourteen parents (10%) had a score below the 'neutral' point of 42 and 128 parents (90%) had scores above this marker suggesting the majority of parents were more likely to select responses about their likely adherence that were in keeping with concussion recommendations. For teachers, the mean score was 54.63 (SD = 6.77) and the range was 33 - 65. Two (5%) teachers score below the 'neutral' total of 42 and 39 teachers (95%) scored above.

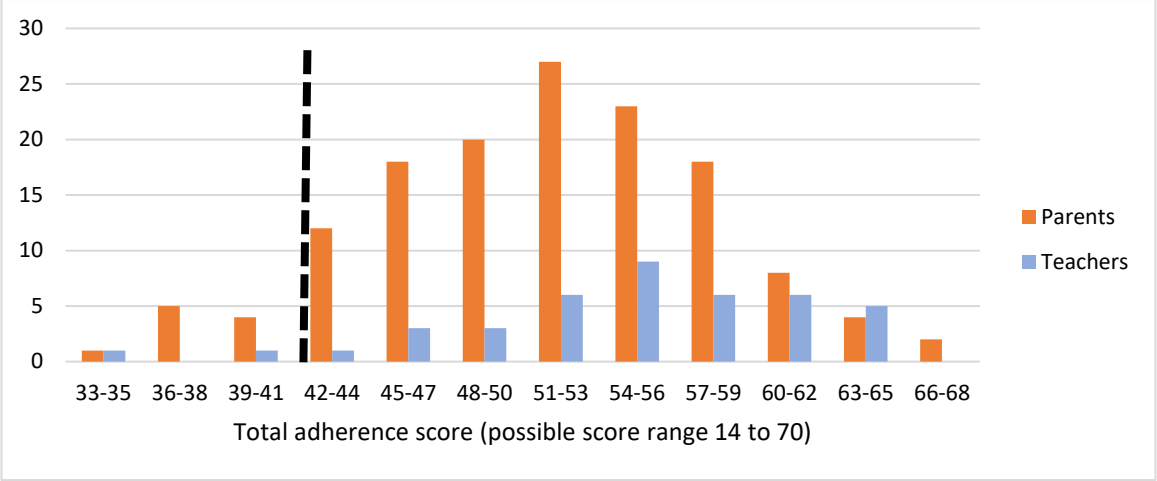

Figure 5. Frequency of parent and teacher scores for likely adherence to concussion guidelines

RQ3: Do parents and teachers score differently on measures of knowledge, perceived severity, and perceived susceptibility?

Independent samples t-tests were performed, and Table 6 indicates there were no significant differences in knowledge scores, perceived severity or perceived susceptibility between teachers and parents.

Table 6

Range, means, SDs and group differences for concussion knowledge, perceived severity and perceived susceptibility

	Teachers observed score range (possible range)	Teachers (N = 44)	Parents observed score range (possible range)	Parents (N = 144)	Group effect (two-tailed)
Knowledge, Mean (SD)					
Acute concussion symptoms	4-6 (0-6)	5.05 (0.68)	3-6 (0-6)	5.02 (0.82)	t(186) = 0.180, p = 0.857
Persistent-Post Concussion symptoms	2-6 (0-6)	4.80 (0.95)	2-6 (0-6)	4.81 (0.81)	t(186) = -0.070, p = 0.945
Return to Normality guidelines	4-10 (0-12)	7.14 (1.49)	3-11 (0-12)	6.80 (1.62)	t(186) = 1.230, p = 0.220

	Teachers observed score range (possible range)	Teachers (N = 44)	Parents observed score range (possible range)	Parents (N = 144)	Group effect (two-tailed)
Perceptions, Mean (SD)					
Perceived severity	25-38 (9–45)	30.11 (2.94)	24-38 (9–45)	29.37 (2.68)	t(186) = 1.565, p = 0.119
Perceived susceptibility	16-27 (6-30)	22.00 (2.27)	16-26 (6-30)	22.17 (2.43)	t(186) = -0.422, p = 0.674

Perceived barriers, perceived benefits, cues to action and self-efficacy

Responses for “strongly agree” and “somewhat agree” were combined, as were responses “strongly disagree” and “somewhat disagree” to make interpretation concise. The total number of participants for these measures were as followed: perceived barriers (teachers, N = 41 and parents, N = 141), perceived benefits (teachers, N = 40 and parents, N = 140), cues to action (teachers, N = 40 and parents, N = 137) and self-efficacy (teachers, N = 40 and parents, N = 137).

Teachers. The most frequently agreed with barriers were: “I do not know enough information already about concussion recovery to effectively support them in the classroom” (N = 30) and “I would find it difficult to provide a quiet workspace for them to learn” (N = 24). Teachers identified the following benefits most frequently: “The child may recover without long term problems” (N = 36), “The child is less likely to have mental health difficulties related to their concussion” (N = 33), and “The child is less likely to sustain a more serious second concussion within the first few weeks of recovery” (N = 33). The least identified benefits related to how others perceived them including other teachers, healthcare providers and parents. Teachers most frequently reported that the following would prompt them to follow the recommended guidelines for concussion “If I was informed by my school of the guidelines” (N = 39), and “If I was told about the long-term consequences

of child concussion" (N = 38). The following statement was the most frequently agreed item by teachers on the self-efficacy measure, "I would need further training in supporting a child to return to activities after a concussion" (N = 38)

Parents. The most frequently agreed with barriers were: "I do not know enough information already about concussion recovery to effectively support them" (N = 84) and "I would find it difficult to limit my child's activities" (N = 72). Parents identified the following benefits most frequently: "My child could recover without long term problems" (N = 127), "My child is less likely to have mental health difficulties" (N = 119) and "My child is less likely to sustain a more serious second concussion within the first few weeks of recovery" (N= 119). The least identified benefits related to how others perceived them including other family, friends and professionals. They most frequently reported that the following would prompt them to follow the recommended guidelines for concussion: if the child's "teacher was noticing problems at school" (N = 133), "if I was told to by a health professional" (N = 132) and "if I was told about the long-term consequences of child concussion" (N = 132). The following statements were most frequently agreed by parents on the self-efficacy measure, "I would be able to ask my GP for help if I needed further guidance on how to follow the recommendations" (N = 116) and "I would be able to identify when a child needed more breaks or quiet time."

RQ 4: Do constructs in the Health Belief Model predict likely adherence to 'Return to Normality' guidelines by teachers and/or parents?

The required sample size was obtained to complete regression analysis using parent data. The teacher sample recruited was not large enough to run a regression with sufficient statistical power. A correlational matrix for parent data and HBM variables is reported in Appendix L. Residual and scatter plots were examined for parent data which indicated the assumptions of normality, linearity and homoscedasticity were all satisfied. No extreme outliers were identified. Leverage values and Cook's distance values were also calculated for case influence and Durbin Watson test for the independent error's

assumption (value was between 1-3) was explored. An examination of the correlations revealed no independent variables were highly correlated and Variance Inflation Factor (VIF) values were all below 5 indicating no significant multicollinearity [53].

The regression statistics are reported in Table 7. The analysis reveals model one is the only significant model, $F (4, 130 = 5.223, p < 0.001$ and explains 11.2% of variance in likely adherence to concussion guidelines by parents. Perceived barriers ($\beta = 0.459, p < 0.001$) and perceived susceptibility ($\beta = 0.536, p = 0.013$) are significant predictors of likely adherence. These two variables remained significant predictors in models two and three after the addition of demographic variables, perceived stress and concussion knowledge. Concussion knowledge is also revealed to be a significant predictor in model three ($\beta = 0.601, p = 0.016$).

Table 7

Summary of Multiple Regression Analysis for variables predicting likely adherence

	β	**t**	**p-value**	**L CI**	**U CI**	**R^2**	**Adjusted R^2**
Model One			**<0.001****			**0.138**	**0.112**
Perceived Severity	0.219	1.153	0.251	-0.157	0.595		
Perceived Susceptibility	0.536	2.521	0.013*	0.115	0.956		
Perceived Barriers	0.459	3.811	<0.001**	0.221	0.698		
Perceived Benefits	-0.024	-0.253	0.801	-0.214	0.165		
Model two			**0.258**			**0.156**	**0.117**
Perceived Severity	0.191	1.002	0.318	-0.186	0.567		
Perceived Susceptibility	0.560	2.621	0.010*	0.137	0.982		
Perceived Barriers	0.407	3.098	0.002*	0.147	0.667		
Perceived Benefits	-0.060	-0.614	0.540	-0.254	0.134		
Perceived Self-efficacy	0.147	0.789	0.432	-0.222	0.516		
Perceived Cues to Action	0.276	1.167	0.245	-0.192	0.743		
Model Three			**0.246**			**0.232**	**0.135**
Perceived Severity	0.164	0.835	0.406	-0.225	0.552		
Perceived Susceptibility	0.529	2.459	0.015*	0.103	0.954		
Perceived Barriers	0.409	3.001	0.003*	0.139	-0.103		

	β	t	p-value	L CI	U CI	R^2	Adjusted R^2
Perceived Benefits	-0.059	-0.603	0.548	-0.254	0.135		
Perceived Self-efficacy	0.210	1.097	0.275	-0.169	0.590		
Perceived Cues to Action	0.192	0.770	0.443	-0.302	0.687		
IMDD	-0.103	-0.482	0.631	-0.529	0.322		
Perceived Stress	0.046	0.547	0.586	-0.120	2.111		
Age group 2 (DC)	-0.017	-0.013	0.990	-2.672	2.637		
Age group 3 (DC)	1.810	1.129	0.261	-1.363	4.983		
Age group 4 (DC)	2.849	0.852	0.396	-3.773	9.471		
Education Level 2 (DC)	0.526	0.299	0.766	-2.961	4.013		
Education Level 3 (DC)	0.084	0.51	0.959	-3.134	3.301		
Education Level 4 (DC)	1.439	0.875	0.383	-1.816	4.695		
Concussion Knowledge	0.601	2.442	0.016*	0.114	1.089		

Note. *p<0.05, **p<.001

Associations between Health Belief Model variables for teachers

Correlation analysis was completed for the teacher sample to explore the relationship between HBM variables and likely adherence. Table 8 shows a weak positive correlation was found between likelihood to adhere to concussion guidelines and self-efficacy (r = 0.34, p = 0.040) which was significant (p < 0.05) before corrections for multiple comparison but not after adjustment. A significant moderate correlation between likelihood to adhere and perceived barriers to following concussion guidelines (r = 0.50 p = 0.002) remained significant after corrections suggesting less perceived barriers is associated with higher adherence to concussion guidelines. Non-significant, weak positive correlations were also found between perceived severity and adherence (r = 0.32) and cues to action and adherence (r = 0.24).

Table 8

Correlations between likelihood to adhere and other HBM variables for teachers

	Total Adherence Score
Indices of Multiple Deprivation Decile	-.041

	Total Adherence Score
Years qualified	.186
Total Concussion Knowledge Score	-.168
Perceived Stress Scale	-.060
Perceived Severity	.315
Perceived Susceptibility	.017
Perceived Barriers	.497*
Perceived Benefits	.079
Cues to Action [1]	.238
Self-efficacy	.339

Note. [1]non-parametric correlation used, * = correlation significant at 0.005 (corrected for multiple comparisons)

Discussion

This is the first study to explore knowledge and perceptions of concussion, PPCS, and likely adherence to child concussion guidelines in a sample of UK parents and teachers that is not solely focused on sports-related concussion. This study tested the applicability of the HBM to likely adherence to help inform future policy, educational resources and support for families and schools.

Key results and interpretation

Participants demonstrated good knowledge of both acute concussion symptoms and PPCS and as highlighted in existing research, knowledge for acute symptoms was slightly better. Both groups showed less knowledge for return to normality recommendations which is consistent with sports-related literature that suggests awareness of concussion management needs improving [26, 54, 55]. Furthermore, the largest self-reported barrier to following guidelines for both participant groups, was a perceived lack of knowledge of how to support a child during recovery.

Interestingly, most teachers (95%) and parents (90%) provided responses on the vignette adherence measure that were largely in keeping with the recommended advice. This is an important discovery as it indicates that despite their low knowledge of guidelines, they are still likely to adhere to the recommended advice. It is possible that the answers participants gave in a hypothetical situation may differ to their actual behaviour when other life

demands are present. Additionally, no participant scored a ‘perfect’ score (e.g., 70/70) on the vignette measure of adherence and the most frequent score was 51-53 out of 70. This highlights that no participant gave answers that were 100% aligned to the recommended advice and further education on the guidelines may still be useful given the potential implications for children if they return to activities, sports and school too soon.

The study explored the application of the HBM to likely adherence of concussion guidelines. The planned analysis was not possible with teachers due to small sample size, however, correlation analysis indicated fewer perceived barriers is associated with higher likely adherence in teachers. For parents, partial support of the HBM was found with the original HBM constructs (perceived barriers, benefits, severity, and susceptibility) explaining 11.2% of variance in likely adherence to concussion guidelines. Perceived barriers, perceived susceptibility and concussion knowledge were revealed as significant predictors of likely adherence. Perceived barriers was the most significant predictor which is in keeping with evidence that has regularly shown perceived barriers to be the strongest predictor of health behaviour using the health belief model [12]. The most agreed with barriers for teachers were difficulties in providing one-to-one support, knowing enough information about concussion recovery to effectively support children in the classroom and difficulties in being able to provide a quiet workspace for the child to learn. The most agreed with barriers for parents were not knowing enough information about concussion recovery, difficulties taking time off work and being able to limit their child’s activities. A systematic review [56] revealed that the HBM was estimated to explain on average 24% of the variance in outcome variables across a broad range of illnesses and injuries. The present study reveals a model explaining 11.2% of variance indicating a substantial proportion of likely adherence by parents remains unaccounted for, which could be attributable to measurement error or other variables aside from the HBM and demographics.

This study highlighted a need for increased awareness of childhood concussion in parents and teachers. Ninety-three percent of teachers indicated they would need further training to be able to support a child to

return to activities after concussion. Furthermore, 82% of teachers were unaware if their school had return to learn guidelines which was higher than in a US study which reported a figure of 64% [23]. These findings may represent a lack of awareness by teachers that the guidelines exist within their school or indicate that many schools in the UK do not have guidelines available. Both highlight further concussion training in schools is likely to be beneficial. Another interesting finding from this study is 87% of parents and 91% of teachers stated they were unaware of what persisting symptoms of concussion were, yet they showed reasonable level of knowledge when presented with a forced choice question. This suggests participants may recognise symptoms but may not understand these are representative of PPCS and therefore, the action they may take, if any, to get the child support is unclear.

Strengths and Limitations

To assess the variables of interest in this study, several new measures needed to be developed specific to this population. The measures developed for this study are the first to attempt to measure concussion knowledge, perceptions, and likely adherence in a UK sample of teachers and parents. This is a key strength of this study and offers alternative measures to those available specifically for sports-related concussion. Additionally, several validated measures and published guidelines were consulted to develop the new measures aiming to assess the constructs of interest as sufficiently as possible. The use of vignette-based questions, which are considered a realistic alternative to standard survey items [49], is also a strength of this study and likely to have increased internal validity of this particular measure. The study also benefitted from including a range of stakeholders during the development of survey measures. Professionals and members of the public, some of whom had concussion expertise and/or personal concussion experience, provided a range of perspectives that were invaluable in creating a meaningful, relevant, and targeted survey. Whilst this study dedicated a significant proportion of time developing these measures through expert panels, a literature review and consultation of the current clinical guidelines, these measures have not been validated. The internal consistency of the

HBM measures developed in this study was calculated and low Cronbach alpha values (<0.7) indicated that some of the items are poorly correlated with each other. The interpretation was based on common guidelines [52] however some researchers suggest that a high Cronbach alpha is difficult to obtain when there are less than 10 items on a subscale. Instead, an alpha value above 0.5 is considered acceptable [57]. As part of the validation process for this survey, items within each subscale should be reviewed. This may include eliminating items that are poorly correlated with each other, reviewing the wording of some of the questions or adding in new items. The lack of psychometric data available for these measures makes it difficult to understand the full extent of any measurement error present and determine how valid and reliable these measures are. In a systematic review of the HBM [58] only 16 out of 200 studies were deemed to have measured the HBM components adequately indicating the development of reliable instruments is challenging.

This study had a survey completion rate of 76% which is in keeping with other surveys with a similar number of questions [59]. The study succeeded in recruiting a sufficient sample of parents for the planned analysis but struggled to recruit teachers. The recruitment for this study took place throughout the global pandemic of COVID-19, which is likely to have impacted on both parents and teachers' ability to commit time to take part in research. The small sample of teachers meant that some of the planned statistical analyses could not be conducted and those that were completed were underpowered. This means that results from the teacher sample should be interpreted tentatively until a larger sample is examined.

Whilst this study aimed to survey parents and teachers across the UK that were representative of the population, descriptive statistics revealed 98% lived in England, 90% were female and 94% identified as white. Important differences in gender and ethnicity have been highlighted in concussion research such as white women having safer attitudes towards concussion and mothers having different concussion perceptions to fathers [60]. Additionally, it was hoped that a variety of teachers would complete the survey to represent state funded, fee-paying and special educational needs

(SEN) schools however, data showed most of the teachers recruited taught at state funded schools. Unfortunately, a flaw in the demographics measure meant that teachers were not asked if they worked at a SEN school which would have been useful to increase generalisability of the findings. It was also noted that the samples in this study were highly educated with 60% having at least one degree. This is particularly important to highlight considering one of the variables examined was knowledge and existing research has demonstrated knowledge of concussion increases with level of general education [29]. Whilst an educated sample may be reflective of the typical individuals who partake in research, the underrepresentation of education levels, along with a lack of gender and ethnic diversity, has led to a biased sample in this study limiting the conclusions that can be generalised.

Likely adherence was chosen as the health behaviour outcome over actual adherence in this study and reflects a common challenge within health psychology literature in examining health behaviours as they happen. One reason likely adherence was chosen in this study was to increase sample size. Recruiting families and schools who were actively supporting a child with concussion was likely to be challenging, particularly from healthcare settings that were already facing elevated burden from the pandemic. In addition, to study predictors of health behaviour effectively, longitudinal studies are most suitable as they can measure change over time. Research has indicated that direct experience of concussion can change level of knowledge and perceptions [29, 33, 61, 62] highlighting the limitations of a cross-sectional design. Due to the scope of this study, a longitudinal design was not possible but future research should aim to explore actual adherence behaviour to concussion guidelines and investigate if variables in the HBM change following adoption of the health behaviour e.g., does perceived severity of child concussion change in parents and teachers after they are required to support a child following concussion.

Implications and future research

The results from this study indicate that training and education may be best focused in the areas of concussion knowledge, including information on susceptibility, and perceived barriers as these were unique predictors of likelihood to adhere and therefore change in these cognitions may increase compliance in parents more so than other variables. The findings relating to barriers provide some clear targets for further education around concussion recovery. This may include more information on anticipated recovery timelines which would be helpful for parents in managing their expectations of how much time off work they may need and offer guidance to schools who may need to temporarily reallocate teaching assistants to make classroom adjustments feasible.

In the future, this survey should be piloted in a larger sample. Exploratory factor analysis, criterion validity of the items and reliability assessment should be completed to explore the psychometric properties and validate the survey. In addition, streamlining the vignette statements across both parents and teacher versions or ensuring they both are measuring the desired construct of likely adherence would be beneficial as it would allow direct comparisons of adherence between the two samples.

Whilst this study adds to the limited literature base, future research exploring adherence behaviour may find it useful to apply other models or frameworks such as the theory of planned behaviour [63] or social cognitive theory [64]. Continuing to explore factors in adherence behaviour to concussion guidelines by teachers and parents is warranted as the findings can have important implications such as ensuring children are supported effectively to reduce long term symptoms. Future research should aim to recruit a more diverse sample in terms of gender, ethnicity, education level and type of schoolteacher to explore how these differences may impact knowledge, perceptions, and likely adherence in a UK sample. A more diverse sample will help findings be generalisable and allow support to be targeted to certain individuals depending on who is identified as being least likely to adhere to concussion guidelines.

Conclusion

Overall, this study highlights that a sample of mostly white, well-educated, female parents and teachers have good knowledge of acute concussion symptoms and PPCS but less knowledge for return to normality guidelines on forced choice questions. The reduced knowledge around return to normality guidelines in this study is consistent with literature relating to sports concussion and return to play recommendations. All participants closely adhered to guidelines on a measure of likely adherence and perceived barriers, perceived susceptibility and concussion knowledge were revealed as significant predictors of likely adherence in parents. These findings extend previous research that has focused on sports-related concussion and non-UK samples and highlight areas where educational resources, guidelines and support can be modified to increase likely adherence by a child's support system during their recovery from concussion. Future research should aim to recruit a larger sample of teachers to determine predictors of their likely adherence, improve diversity of the sample recruited and consider the application of other health models to understanding this health behaviour.

Disclosure of interest

The authors report no conflict of interest

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Chapter Four:

Extended Methodology

Chapter Four: Extended methodology

Systematic Review

-None

Empirical Research Study

Survey development

A significant and time-consuming element of this project was the development of the survey. A thorough search was initially conducted looking for studies that used surveys to explore concussion and persistent post-concussion symptoms (PPCS). Many of these focused on sport-related concussion only, targeted sports coaches as the population or did not include all constructs that were of interest in the present empirical paper. Therefore, a new set of measures were required to explore the Health Belief Model (HBM) variables and likely adherence behaviour in the target population.

General Survey Design

Two versions of the survey were created: one for parents (Appendix H) and one for teachers (Appendix I). The overall survey was designed to take no more than 25 minutes with the aim of reducing drop-out (Cape & Phillips, 2015). Within this timeframe, it was considered that 60 items could be reasonably completed (Hopper, 2017). To adequately cover each variable of interest, it was determined that 4-7 items per HBM variable would be included up to a total of 48. In addition, a short vignette would be presented with 12 corresponding items to measure likely adherence to concussion guidelines. To reduce missing data, the items were formatted in a way that requires an answer before the participant was able to progress in the survey.

New Survey Measures

As highlighted in the main empirical paper, items for the new measures were modified from existing, validated measures and/or widely accepted clinical guidelines, wherever possible. This was felt to be justified given the scope of the current thesis in which validation of several new measures would not be feasible prior to data collection. In addition to what is described in the main empirical paper, a list of the items adapted from resources is presented in Table 9. These were reworded to be non-specific to sports concussion (e.g., “A concussion only occurs when the student-athlete

loses consciousness (blacks out)" replaced with "Concussion can only occur if a child blacks out or loses consciousness"), to reflect updates in the diagnostic criteria (e.g. "Symptoms of a concussion can last for several weeks" replaced with "Concussion can sometimes result in problems lasting more than 4 weeks for children") and to directly mention children as the population of interest (e.g. "A concussion can only occur if there is a direct hit to the head" replaced with "A child can have concussion without a direct hit to their head"). Existing items were described to assess perceived severity and susceptibility within the original study (Rosenbaum & Arnett, 2010).

Items for the other HBM constructs (perceived barriers, benefits, cues to action and self-efficacy) were generated from discussion with stakeholders including parents, teachers, and professional healthcare staff. Six meetings in total focused on the development of the survey items. Prior to these meetings, stakeholders were asked to review each measure to consider if items appeared to measure the construct it was intended to. They were invited to suggest additional items and these were implemented where agreed on by the supervisory team (e.g., a parent highlighted that a benefit to adhering to the guidelines could be that there child would potentially be able to help others in the future). One meeting was held with an occupational therapist working in brain injury, one with a parent whose child had sustained a concussion and two meetings with two different physical education teachers. The draft measures were discussed with the research team (an experienced neurophysiologist with expertise in mTBI, MG; and a consultant clinical neuropsychologist with expertise in child brain injury rehabilitation, FG) iteratively until there was agreement on items within each construct.

The vignette that measured adherence was devised with the supervisory team and discussed with the stakeholders to determine if they felt enough detail was provided and if it felt like a realistic scenario. It was ensured that both the teacher and parent versions contained the same key information e.g., age and gender of child, cause of injury, and that help was sought from a doctor, to attempt to reduce the possibility of confounding variables affecting the results between groups.

Table 9

Items modified from other published measures

Study Measure	New item	Original item	Source of original item
Perceived Severity	There is a possible risk of death if a second concussion occurs before there is a full recovery from the first.	There is a possible risk of death if a second concussion occurs before the first one has healed.	ROCKAS-ST (Rosenbaum & Arnett, 2010)
Perceived Severity	Concussion is only serious if a child loses consciousness/blacks out.	Being knocked unconscious always causes permanent damage to the brain.	ROCKAS-ST
Perceived Severity	Concussion can sometimes result in problems lasting more than 4 weeks for children.	Symptoms of a concussion can last for several weeks.	ROCKAS-ST
Perceived Severity	A full recovery from concussion is typically complete within one week for children.	a. After 10 days, symptoms of a concussion are usually completely gone. b. Recovery from an SC is usually complete in about a week	a. ROCKAS-ST b. Sports Concussion Knowledge Scale (Weber & Edwards, 2012)
Perceived Severity	Concussion in children should be taken seriously by others.	A concussion requires immediate removal from a game or practice.	BAKPAC-TEACH (Kasamatsu et al., 2017)

Study Measure	New item	Original item	Source of original item
Perceived Severity	Concussion is a minor brain injury.	A sports concussion is harmless and never results in long-term problems or brain damage.	Sports Concussion Knowledge Scale
Perceived Susceptibility	A child is less likely to sustain another concussion if they've already had one.	People who have had one concussion are more likely to have another concussion.	ROCKAS-ST
Perceived Susceptibility	Concussion can only occur if a child blacks out or loses consciousness.	A concussion only occurs when the student-athlete loses consciousness (blacks out).	BAKPAC-TEACH
Perceived Susceptibility	A child can have concussion without a direct hit to their head.	A concussion can only occur if there is a direct hit to the head.	ROCKAS-ST
Perceived Susceptibility	Girls are more likely to experience concussion than boys.	A sports concussion affects men's and women's brains differently	Sports Concussion Knowledge Scale

Reviewing and Piloting the Survey

A wide range of stakeholders reviewed and provided feedback on the survey developed. Feedback from parents, teachers, and individuals with experience of concussion (personal or professional) resulted in the development of a meaningful, easy to read and clear survey. Suggestions that were implemented included rewording text on the information sheet and vignettes, as well as adding simple explanations throughout e.g., a sentence

was added to introduce the Perceived Stress Scale and assist participants to the next set of questions. Furthermore, an extra option for gender demographics (“prefer not to say”), justification of postcode information, and extra survey items (e.g., “The child would be able to share information with other children on how to manage after concussion”) were added.

The measures were piloted with 7 individuals (3 parents, 3 teachers and 1 postgraduate student) to review the timing, survey structure and wording. All individuals completed the survey within 16 minutes, and it was decided that 20 minutes would be sufficient time for participants of differing reading abilities.

Patient and Public Involvement (PPI)

In addition to PPI in the survey development, the research team liaised with Headway Norfolk, UK Acquired Brain Injury Forum (UKABIF) and the Child Brain Injury Trust (CBIT). Meetings with these organisations offered valuable advice in the development of this study and provided insight into other projects currently exploring concussion in schools. Both UKABIF and CBIT are part of the National ABI Education and Learning Syndicate (N-ABLES) which is a steering group set up to support education professionals to gain a minimum level of awareness of Acquired Brain Injury (ABI) and the educational requirements of children and young people with this condition. Both organisations, as well as Headway Norfolk, expressed a wish to support the dissemination of study findings to increase visibility and improve awareness of Persistent Post-Concussion Symptoms.

All members of the research team are part of the Concussion Action Programme (CAP) supported by UEA Health and Social Care Partners. One of CAP’s aims is to raise awareness of concussion and reduce risks related to concussion in school children. The lead researcher presented the study at a meeting and gained useful guidance in developing this study. Additionally, CAP will be approached during the dissemination stage to ensure findings are wide-reaching.

Recruitment

Regional schools were selected from www.theschoolswebdirectory.co.uk which holds contact data for over 30,000 UK schools. In an excel sheet, counties were randomly sorted using the ‘sort’

function and the top 10% were chosen in England, Wales, and Scotland. Using the same method, schools within these counties were sorted and selected. The lead researcher used a standardised email (Appendix M) to contact thirty-two schools to provide information on the study and attach a study poster (Appendix N). Within the email it was suggested to schools to disseminate the study survey link using email databases and newsletters to promote the study. Due to the ongoing pressure on schools during the pandemic, many schools did not respond to the email, several apologised that they did not have the time at present to contribute and one school responded to say they would disseminate the survey link with their teachers and parents. Meetings were also held with a course director in the School of Education at the university to explore opportunities for further recruitment of teachers that offer placements for students. Unfortunately, due to the global pandemic and pressure on schools during the study period, these options did not materialise.

The study was also advertised on social media platforms using the same poster. On Twitter, tweets were pre-planned to make regular posting simple. Additionally, a variety of Twitter accounts were tagged in posts to encourage re-tweeting of the post with the aim of reaching more potential participants. Tagged accounts included school organisations, parent groups and brain injury organisations. The study poster was also advertised at a University Sports Centre on a television in the reception.

Detailed procedure

Participants could access the survey through a link included in the advertised materials or social media posts. They were greeted with an information page (Appendix O) and instructed to read the information. If participants gave consent to participate, they were asked to click the “START SURVEY” button. The demographic questions (Appendix P) were the first to be completed. This was when participants had to select whether they were participating as a teacher or parent. The version of the survey participants saw was dependent on this selection. Participants then completed the Perceived Stress Scale (Cohen et al., 1983), measures of concussion knowledge, concussion perceptions and likely adherence. Next, participants viewed a page thanking them for their time and were provided with

information on the second study that aimed to explore feasibility and acceptability of using an educational resource with parents and teachers. Participants were given two options on how they would like to proceed; “I would like to contribute further to this study and consent to be contacted in four weeks' time to complete Stage 2 of this study. (Please note you will need to provide your email address on the next page)” or “I would not like to contribute further to this study and do not consent to be contacted in four weeks' time to complete Stage 2 of this study.”. Participants who consented to take part in the second study were asked to provide their email address on the next page. All participants then viewed information on the prize draw and those who wished to be entered, were required to enter their email address. On the next page, participants were asked to provide their email address if they would like a summary of study findings. The study was formatted to not require the email to be entered again if already provided. Finally, all participants saw the debrief screen with sources of support (Appendix Q).

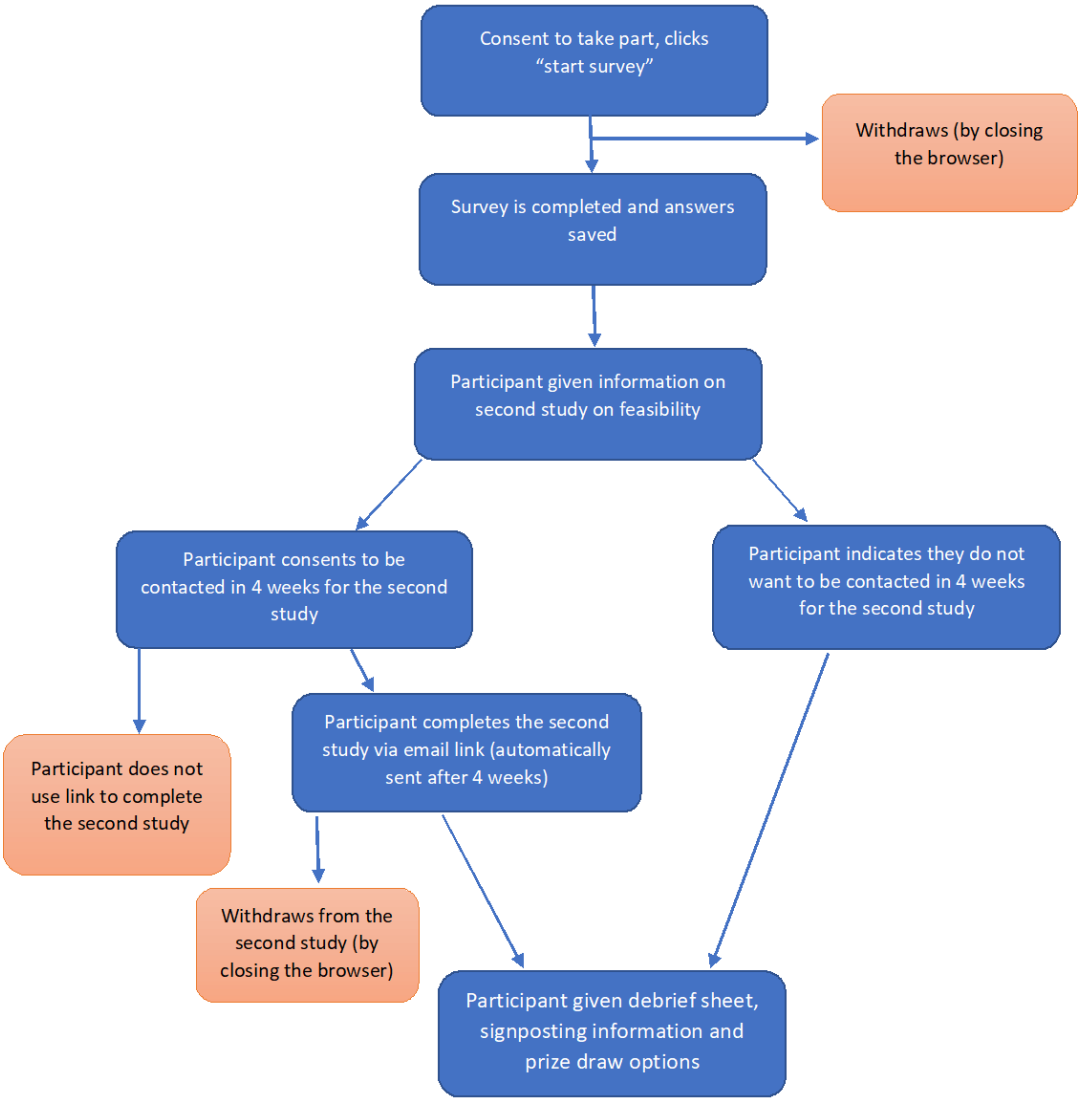

Figure 6. A participant's journey through the study

Ethical Considerations

Gatekeeper consent. Written gatekeeper consent was sought (e.g., from group administrators on social media sites) before researchers posted study information for recruitment. Gatekeeper consent was also obtained from a course director prior to ethical approval however as previously mentioned this avenue for recruitment did not progress due to pressure on schools during the global pandemic.

Informed consent and right to withdraw. Research sites and individual respondents were provided with the necessary information to make an

informed decision to participate. Respondents read the following statement prior to starting, “By clicking START SURVEY I understand that I consent to my responses being used within this study and that I can withdraw at any point by closing the browser”. Respondents were informed that they had the right to withdraw from the survey at any point by closing the browser. As a token of gratitude for taking the time to complete the survey, participants were offered the option of entering a prize draw which included a chance to win one of four £25 Love2Shop vouchers. The number of entries participants received was reflective of the time commitment given by participants e.g., participants received one entry for taking part in the empirical study and two entries for completing both the main empirical study and the second empirical study surveys. Participants did not have to provide their details if they did not want to be entered into the prize draw. There was no deception or coercion to respondents.

Confidentiality. All data was anonymous and no personal information was gathered as part of the survey data. Recruitment for participants was facilitated within schools or via social media meaning no individual participant contact details were viewed by the research team during the recruitment phase. Respondents had the option to provide their email address at the end of the survey if they wished to receive a summary of the findings or wished to enter the prize draw. At no point were email addresses and individual datasets linked. To trace participants through the main empirical study and the second empirical study, anonymity codes were generated for all participants and emailed to those who opted into the second study. Confidentiality was upheld, in line with the Data Protection Act (2018).

When the survey closed, the dataset and any non-anonymised participant information (email addresses) were exported separately to password protected Excel files and stored on a secure part of the UEA secure server (OneDrive for Business, a secure, cloud-based storage system approved by the UEA data management policies). Access to all study files was restricted to the research team. The account with Qualtrics was deleted in order to remove the data from the server storage. In accordance with UEA Research Data Management policy, data will be kept on a secure server at UEA for no less than 10 years. As postcode was requested as part of the

demographic section of the survey, as soon as the socioeconomic status was determined using the Indices of Multiple Deprivation, the post code data was deleted. Email addresses will be erased after the summary of findings are sent and the prize draw completed which is estimated to take place in September 2022.

Distress and debrief. The proportion of individuals with direct concussion experience was anticipated to be minimal and it was perceived that the content of the survey was unlikely to cause distress. Nonetheless, in keeping with BPS (2014) guidance, all participants viewed a debrief sheet with resources at the end of the study (Appendix Q) to ensure they felt supported. Participants were advised to seek support from their GP or NHS Direct if they believed they or someone else may have recently suffered concussion. Whilst there was a plan in place to signpost individuals to appropriate support resources if they contacted the researcher during the study, no participant contacted the researcher.

Sample size calculations

The study aimed to recruit as many participants as possible in the timeframe available. In order to establish the minimum sample sizes required to complete appropriate statistical analyses, a series of priori power analysis using GPower3 (Faul et al., 2007) were conducted. To detect medium effects with 80% statistical power and 5% alpha level it was calculated that a minimum sample size of 84 in each group was required for bivariate analysis (correlations, two-tailed) and 128 for independent sample t-tests (two-tailed).

Carpenter (2010) conducted a meta-analysis of 18 studies that used HBM constructs to measure prospective behaviour and found the average effect size detected between perceived severity, perceived benefits, perceived barriers, and health behaviour were of medium effect size (r = 0.15, 0.27 and 0.30, respectively). Small effects for perceived susceptibility and health behaviour were reported. A minimum sample size of 139 was determined using GPower3 to detect medium effects with 80% statistical power, 5% alpha level and up to 15 predictors. A statistician was consulted, and it was advised that a multiple linear regression was completed to allow comparison of individual variables which could be entered into the models selectively.

Data transformation

Prior to exporting data from Qualtrics, reverse scoring was applied to some questions that were negatively phrased to transform high scores to low scores. In addition, scores were assigned to some questions e.g., answers in the concussion knowledge section were allocated a score of one if the answer was correct, all incorrect scores obtained zero. Total sores for each survey section were also calculated.

To determine socioeconomic status, postcodes were entered into the English, Welsh and Scottish government websites where the Indices of Multiple Deprivation Deciles could be obtained. Data is based on the “English indices of deprivation 2019” (*Office for National Statistics*, 2019), “Scottish Index of Multiple Deprivation 2020v2” (*Office for National Statistics*, 2021) and “Welsh Index of Multiple Deprivation 2019” (*Office for National Statistics*, 2019). There was no Northern Irish (NI) database to obtain the one NI postcode provided.

Chapter Five:

Extended Results

Chapter Five: Extended results

Systematic Review

-None

Empirical Research Study

In addition to the results presented in the main empirical paper, additional information is reported here on the sample including missing data, time taken to complete the survey and drop-out characteristics.

Missing data. Twenty-five responses were less than 5% complete meaning these participants exited the survey after the information page and before the demographic questions. Eleven responses were less than 15% complete indicating they exited the survey after the demographic questions. A further 9 responses discontinued the survey during the concussion knowledge section. Of the 20 responses that had some demographic information complete, 15 had identified either parent (N = 8) or teacher (N = 7) status. All information below, except for the completers and non-completers section, refers to the 188 participants left in the dataset for analysis. Data could not be reported for sociodemographic status for four participants as three did not provide their postcode and one had a Northern Irish postcode where Indices of Multiple Deprivation Deciles could not be comparably calculated.

Time taken to complete survey. There were seven outliers that took between 2.5 hours and two days to complete the survey. With these outliers removed, the average time taken to complete part one of the survey was 18.1 minutes. Eleven participants completed the survey in under eight minutes which was half the time taken during survey trials. These responses were briefly explored, specifically their total concussion knowledge score to determine to some extent whether their answers had been thoughtfully considered. All eleven had a mean concussion knowledge score within two standard deviations of the sample mean and therefore, remained in the dataset for analysis.

Completers vs non-completers. Twenty participants (10.6%) discontinued the survey after the demographic questions. There was no significant difference in gender between completers and non-completers, $X^2(1) = 0.458$, $p = 0.451$, two tailed Fisher's Exact Test. Chi-square analysis was not completed on other variables due to expected frequencies in each cell being below 5. Table 10 shows most participants who did not complete the survey were aged between 25 and 34 (40%), white (80%), had completed at least a bachelor's degree (50%) and employed full-time (65%). Nineteen had heard the term concussion before and thirteen were first aiders. Three had received formal training about concussion. Similar percentages of direct and indirect concussion and moderate to severe brain injury were reported in non-completers in comparison to completers.

Table 10

Sample characteristics of completers versus non-completers

	Completers (N = 188)	Non-completers (N = 20)
Age, N (%)		
16-24	5 (2.6)	3 (15.0)
25-34	52 (27.5)	8 (40.0)
35-44	85 (45.0)	6 (30.0)
45-54	38 (20.1)	3 (15.0)
55-64	7 (3.7)	0
65+	1 (0.5)	0
Females, N (%)	169 (89.9)	17 (85)
Ethnicity, N (%)		
Black/African/Caribbean	0	1 (5.0)
Asian	4 (2.1)	3 (15.0)
Mixed/Multiple ethnic	3 (1.6)	0
White	177 (94.1)	16 (80.0)
Other	3 (1.6)	0
Prefer not to say	1 (0.5)	0
Highest qualification, N (%)		

	Completers (N = 188)	Non-completers (N = 20)
No qualifications	4 (2.1)	0
Secondary school Further	19 (10.1)	4 (20.0)
education	33 (17.6)	2 (10.0)
Bachelor's level	79 (42.0)	10 (50.0)
Masters level or above	53 (28.2)	4 (20.0)
Employment, N (%)		
Full-time	78 (41.5)	13 (65.0)
Part-time	65 (34.6)	3 (15.0)
Self-employed Full-time	7 (3.7)	0
Self-employed Part-time	9 (4.8)	0
Retired	2 (1.1)	0
Homemaker	16 (8.5)	1 (5.0)
Student	8 (4.3)	1 (5.0)
Unable to work/ unemployed	3 (1.6)	1 (5.0)

Note. Completers refer to participants who continued the survey past the demographic section

Likelihood to adhere. The individual survey items for the parent and teacher vignettes were explored to see if there were common items that generated a response not in keeping with the recommended guidelines for RTN after concussion. Forty-eight percent of teachers agreed they would leave 'James' sitting on a middle table with his five friends and 37% agreed they would set 'James' the same tasks as all the other children. On the parent measure, 32% of parents indicated they would allow 'James' to watch as many films as he likes whilst he recovers, even though screen time is recommended to be limited during the first few days according to guidelines. Forty-one percent of parents reported they would restrict physical games for the first 24 hours but would allow 'James' to re-join after this period. Current guidelines suggest physical games and play should be avoided for two weeks after child concussion. Sixty percent of parents indicated they would allow 'James' to read his favourite books straight away during his recovery from concussion and thirty-three percent would allow 'James' to play his

computer games after 24 hours, both of which are not in keeping with health recommendations. Twenty-six percent of parents reported they would have no concerns about 'James' taking a maths test four days after concussion and 28% would not support a phased return to school over one to two weeks.

Perceived barriers, perceived benefits, cues to action and self-efficacy. Except for perceived benefits, the neutral option was selected by 2-20% of participants per survey item. This indicates that individuals frequently had a favoured opinion for most survey items. The proportion of neutral responses observed in this study is in keeping with survey literature. Neutral responses are considered by some to reflect either a participant's ambivalence to the question, avoidance of cognitive effort, social desirability or genuinely not having a favoured or unfavoured response to the question. For the perceived benefits section, two items on the teacher survey and two items on the parent survey obtained neutral responses by more than 20% of participants. On the teacher survey, neutral responses were selected by 27% of participants for the item "I will be more positively thought of by the child's parents" and by 42% of participants for the item "I will be more positively thought of by health professionals". On the parent survey, the item "I will need to take off less time in the future months to look after them" resulted in 23% participants selecting the neutral response and the item "I will be positively thought of by others e.g. family, friends and professionals" was answered neutrally by 30%.

Whilst an overview of the most agreed with statements has been reported in the main paper, we wanted to explore the dataset further and extract information that may be of clinical relevance e.g., any barrier that is agreed with by participants is a potential area to target support and training. The following figures indicate the frequency of responses for all survey items and the breakdown of these responses. Responses for "strongly agree" and "somewhat agree" were combined, as have responses "strongly disagree" and "somewhat disagree" to make interpretation concise. The total number of participants for these measures were as followed: perceived barriers (teachers, N = 41 and parents, N = 141), perceived benefits (teachers, N =

40 and parents, N = 140), cues to action (teachers, N = 40 and parents, N = 137) and self-efficacy (teachers, N = 40 and parents, N = 137).

***Barriers of following concussion guidelines*.**

Teachers. Figure 7 shows responses from teachers indicating all barriers presented in the survey had some agreement among teachers. Participants agreed that they would struggle to seek the right help from their school (N = 11, 27%), to offer one to one support (N = 19, 46%) and provide a quiet workspace for the child (N = 24, 59%). The least agreed with barrier was finding it difficult to facilitate a phased return to school (N = 5, 12%).

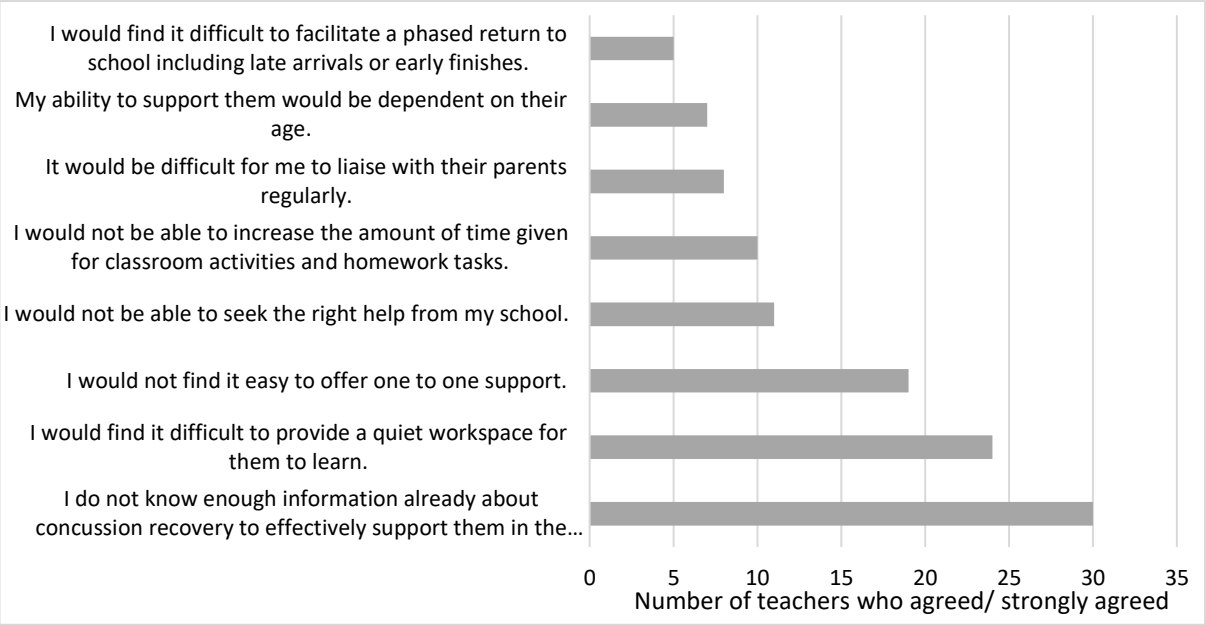

Figure 7. Frequency of teacher responses for perceived barriers to following concussion guidelines

Parents. Figure 8 also shows all barriers presented had some agreement from some parents. Participants agreed that providing a quiet environment at home (N = 36, 26%), taking up to one week off work (N = 61, 43%) and limiting their child's activities would be difficult (N = 72, 51%). Parents also indicated that the support they could provide would be dependent on the child's age (N = 58, 41%). The least agreed with barrier was finding it difficult to implement changes in their child's daily routine due to their own health difficulties (N = 5, 4%).

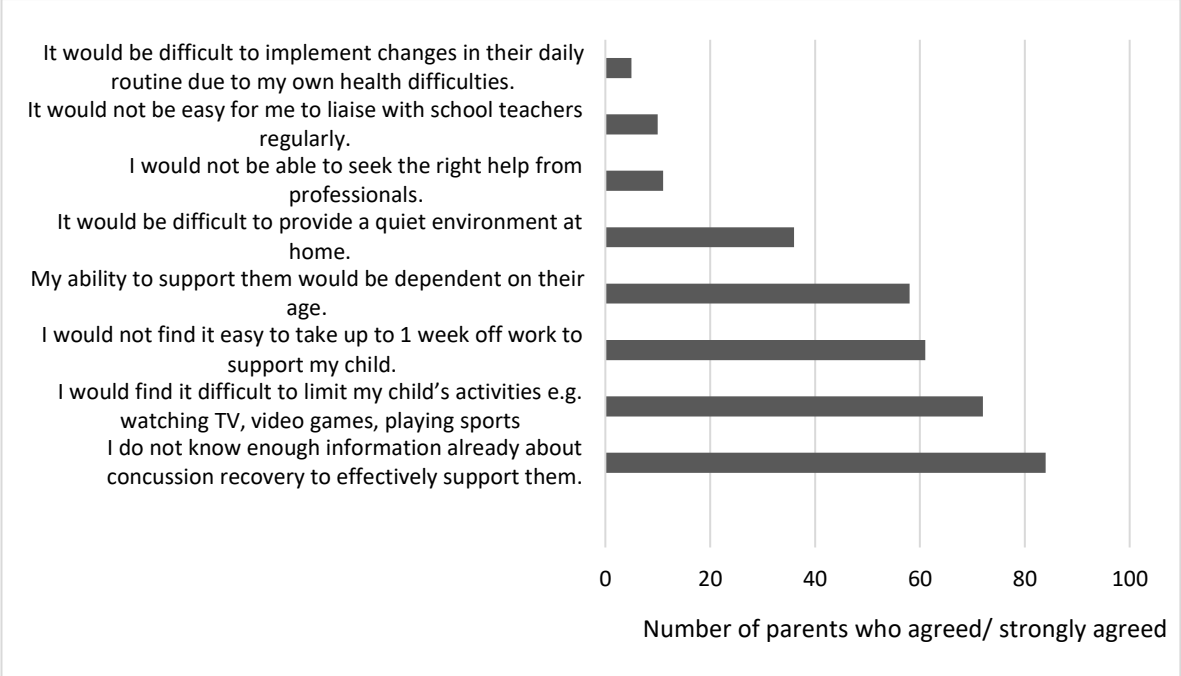

Figure 8. Frequency of parent responses for perceived barriers to following concussion guidelines

***Benefits of following concussion guidelines*.**

Teachers. Figure 9 shows the benefit statements with the least agreement by teachers were "I will be more positively thought of by health professionals" (N = 12, 30%), "I will be positively thought of by teaching colleagues" (N = 14, 35%) and "I will be more positively thought of by the child's parents" (N = 18, 45%).

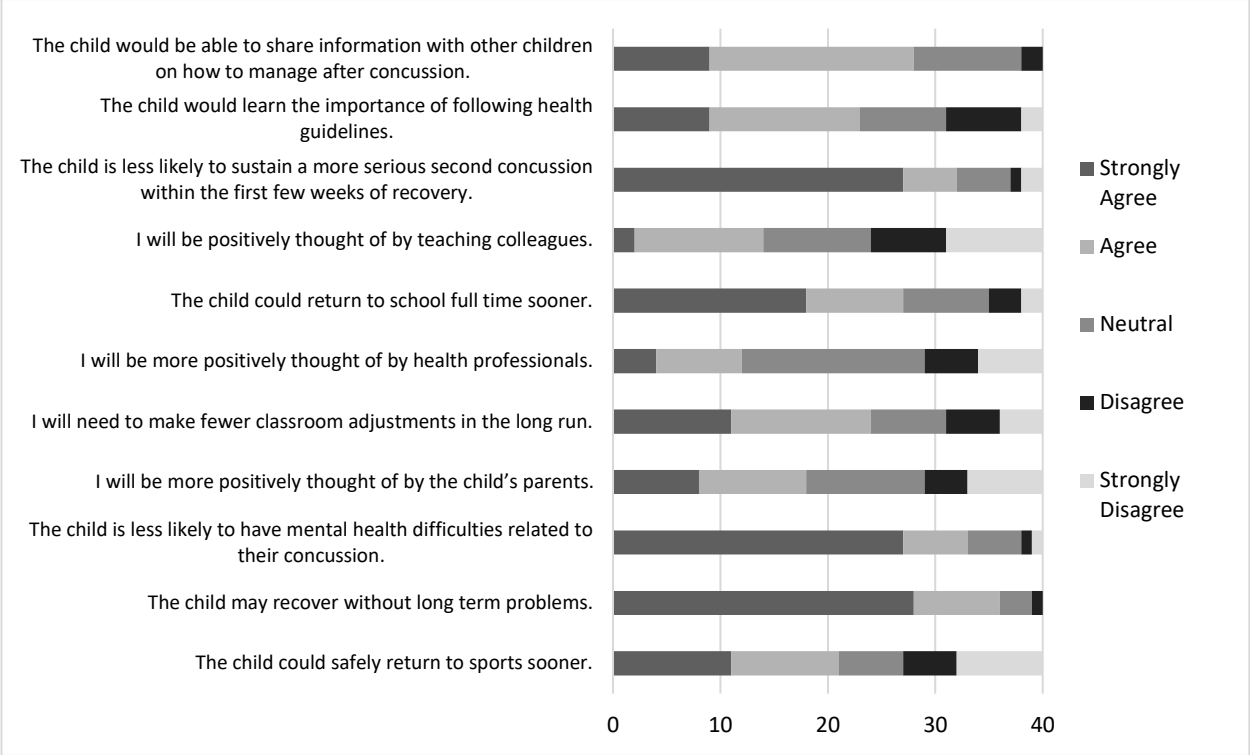

Figure 9. Frequency of teacher responses for perceived benefits to following concussion guidelines

Parents. Figure 10 indicates the benefit statements with the least agreement by parents were "I will be positively thought of by others e.g. family, friends and professionals" (N = 45, 32%), "My child could safely return to sports sooner" (N = 78, 56%), and "I will need to take off less time in the future months to look after the" (N = 86, 61%).

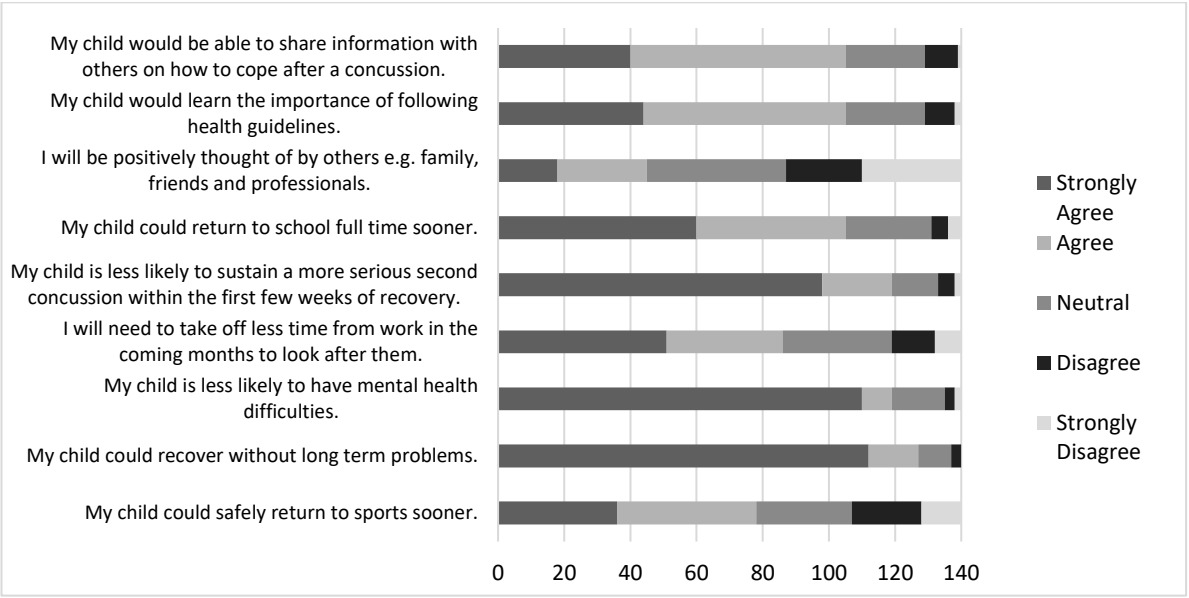

Figure 10. Frequency of parent responses for perceived benefits to following concussion guidelines

Following these Likert scale questions, participants were given the opportunity to share any other benefits they identified for following return to learn and play guidelines. Six teachers provided responses with themes of increasing others understanding and awareness of concussion guidelines, changing the behaviour of others through modelling how they are supporting a child following concussion, direct benefits to the child such as increasing happiness and self-esteem, and decreasing stress and fatigue. Nine parents also provided qualitative responses to describe other benefits they perceived to following concussion guidelines including themes of improving knowledge and understanding of concussion symptoms and recovery, setting an example to others in a team sport, self-reassurance knowing the individual had done the right thing for their child, improved confidence in communicating with a child's school about their needs following concussion, and improving the child's well-being and reducing the chance of long-term effects.

Cues to action i.e., cues to use concussion guidelines*.*

Teachers. The least agreed item by teachers was "I would follow the recommended guidelines for child concussion if I was informed by a parent of the guidelines" (N = 33, 83%) in which two teachers disagreed they would do so and five responded neutrally. Figure 11 shows both teacher and parent responses on the cues to action measure.

Parents. The following statements were most frequently agreed by parents, "I would follow the recommended guidelines for child concussion… if their teacher was noticing problems at school" (N = 133, 97%), "…if I was told to by a health professional" (N = 132, 96%) and "…if I was told about the long-term consequences of child concussion" (N = 132, 96%). The item with the least agreed responses was, "I would follow the recommended guidelines for child concussion if I was told to by a teacher" (N = 112, 82%) in which three parents strongly disagreed, five disagreed and 17 provided neutral responses.

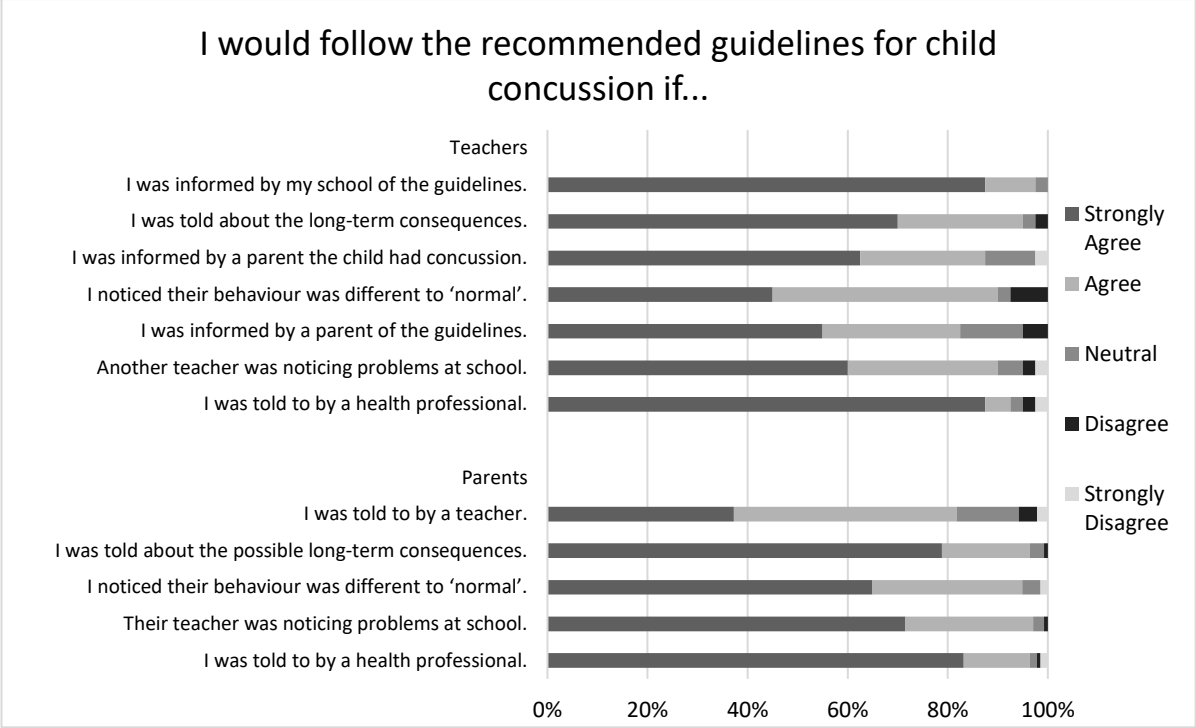

Figure 11. Frequency of parent and teacher responses for perceived cues to action

Self-efficacy in following concussion guidelines.

Teachers. The statement with the least agreement was "I would be able to identify when they were ready to return to school full time" (N = 16, 40%). Figure 12 shows responses for both parents and teachers.

Parents. The item with the least agreed responses was, "I would feel confident supporting a child after concussion." (N = 93, 68%).

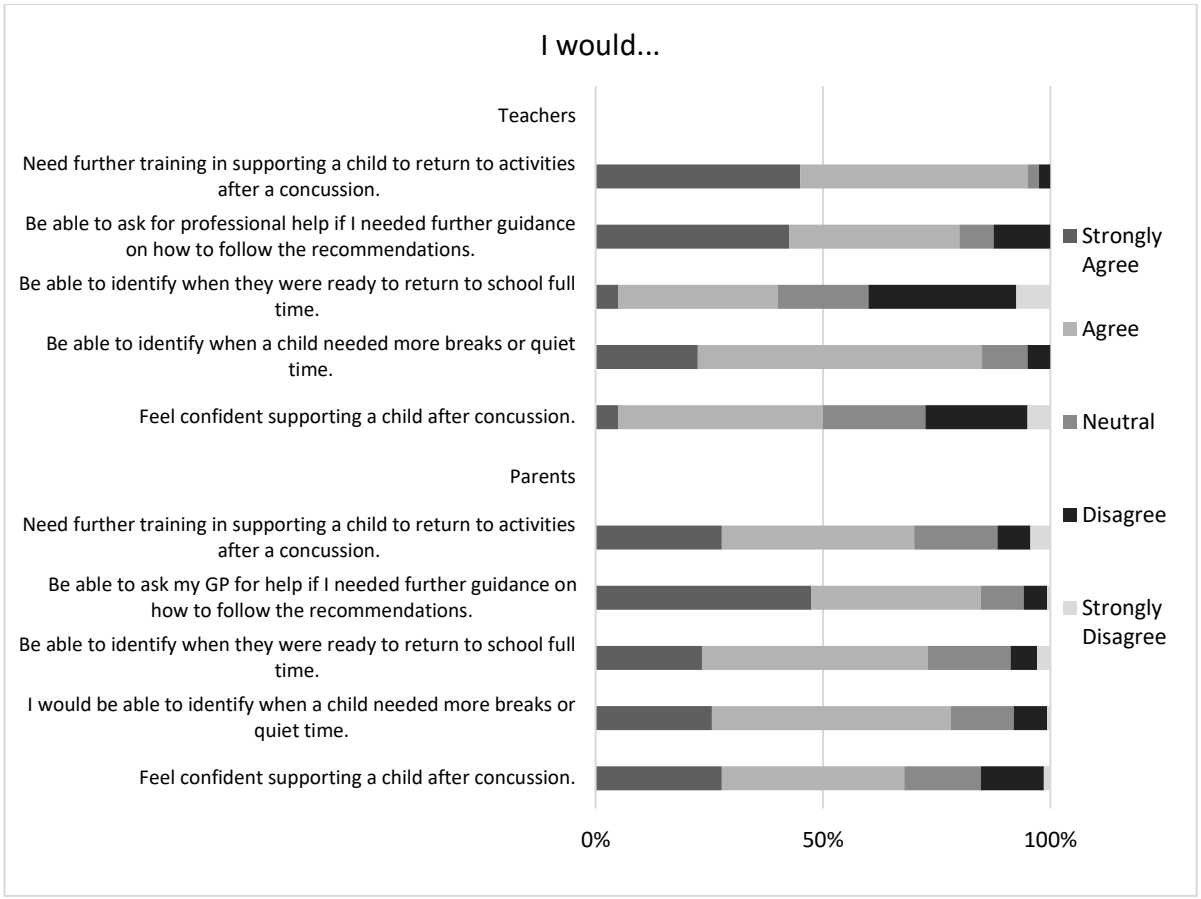

Figure 12. Frequency of parent and teacher responses for perceived self-efficacy in following concussion guidelines

Chapter Six:

Second Empirical Study

Chapter Six: Second Empirical Study

Background

Concussion is a type of traumatic brain injury (TBI) that is common in children and adolescents. Symptoms of concussion include confusion, headache, dizziness, insomnia, mood changes, and balance difficulties. Usually, symptoms of concussion resolve without the need for intervention, but some may experience ongoing symptoms for many months or even years (Yeates et al., 2009). This is referred to as Persistent Post-Concussion Symptoms (PPCS) and in children is defined by difficulties persisting beyond the expected recovery time frame of four weeks (McCrory et al., 2017).

Parents and educators worry about the consequences of paediatric concussion (Grool et al., 2021) and regularly indicate they want more information and training (Dreer et al., 2017; Ha et al., 2020; Romm et al., 2018). This is in keeping with the empirical paper within this thesis which found 93% of teachers and 68% of parents reported needing more training to effectively support children after concussion. Therefore, developing educational resources for families and schools informing them of the consequences and recovery process, is likely to be useful. Education interventions have been used in several studies to monitor change in concussion knowledge with mixed results (Falla et al., 2021; Kurowski et al., 2015; Miyashita et al., 2014; Otomo et al., 2014). One study found formal education of concussion recovery can increase the frequency of teachers recommending academic adjustments in the classroom (Kasamatsu et al., 2017) highlighting some of the implications such resources may have. Educational materials used among studies vary, with some using an information leaflet to monitor change in concussion knowledge (Rice & Curtis, 2019) and others using lectures (Otomo et al., 2014) or online videos (Falla et al., 2021). Rice and Curtis (2019) reported concussion knowledge improved in both groups of parents that were given concussion education via a leaflet versus online video. Whilst the scope of this thesis did not allow new educational materials to be developed, the researchers wanted to conduct a

small-scale study exploring feasibility and acceptability of an education intervention utilising a leaflet already available in the NHS.

Study aims

The aim of this study was to explore the feasibility of conducting a future randomised control trial (RCT) using educational materials as an intervention for improving concussion knowledge and adherence behaviour. The acceptability of the methods and materials used was explored.

Research Questions (RQ)

1. Are the intervention methods and materials used acceptable to participants?
    a. What proportion of participants choose to access the information leaflet and complete additional measures?
    b. What proportion of participants report reading the education materials?
    c. Do participants think the leaflet would be applicable to children of all ages under 18?
    d. Do participants think they would be able to implement the guidance suggested by the electronic leaflet?
    e. Do participants think the adherence quiz was reflective of the actions they might take if their own child or a child they teach experienced concussion?
    f. Do participants indicate other preferred methods for communicating concussion recovery information e.g., video, paper format?
2. Is using an education intervention on concussion guidelines feasible to use with parents and teachers?
    a. Does level of knowledge increase after the intervention?
    b. Does likely adherence to concussion guidelines increase after viewing the information leaflet?
    c. What is the estimated sample size required for a future Randomised Control Trial (RCT)?

Methodology

Design

A pre-post, feasibility study design was used.

Participants

Teachers and parents were recruited as an opportunity sample from the first study (empirical research study). All participants who reached the end of the survey in study one was provided information about taking part in study two. Participants were requested to complete the survey in the same role (parent or teacher) that they had completed the first survey. Teachers were included if they were employed in a public, private or special educational needs school supporting school-age children. Teachers self-identified themselves and may have had a formal qualification or be working in an unqualified role such as a teaching support assistant. Parents were self-identified and given options to identify as guardian or “other” to capture the realistic support systems of children. Cocks and Torgerson (2013) state sample sizes between 20 and 80 are commonly recommended for pilot studies. Where researchers want to estimate the parameters and expected effect sizes are unknown, a sample size larger than 50 is suggested. Therefore, the second study aimed to recruit a minimum sample size of 50.

Materials

An online survey was developed using Qualtrics XM. The measures were piloted with 7 individuals (3 parents, 3 teachers and 1 postgraduate student) to review the timing, survey structure and wording. All piloted individuals completed the survey in 10 minutes and to allow for different reading abilities an estimated completion time of 15 minutes was advertised.

Demographic information

Using the anonymity codes, demographic information was retrieved from study one including gender, age, ethnicity, education, employment status, experience of first aid training, and direct or indirect concussion and/or traumatic brain injury experience.

After Concussion, Return to Normality (ACoRN)

This short leaflet was included as the concussion education material to be read by participants. Lilley (2019), in collaboration with NHS Greater Glasgow and Clyde and Child Brain Injury Trust, designed the leaflet for families following child concussion. It uses a traffic light system to guide families through a three-stage recovery process and encourages the child

and their families to discuss recovery at each stage and seek agreement before moving to the next stage. Families would be expected to guide children to slowly increase their activity at home (e.g., slowly increasing TV time, reading, and playing games), and liaise with schools to help them re-integrate (e.g., school attendance may need to be phased, homework tasks limited, and classroom environment adjustments made).

Knowledge of acute concussion, Persistent Post Concussion Symptoms (PPCS) and RTN guidelines

This measure aimed to assess a participant's health-related knowledge as included in the HBM. The measure had three sections to assess knowledge of acute symptoms, persistent symptoms, and 'Return to Normality' guidelines. Current questionnaires did not adequately measure these three areas and items were often based on sports-related concussion (RoCKAS (Rosenbaum, 2007), worded for a US population or were not up to date with recent guidelines. A score was produced for each of the three sections along with an overall concussion knowledge score. Higher scores demonstrated higher knowledge across all measures (score range = 0 to 24).

Knowledge of acute symptoms and PPCS. Each measure had 20 items (six correct and 14 distractor items). Participants were required to identify the six correct symptoms (score range = 0 to 6 on each measure). Common symptoms of concussion and PPCS were obtained from the NHS conditions website and the Consensus statement on concussion in sport (McCrory et al., 2017). Distractor items were taken from other health conditions such as severe brain injury, mental health disorders and physical health problems.

Knowledge of 'Return to Normality' guidelines. This measure had 12 items made up of possible activities (e.g., easy crafts, exams and playing competitive sports) which were presented with three time intervals ('straight away after concussion', 'between one and seven days after concussion' and 'between one and two weeks after concussion'). Participants were asked to indicate at what time point they thought was the soonest a child should undertake each activity following a concussion. Items were taken from the guidance on the ACORN leaflet (Lilley, 2019) Appendix E) and designed to have one correct answer per item (score range = 0 to 12).

Likely adherence to concussion guidelines

Likely adherence was measured using vignettes and a 5-point Likert scale. There were separate vignettes for parents and teachers, and both described scenarios in which a child has experienced an injury and was recovering from a concussion. There were 14 items on the parent measure and 14 items on the teacher measure. The measure used a Likert scale and the items were developed using the following resources to include a mixture of recommended and non-recommended statements: Return to Normality leaflet (Lilley, 2019) and the CanChild Return to School/ Return to Activity Brochures (DeMatteo et al., 2019).Items on the parent measure included statements such as “I would let Zach play in his football match tomorrow” (not recommended) and “I would try to minimise screen time for Zach over the next few days” (recommended), and on the teacher measure “I would offer one to one support for Zach in my classroom” (recommended) and “I would expect Zach to join in during physical education lessons” (not recommended). The score range was 14 to 70 where higher scores indicated higher adherence to the concussion guidelines. If a participant provided neutral responses across all 14 items, they would obtain a score of 42. Vignette questionnaires have been regularly used in research to measure behaviour and are thought to be a realistic alternative to standard survey questions thus increasing internal validity (Steiner et al., 2016).

Communication of concussion guidelines

This measure was designed to explore how child concussion is communicated between support systems e.g., home, education, and health. This section was included following feedback from a PPI meeting that raised lack of communication as an issue in being able to adhere to guidance. The measure required participants to indicate how often and when they would contact the named person on the list e.g., sports coach, pastoral team, headteacher, GP. There were different versions for parents and teachers. Participants had the following options for how often: “once only to notify them”, “every few days to provide updates”, “every few days to provide updates” and “not at all”. They had the following options for when: “as soon as possible after concussion”, between one and seven days”, “after the child had recovered” and “not at all”. Each item (or named person) required one

answer for how often and when before the participant could move on in the survey.

Acceptability

To examine the acceptability of the leaflet and the vignette-based questionnaire. There were five main items to obtain the views of participants on the psychoeducational material provided and the methods used to examine likelihood to adhere (e.g., vignettes). Open and closed questions were used such as “do you think the leaflet would be applicable to children of all ages under 18?” and answer choices “yes” and “no”, with a follow question “if no, why do you think the leaflet is not applicable to children of all ages under 18?” and a free-text response box. Two questions were presented with a 5-point Likert scale with measurement labels “strongly agree” one end and “strongly disagree” at the other.

Procedure

The Qualtrics software was formatted to automatically send a survey link to participants who opted in to the second study. The email was sent four weeks after completion of the first study and included an anonymity code which participants were requested to input on page one of the survey. Participants then progressed through the survey and finished with the same debrief screen show in study one. They then exited the survey by closing the browser and their answers were recorded.

Data analysis

To explore feasibility questions, recruitment and retention rates were calculated. Descriptive statistics were used to explore the sample characteristics of those that opted-in to the second empirical study as well as explore the direction of change in scores pre- and post-intervention. The acceptability of the materials was assessed through open and closed questions in the survey. A paired samples t-test was conducted on knowledge and likely adherence scores pre- and post-intervention. It was planned that the effect size could then be used to estimate the sample size required to detect medium effects in a future RCT.

Results

In total, 143 participants (82%) opted in to receive information for the second empirical study. Out of these, 31 participants started the study survey

indicating a retention rate of 22% (RQ1a). Three responses had to be removed from the analysis due to significant missing data (<8% complete) which left 28 sets of paired data for analysis and a survey completion rate of 85%. The mean number of days between completion of study one and study two was 30 days (range 28-48 days).

Time taken to complete survey.

The minimum time taken to complete was five minutes, however it was noted that this participant did not complete the final section of the survey. The minimum time taken for a participant who completed the entire survey was seven minutes. Seven minutes was deemed to be a plausible length of time to complete this survey and on further exploration of this participant it was discovered they had a large improvement in their likelihood to adhere score from study one to study two indicating it is likely they completed their answers thoughtfully.

Sample characteristics

Table 11 presents the sample characteristics indicating 23 parents and 5 teachers completed the survey. All completed the survey in the same role as they had in the empirical research study. Twenty-six participants identified as female and twenty-seven identified as white. Most participants had completed at least one degree (79%).

Table 11

Sample characteristics

		Total Sample (N = 28)
Parents (%)		23 (82.1)
Age (%)		
	16-24	1 (3.6)
	25-34	7 (25)
	35-44	13 (46.4)
	45-54	7 (25)
Females (%)		26 (92.9)
Ethnicity (%)		
	White	27 (96.4)
	Other	1 (3.6)
Highest qualification		

	Total Sample (N = 28)
Secondary school	3 (10.7)
Further education	3 (10.7)
Bachelor's level	10 (35.7)
Masters level or above	12 (42.9)
Employment	
Full-time	11 (39.3)
Part-time	9 (32.1)
Self-employed FT	2 (7.1)
Self-employed PT	3 (10.7)
Unable to work/ unemployed	3 (10.7)

Six (21%) participants had a friend or family member who had experienced concussion, eight (29%) had experienced concussion themselves, four (14%) had a friend or family member who had experienced moderate to severe brain injury, and one (4%) had experienced a moderate to severe brain injury themselves. These proportions were not dissimilar to the overall sample that completed study one.

Acceptability (RQ1)

All 28 participants report reading the return to normality leaflet (RQ1b). Twenty-seven (96%) of those reported learning something new from reading the leaflet. Figure 13 shows the responses grouped into themes that participants gave when asked what new information they learnt from reading the leaflet.

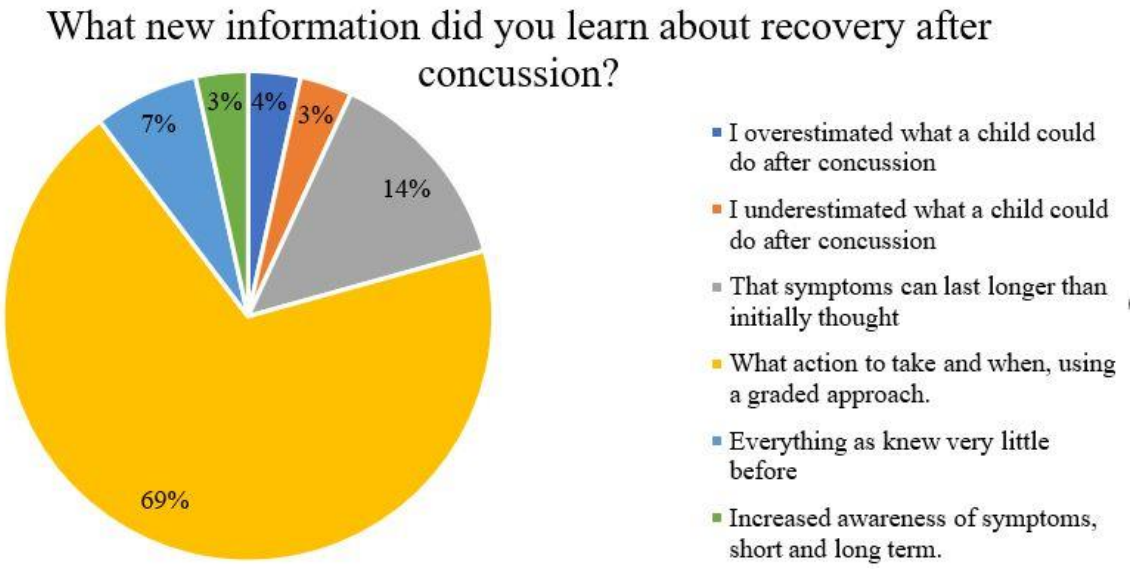

Figure 13. Responses grouped into themes indicating what participants learnt after reading the 'After Concussion, Return to Normality' leaflet

Eighty-eight percent of participants felt the leaflet is applicable to children of all ages under 18 (RQ1c). Nineteen percent indicated the leaflet would need to be adjusted for different age groups. Fourteen percent indicated the leaflet and guidance is less applicable to very young children and infants. Qualitative feedback indicated concerns around identifying symptoms in younger children due to reduced communicative skills and that the recommendations within each stage would not be applicable. Ninety-two percent of participants agreed that they felt they had the knowledge to implement the guidance suggested by the leaflet (RQ1d). With regards to the vignette scenarios, 96% of participants agreed their answers were reflective of the actions they would truly take if their own child or a child they teach experienced concussion (RQ1e). Figure 14 indicates most participants would prefer to learn about concussion recovery via an online leaflet (RQ1f).

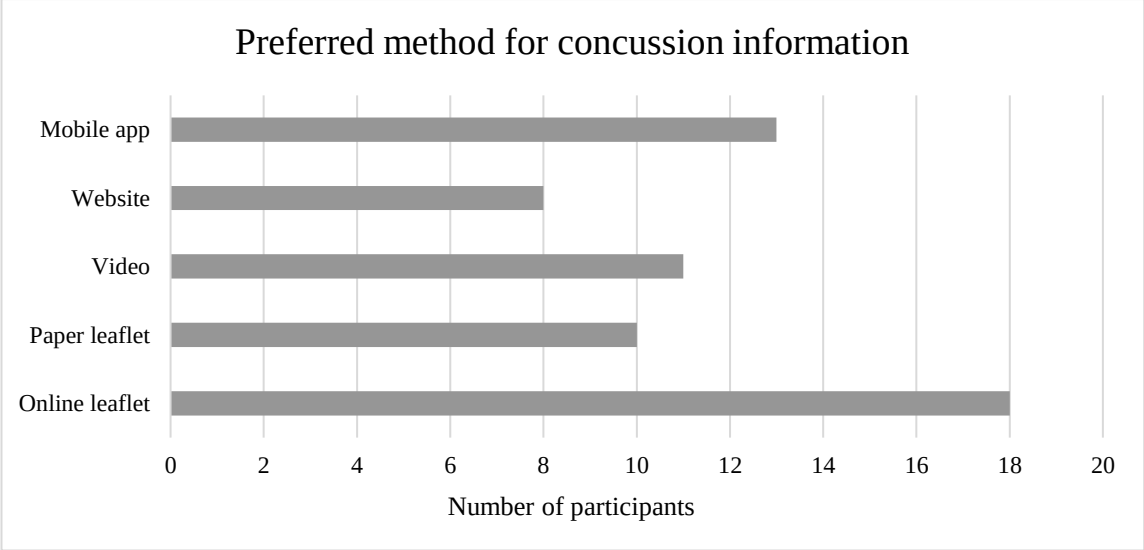

Figure 14. Bar chart indicating the preferred method of learning about concussion

Feasibility (RQ2)

Matched pairs comparisons

Participants scores for knowledge were explored between study one and study two. Figure 15 shows the number of individuals who had an increase, decrease or no change in their knowledge scores. Most individuals (86%) had an increase in their total concussion knowledge score which is a sum of the three other subsections (RQ2a). For those who demonstrated increased total concussion knowledge scores, there was an average increase of 3 points (maximum score was 24). Of the four participants that showed a decrease in their total concussion knowledge score, they either dropped by one or two points.

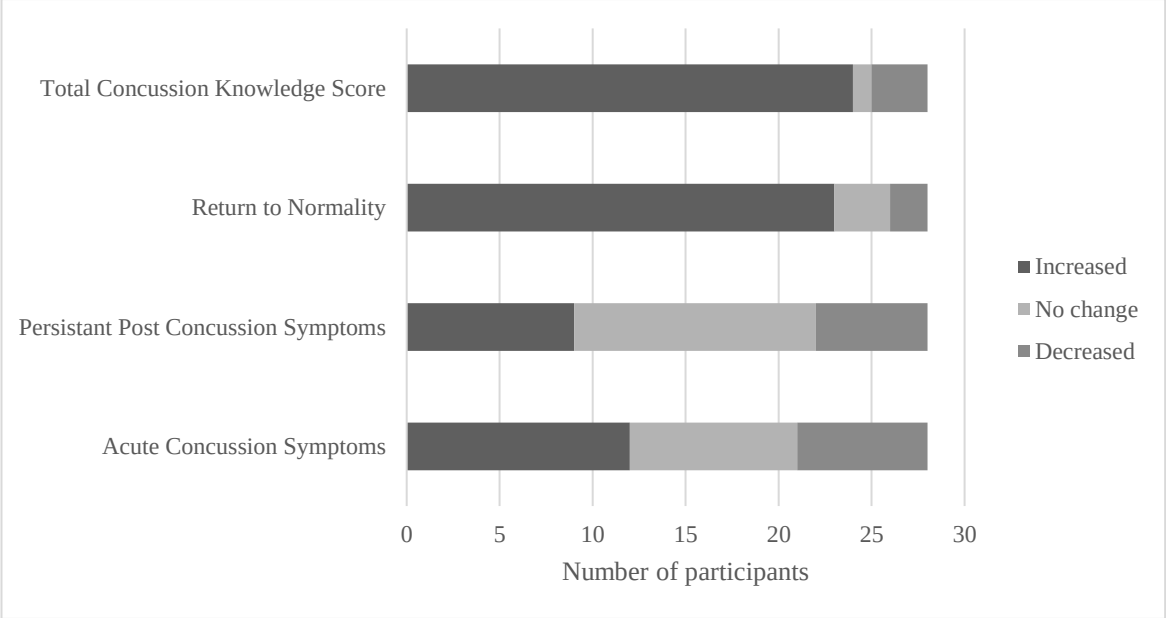

Figure 15. Stacked bar chart showing changes in knowledge scores from study one to study two after reading the Return to Normality leaflet

Participant scores were also explored for the vignette-based questions that aimed to identify the likelihood that participants would adhere to concussion guidelines. Figure 16 shows the number of individuals who had an increase, decrease or no change in their likelihood to adhere scores. Most individuals (82%) had an increase in their likelihood to adhere scores (RQ2b). For those who demonstrated increased scores, there was an average increase of 8 points and a range of one to 18 points (maximum score on likely adherence was 70). Of the three participants that showed a decrease in their score, this ranged from one point to four points.

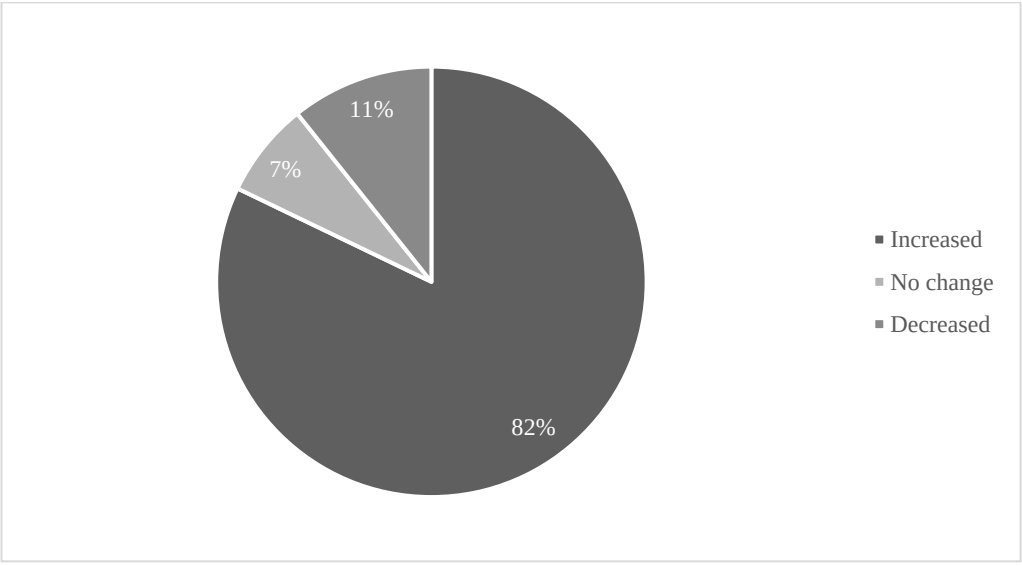

Figure 16. Pie chart showing percentage of those who increased, decreased or had no change in likelihood to adhere scores between study one and two after reading the Return to Normality leaflet

To determine the sample size required for a future RCT, a paired samples t-test was completed for concussion knowledge scores and likely adherence scores from study one and two (RQ2c). Results showed participants had a higher concussion knowledge score in study two (M = 19.32, SD = 1.93) than in study one (M = 17.07, SD = 1.98). This improvement was statistically significant, $t(27) = 5.36$, $p < 0.001$ (95% CI's 1.38 and 3.11) with a Cohen's d effect size of 1.01.With an effect size of 1.01, large effect sizes could be detected with 10 paired samples. Results also showed that participants (parents only) had higher likely to adhere scores in Part Two (M = 58.08, SD = 3.49) than in Part One (M = 51.52, SD = 6.13). This was also statistically significant $t(22) = -5.58$, $p < 0.001$ (95% CI's -9.00 and -4.13) with a Cohen's d effect size of 1.16.

Communication

Participants were asked who and when they would contact named individuals after a child sustained a concussion. Figure 17 shows the most frequent answers by parents (N = 22) were contacting their child's GP (N = 19), classroom teacher (N = 15) and school pastoral team (N = 13) as soon as possible. The following individuals would most likely be contacted between one and seven days after concussion by parents: the child's PE teacher (N = 14), external sports coach (N = 12), school nurse (N = 10) and child's mental health team (if open to one) (N = 10). Most indicated they would only contact the named individuals once except for the classroom teacher who they would contact every few days (N = 16) and the child's mental health team (N = 14).

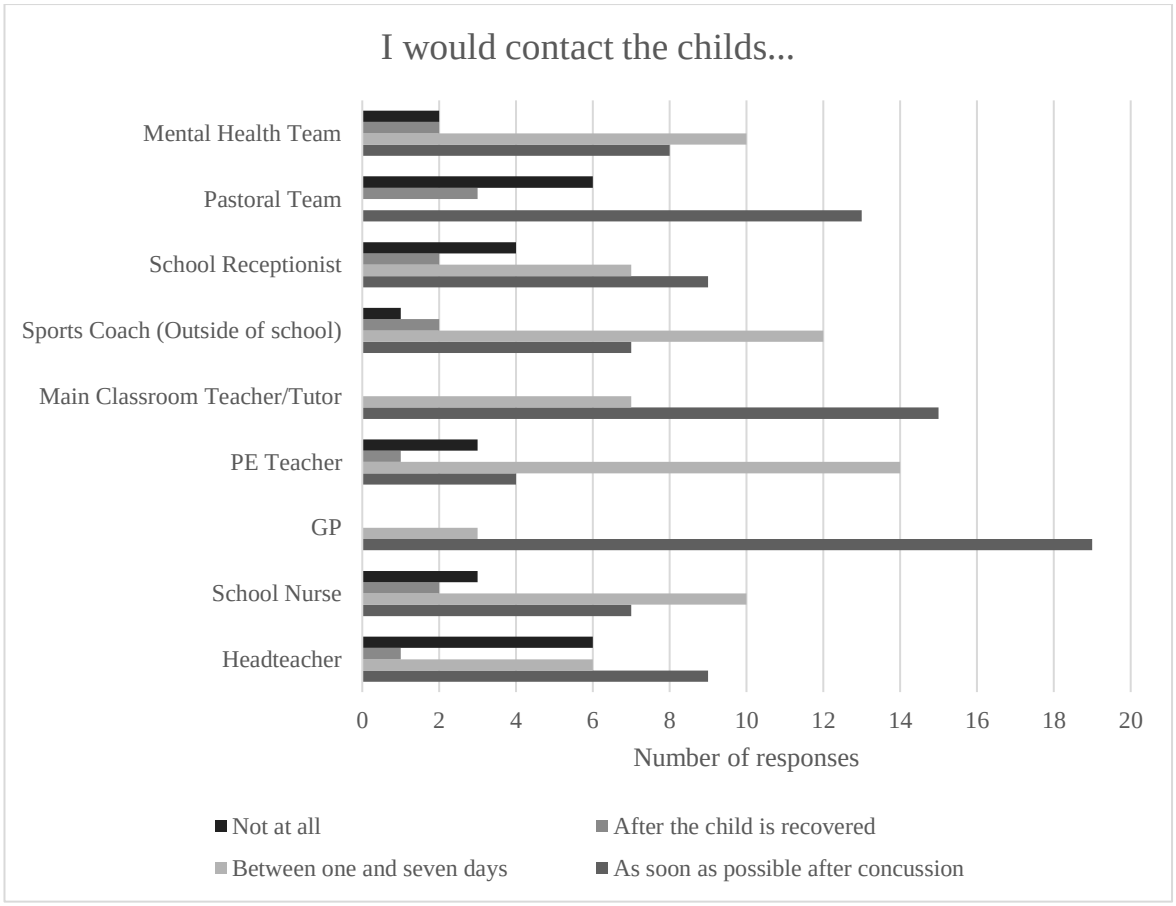

Figure 17. A bar chart showing when parents would contact named individuals after child concussion

Figure 18 shows the most frequent answers by teachers (N = 4) were contacting parents (N = 4), other teachers (N = 3), school pastoral team (N = 3), school nurse (N = 3), and headteacher (N = 3) as soon as possible after concussion. Three teachers would not contact the GP at all and two indicated they would not contact the child's sports coach if it was a sport they engaged with outside of school. Most indicated they would contact the named individuals between once and every few days except for the child's GP and the sports coach which most teachers would not contact at all.

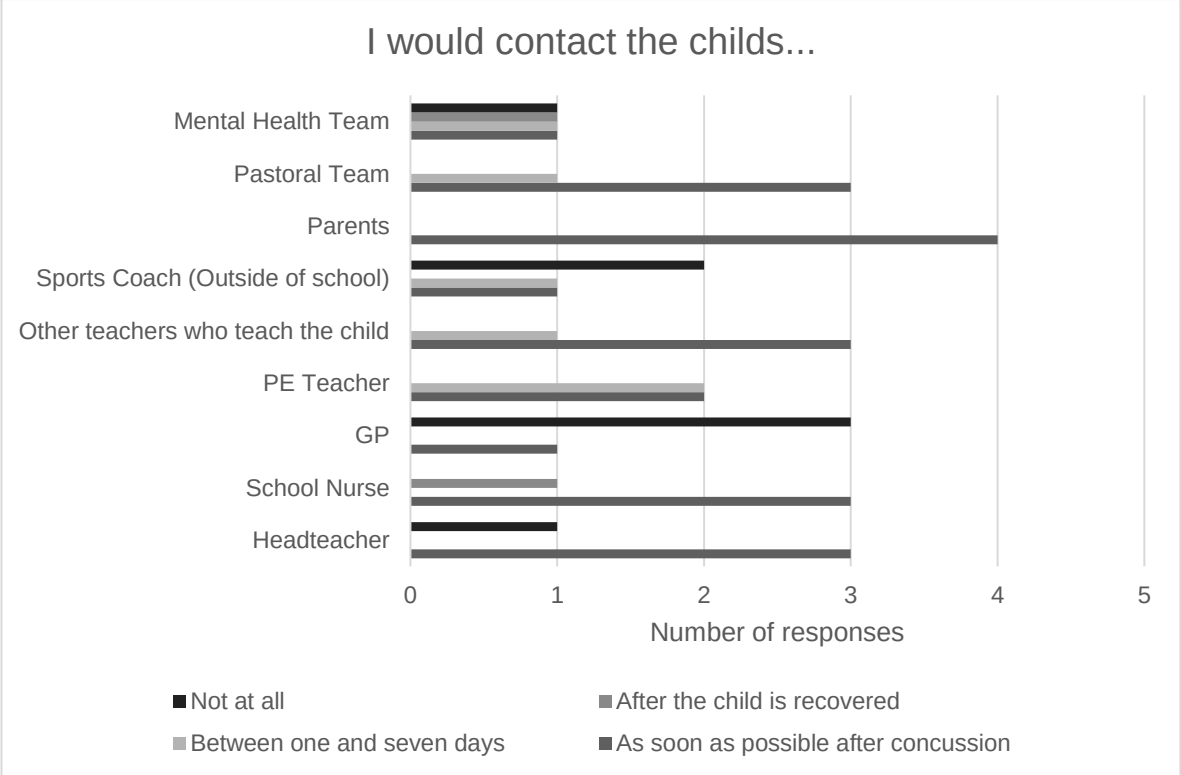

Figure 18. A bar chart showing when teachers would contact named individuals after child concussion

Conclusion

The current study demonstrated that a short educational leaflet presented to teachers and parents was an acceptable measure for learning about concussion. Eighty-five percent of participants who started the survey completed it indicating the methodology used was acceptable and feasible to examine changes pre and post intervention. Whilst the completion rate was high for those who started the survey, the retention rate from study one to two was low at just 22%. This means the results from study two are not highly representative of the participants who completed study one. It may be useful in future to consider extra steps in the study procedure to improve retention rate e.g., additional reminder emails for participants who opted in to prompt them to complete the survey.

The study highlights that the most favoured way of learning about concussion information is via an online leaflet and then a mobile app. This is useful for individuals who develop concussion education resources to be aware of and for clinicians who directly give out resources in primary care

settings to ensure the information is most accessible for families and schools. Whilst this study only aimed to explore feasibility, there were some findings to suggest an educational leaflet may increase concussion knowledge and likely adherence behaviour. Large effect sizes were reported which is encouraging considering the small sample size. However, given the small retention rate from study one, the sample in study two is likely to be biased by individuals who were more willing or more interested to learn about concussion. It is also noted that a small number of participants had a decrease in their concussion score which may be a result of individuals not carefully reading the leaflet despite reporting they had. As there is no psychometric data available for the measures it is difficult to determine what, if any, change in score is reflective of a true change in concussion knowledge or adherence. It is noted that there was a greater percentage of participants with a “no change” score on PPCS than for acute symptoms or return to normality knowledge. This pattern is in keeping with the information that is provided on the leaflet and is suggestive that the information presented may be linked to the improvements seen.

Some participants highlighted that the leaflet may not be applicable to very young children and reported they had lower confidence in being able to identify symptoms in this age group due to the child’s developmental stage and lack of communicative skills. Educational resources and formal clinical guidelines may need reviewing to determine if adaptions to these are required or if advice provided to families and schools needs adjusting for different aged children.

A full-scale RCT should be conducted given the outcome data presented here to test the effect of educational interventions on concussion knowledge and guideline adherence in parents and teachers. Families could be recruited through healthcare settings (e.g., Accident and Emergency (A & E) and General Practitioner (GP) surgeries) and also through schools (where concussion has been reported to the school medical team) along with teachers. Participants should be randomised to either the intervention group or treatment as usual group. Both groups would be asked to complete a short survey (e.g. like the one used in this study) at the point of accessing care and after consenting to take part in the research project. The

intervention group would receive enhanced educational materials either via leaflet or mobile app, as identified as the preference by most participants in this second empirical study. Following this, the short survey would be repeated with both groups at agreed timepoints (e.g., one week, four weeks and three months to measure longitudinal effects). The study will need to recruit a diverse sample to improve generalisability and control or measure confounding variables such as learning about concussion from other resources whilst part of the trial. In this study it was not possible to determine if the increase in scores was solely due to the educational leaflet or if participants may have completed individual learning between study one and two. As mentioned above, it would be helpful for the study to use a longitudinal design to monitor if increases in concussion knowledge and likely adherence are maintained over time. It would also be important to define treatment as usual if participants are recruited at different sites e.g., how much information and support is given in A & E versus GP surgeries versus schools. Given it is the symptomology experienced by children after concussion that we are ultimately interested in when exploring adherence behaviour, it would be beneficial to also document parent and child reported symptoms at each time point. Exploring the prevalence rates of PPCS in the study sample in comparison to those previously published (e.g., Fried et al., 2022) would be valuable to understand if increased concussion knowledge and higher adherence to guidelines is associated to symptom presentation in children.

Chapter Seven:

Discussion and Critical Evaluation

Discussion and Critical Evaluation

This chapter will offer an extended discussion of the main empirical study, second empirical study and systematic review, and contextualise these findings in relation to the wider literature. It will highlight the contribution this thesis brings to our understanding of concussion prevention and intervention in children. The clinical and theoretical implications will be considered followed by a critical evaluation of the thesis portfolio and suggestions for future research.

Summary of Main Findings

This thesis portfolio aimed to explore concussion recovery in children, with a focus on adherence to acute management guidelines, concussion education and the availability and effectiveness of longer-term psychological interventions. Most literature has focused on sports-related concussions and return to play guidelines outside of the UK, limiting the application of the current evidence base. It was hoped through understanding these key areas, children who experience concussion and/or PPCS could be more effectively supported in the future. The main empirical paper focused on adherence behaviour to child concussion guidelines and explored what factors may predict this health behaviour in parents and teachers. A second empirical study sought to understand the practicality and acceptability of using a concussion education intervention with this population and a systematic review explored psychological interventions for child concussion, the components of these and the effectiveness.

The empirical paper demonstrated that parents and teachers in the UK have good knowledge of acute concussion symptoms and PPCS but less knowledge for return to normality guidelines. It also revealed that most participants were likely to adhere to child concussion guidelines when presented with a hypothetical scenario. The Health Belief Model (HBM; Rosenstock (1974) was applied to determine if any of the variables within the model may predict likely adherence. Perceived barriers, perceived susceptibility and concussion knowledge were revealed as significant

predictors of likely adherence in parents. The second empirical study found that a short educational leaflet used as an intervention was an acceptable method for learning about concussion for parents and teachers. An increase in concussion knowledge scores and likelihood to adhere following the intervention were noted.

The systematic review highlighted the literature for psychological interventions following child concussion is minimal and of those that are available, the approaches used are highly heterogenous and of varying quality making it difficult to draw firm conclusions. Despite this, it is useful to understand that interventions can be grouped into either prevention or treatment of PPCS. This highlights there are two timepoints where psychological intervention can be of potential benefit. Whilst the findings need to be understood tentatively, there is some indication that improvements occur in quality of life (QoL) and persistent post-concussion symptoms (PPCS) following intervention. The studies with the highest quality ratings that found improvements tended to use a multimodal approach that combined psychological and physical treatment, or psychoeducation as a standalone treatment. The review showed that psychological approaches are used in treatment to reduce distress by providing knowledge about the condition or promoting new coping strategies to improve the individual's level of functioning and reduce symptomology.

Integration With Wider Literature

The systematic review, main empirical paper and the second empirical study all suggest that concussion knowledge is an important element for managing concussion in children. The lack of concussion knowledge by children, parents and coaches has regularly been reported in sporting literature (Feiss et al., 2020; Kuzma, 2015; Rice & Curtis, 2019; Sullivan et al., 2009; Weerdenburg et al., 2016) and the empirical paper confirmed that parents and teachers in the UK have reduced knowledge for return to normality guidelines. It also highlighted lack of knowledge was a common barrier to implementing recommendations and that concussion knowledge in parents was predictive of likely adherence to these. Health literacy across

conditions is recognised to empower individuals and improve health outcomes. In 2015, it was the focus of a Public Health England document to draw attention to the importance of ensuring individuals have the appropriate skills and knowledge to manage health conditions. Considering the high prevalence of concussion in children, good educational programmes in the UK are needed to ensure children are well supported.

To date, concussion education interventions have largely focused on sports-related concussions due to the high rates of under-reporting and the risks associated with a second concussion (Kroshus et al., 2015; McDonald et al., 2016; Williamson & Goodman, 2006). In the US, formal concussion education programmes for youths who play sport are mandatory but only some include education modules for teachers and parents (Williamson et al., 2014). The empirical paper revealed perceived susceptibility, perceived barriers and concussion knowledge may be areas to focus education interventions on. Whilst the Health Belief Model (HBM) was primarily used in this thesis to understand adherence behaviours, it can be used as a framework to develop educational interventions (Glang et al., 2010; Patel & Trowbridge, 2017). The Centre for Disease Control and Prevention (CDC) produced a video campaign to educate individuals of concussion and evaluated this using the constructs of the HBM (Quick et al., 2021). They found that it lacked informational content addressing barriers to following recommended guidelines which as thesis has shown, is a significant predictor of adherence and likely to be an important component to any educational resource that is produced. This is also in keeping with the wider literature across health conditions where perceived barriers is commonly found to be the most predictive variable of the HBM (Carpenter, 2010).

The systematic review also revealed the importance of improving concussion knowledge in interventions for the management of concussion symptoms. Psychoeducation was a frequent component across interventions either aiming to prevent the development of PPCS or aiming to treat PPCS once assessed to be persistent. Whilst no conclusions could be drawn specifically about psychoeducation as a preventative intervention, due to poor methodology and lack of appropriate statistical analyses, two of the

three randomised control trials rated as good quality that used psychoeducation as a standalone treatment found improvements in concussion symptomology. It was rationalised across studies that psychoeducation may empower individuals, resulting in a greater sense of control over their condition and defuse negative stereotypes. These findings are interesting given the debate around the mechanisms maintaining persistent concussion symptoms and introduces the idea that symptomology might improve without physical therapy intervention. It is probable that including psychoeducation as a component in 'treatment' interventions is useful from the findings in the systematic review, but the literature is in its infancy and needs further exploration to confirm if standalone psychoeducation would be an comparable alternative to multimodal interventions. Whilst it is useful to be mindful of how symptoms are maintained, as with other conditions that stimulate this type of debate (e.g., Chronic Fatigue Syndrome, Fibromyalgia, Functional Neurological Disorder) it is likely to be most productive in clinical practice to instead focus on the individuals' symptoms to tailor the treatment they receive.

CBT was also indicated to have promising results in the treatment of PPCS in children which is in keeping with findings from the adult population (Al Sayegh et al., 2010). It is noted that other reviews have not found this pattern of improvements in the adult population (Teo et al., 2020) which emphasises the lack of understanding of treatments across the lifespan, often resulting from an absence of high-quality studies. Additionally, psychoeducational interventions have been documented to be less useful in adult populations and may represent the complexity of psychological factors that maintain PPCS in adults in comparison with children who may, along with their parents, benefit more greatly from basic educational information over a formal sit-down therapy. Indeed, psychoeducation as an intervention has been shown to have good outcomes for children across health conditions such as depression, asthma, inflammatory bowel disease and other chronic illnesses (Day et al., 2020; Jones et al., 2018; Last et al., 2007).

Concussion is particularly prevalent in children under five due to their physical development and lower sense of danger. Participants who completed the second empirical study raised questions as to whether the leaflet and guidance was applicable to the management of concussion in younger children. Issues such as being able to identify symptoms and implement guidance for younger children versus adolescents was raised and commonly linked to parents and teachers worry that the child would not be able to communicate their symptoms. Indeed, McKinlay et al. (2014) found that parents of younger children did report significantly fewer concussive symptoms than parents of older children despite all being later diagnosed with a mild Traumatic Brain Injury (mTBI). It is reasonable to see how certain concussive symptoms could be mistaken for 'normal' age-related behaviours e.g. tantrums/irritability, learning to walk/co-ordination difficulties, being overtired/drowsy. Current guidelines described at the 5th International Consensus Conference (ICC) for concussion management do not differ dependent on the child's age. However, with more research focusing on PPCS in recent years, it is becoming apparent that developmentally appropriate tools and recommendations are needed to identify and manage symptoms across age groups (Davis & Purcell, 2014). Researchers in Canada have recently undertaken this task and created a tool to address these concerns through observational manifestations of symptoms (Dupont et al., 2022). The systematic review also discovered a lack of variation of interventions dependent on age. The youngest mean age for studies included in the review was 10.9 years. Understandably, psychological interventions such as therapy are more challenging with younger children across conditions however, adaptions can be made to ensure younger children are supported (Brigden et al., 2019; Keefer & Vasa, 2021; Minde et al., 2010). Alternatively, it is common for psychological therapy to be parent-focused to subsequently support children with their health condition (Antonini et al., 2014; Hirshfeld-Becker et al., 2019). This thesis highlights that there are no psychological interventions currently evaluated sufficiently with younger children, leaving a substantial proportion of children who may sustain concussion without evidence-based support.

Strengths and Limitations

This thesis has brought together research literature focused on improving outcomes for children who have sustained concussion. It uniquely contributes to the evidence base by providing a comprehensive systematic review of psychological interventions for children with PPCS which was noticeably missing. It also offers the first empirical paper to apply the HBM to adherence behaviour within this population relevant to child concussion recovery. A key strength of the systematic review is that by focusing not only on the effectiveness of studies but also offering a breakdown of the intervention components, it offers a practical document to be used by clinicians with commissioners to discuss the implementation of such interventions within services. Through the inclusion of research protocols, where data is yet to be published, it also ensures the array of interventions reviewed was up to date and relevant.

The framework used to assess the quality of trials included within this review was chosen as it offered similar tools for different study designs. This allowed the reviewers to build up a familiarity of assessment items that were common across the tools allowing some consistency of decisions. Whilst the tools are not standardised, they are developed by researchers based on quality assessment methods, concepts and other tools such as the Cochrane Collaboration, Agency for Healthcare Research and Quality, and the National Health Service Centre for Reviews and Dissemination. The detailed guidance document provided for each quality assessment tool was also appealing as it allowed the first and second reviewer to refer to these during the assessment and ensure judgements were fitting to the descriptions offered. Other tools could have been selected that are more established such as the Cochrane risk of bias (ROB) assessments, but these too have limitations. For instance, the Cochrane ROB tools also tend to focus more on research process (e.g., randomisation, suitable analyses) and place less emphasis on clinically important information (e.g., replicability, sample generalisability) which is still relevant to the quality of a study and likely to indicate more closely if interventions will translate effectively into clinical

settings. Additionally, the applicability of these tools for psychological interventions has been raised (Martins Scalabrin et al., 2018).

Limitations of the systematic review were largely due to the shortage and quality of existing randomised control trials available for synthesis which would have improved the robustness of conclusions drawn. Additionally, considering the number of studies that met eligibility criteria was small, the range of available treatments amongst these was varied making it difficult to group together studies for narrative synthesis. The main author initially expected that interventions included in the review would have a substantial component that was psychologically driven but instead, there were a number of papers that met inclusion criteria by utilising a single psychological skill aiming to improve wellbeing such as a short visualisation task. This resulted in a broader review that allows readers to see the breadth of possible interventions using a psychological approach but also compromised the comparisons between interventions that could be made. Another factor that affected how studies were compared were the measures used to assess PPCS, mood and quality of life, both in terms of who completed them (e.g., child vs parent vs both) and the variety of measures used.

The empirical paper offers novel insights into an area of growing interest. It is the first study known to measure concussion knowledge, perceptions, and likely adherence in a UK sample of teachers and parents and importantly, the findings are not confined to sports related concussion only. The study reveals what factors may predict likely adherence behaviour building on the literature that already demonstrates poor adherence to concussion guidelines exists in children. The inclusion of a small-scale second empirical study elevates the thesis portfolio by demonstrating a very short educational intervention is feasible and acceptable to this population. Whilst significance testing was not conducted for the purpose of measuring effectiveness, it did highlight changes pre- and post-educational intervention may be present, emphasising the need for further exploration.

Vignette-based questions were used to reflect real-world scenarios (Steiner et al., 2016) and participants in the second empirical study

confirmed they felt their responses on the questions were representative of how they would truly behave. It would have been beneficial for understanding the reasoning behind responses to have included follow-up questions to these scenarios. This would have been useful on occasions where discrepancies were noted e.g., 48% teachers agreed with leaving the child on their usual classroom table with friends but 73% later indicated they would try to sit the child in a quieter location. Understanding these decisions more deeply may have resulted in more meaningful implications for schools.

A core limitation of the empirical paper is the lack of psychometric data available to validate and determine reliability of the measures developed. In order to assess the population of interest, the development of new measures was unavoidable and due to the scope of the doctoral project, thorough validation of these measures was not possible. To manage this, substantial efforts were made to increase the rigour of these through conducting a literature review and incorporating existing survey items, consulting expert panels, utilising clinical guidelines and piloting the overall survey. Numerous revisions to the measures were made and discussed amongst authors at the outset of this thesis to successfully address a wide range of constructs guided by the HBM. The measures were designed to include multiple items to improve content validity (Rossiter, 2008) and the use of expert panels contributed to both content and face validity. Whilst a strength of these measures is their tailoring to the two sample groups, it is noted that if the design and survey items had been the same across all participants then the data could have been combined to improve statistical power, particularly given the small sample of teachers recruited meant the planned analysis could not be conducted.

Sample diversity was an issue across the systematic review and empirical paper. Both papers are limited in their generalisability across ethnic groups, with the empirical paper recruiting predominately white participants and the systematic review revealing most research studies on psychological interventions did not report the ethnicity of their sample. Level of education, gender and socioeconomic status was also unvaried in the empirical study. It was particularly noticeable that over 50% of the total sample lived in the

three least deprived areas of the UK. Demographic variables including female gender, low education, work status, low-income level and chronic ill health have all been identified as risk factors for PPCS (Voormolen et al., 2019) whilst living in urban areas and being male increase the risk of head injury such as concussion in the UK (Yates et al., 2006). It is therefore likely that the thesis portfolio is missing valuable data on individuals who are most likely to need to access interventions and families who need targeted support. It is also likely that teachers in more deprived areas may have different perceptions, specifically perceived barriers of implementing guidance.

A concern raised by this thesis was the definition of PPCS across empirical research and how this was applied in the recruitment of participants. McCrory et al. (2017) define PPCS as symptoms persisting beyond four weeks in children yet a handful of studies included participants with symptoms at two or three weeks. It has been raised that there is a lack of consistency in the criterion across diagnostic manuals such as the ICD-10, DSM-IV, DSM-V and ICC (Dwyer & Katz, 2018) and that the tools used frequently in the UK to measure PPCS do not have clear cut-off points (Voormolen et al., 2019). The symptoms of PPCS were also not familiar to participants in the empirical study with 88% reporting they were unaware of these. However, it is not surprising that members of the public were unaware of the symptoms when the classification of this by researchers and potentially, clinicians, is not clear. Improvements are required to firm up the definition of PPCS both clinically and in research. This will be important for ensuring homogonous samples in research, accuracy of information shared with the public and clear criterion for services supporting individuals with persisting symptoms.

Theoretical Implications

Non-adherence to treatment, medication and clinical recommendations commonly affects health outcomes for patients and impacts healthcare systems financially. Understanding the underlying causes of adherence behaviour from a theoretical stance is important to be able to reduce burden

on services by developing targeted and effective interventions. The HBM was designed to explain health behaviour such as adherence and this thesis portfolio includes the first empirical study to apply the HBM to understand parental and teacher adherence to child concussion guidelines. It demonstrates there were weak correlations between constructs of the HBM and adherence, and in keeping with existing literature in other health conditions, perceived barriers was the most significant predictor (Carpenter, 2010) and perceived susceptibility was the second most significant for likely adherence (Janz & Becker, 1984; Zimmerman & Vernberg, 1994). These findings offer a way in which stakeholders (schools, medical professionals, therapists) may choose to engage with families in order to increase adherence behaviours.

One complexity with the HBM is that constructs are often operationalised differently across studies (Abraham & Sheeran, 2015) and the model does not include all variables known to determine health behaviour such as perceived social norms (Kroshus et al., 2015), social pressure (Haas & Schaefer, 2014; Weber Rawlins et al., 2020) or access to social support (Harvey & Alexander, 2012). Additionally, a review commissioned by NICE (2006) found that the “HBM has relatively weak predictive power. This is in part a result of poor construct definition, a lack of combinational rules and weaknesses in the predictive validity of the HBM’s core psychological components”. Whilst these are important limitations to consider and may help understand why only 11.2% of variance was explained by the model in the empirical study, all models have strengths and weaknesses and applying these to novel areas contributes to the literature base and helps direct future research. Alternative theoretical models of health behaviour were considered in the development of this thesis including the Theory of Planned Behaviour (TPB; Ajzen, 1985). Whilst the TPB assumes our actions are determined by our intentions and could have been useful in explaining likelihood to adhere, the model is not specifically focused on health behaviours and has instead been frequently applied to other behaviours such as gambling, consumer habits, and financial investments. A strength of the HBM in comparison to the TPB is that it focuses on the ‘threat of illness’ being an important element in

understanding health behaviour. Given concussion and its severity is often misunderstood it was felt that using a model with this element was crucial in identifying predictive factors. Furthermore, the HBM includes demographics as a variable which TPB does not and these have been previously evidenced to be important in concussion knowledge (Cusimano et al., 2017; Lin et al., 2015; McCoy et al., 2011; Roberts et al., 2020). The TPB has been applied to some aspects of concussion recovery, including youths' likelihood to report concussive symptoms (Register-Mihalik et al., 2013) but may warrant further exploration, along with other models such as Theory of Reasoned Behaviour (Fishbein & Ajzen, 1975), to examine predictors of adherence to concussion guidelines in parents and teachers.

Clinical Implications

The findings of this thesis portfolio can be applied to better understand interventions for both prevention and management of this condition and have several key areas that enrich the evidence base and have clinical implications to take forward. Information provision and improving concussion knowledge amongst child support systems has been highlighted. Ensuring adequate educational resources are available pre-injury, at the time of injury and during recovery may reduce concussive injuries, improve identification and diagnosis, and increase appropriate support during recovery (Chrisman et al., 2014). In this thesis, parents and teachers recognised they need more information about concussion to successfully support a child and therefore, it is likely additional training or educational resources would be welcomed within this population. The findings of the second empirical study suggest that an online leaflet or mobile app focusing on the susceptibility of concussion, acute symptoms, expected recovery timeline, potential development of PPCS, recommendations for return to normality and the common barriers to implementing these guidelines problem solved, would be key areas for educational resources to focus on. An online resource at the time of injury is also beneficial as it allows access to this information across settings e.g., in schools, at sporting events, in the emergency department or at home. Whilst some mobile apps have been developed for this exact purpose, such as the Concussion Recognition and Response App (Gioia &

Mihalik., 2011), these are still often developed with sports concussion in mind, and it would be useful for these apps to be injury encompassing. If the evidence base continues to grow, then separate educational and training resources should be developed to be age appropriate.

The current provision of concussion information is documented to be inconsistent (NICE, 2014) and thus, work needs to be conducted to roll out such educational resources across primary care settings and schools. It was highlighted by the Time for Change report (Menon, 2018) that there was a widespread lack of education on Acquired Brain Injuries (ABI) and a National ABI Education and Learning Syndicate (N-ABLES) was set up to start to address these issues. The group are already working on ways to support educational professionals to gain a minimum level of awareness and understanding of acquired brain injuries and have produced several useful documents including guides for teachers to support children returning to school after ABI. Specifically, there is a useful “Return to Education Checklist” (N-ABLES, 2021) that may be important in acknowledging and problem solving through some of the barriers that teachers perceive, as highlighted in the empirical paper. The syndicate and other working groups are likely to be interested in the findings of this thesis and it could be of use to develop a concussion specific return to education checklist as some of the items for ABI are less applicable and may result in educators deeming it not of use.

As highlighted by this portfolio, perceived barriers are likely to be a useful area to target educational resources and training. Environmental adjustments were commonly highlighted by both teachers and parents and therefore, may need specific consideration. A quiet learning space with one-to-one support was reported by teachers as a barrier to following the recommended guidelines and schools may wish to have a protocol in place for managing these requirements when a child is returning to school e.g., temporarily moving teaching assistants, adjusting the classroom space or allowing online learning. Parents also reported environmental adjustments as barriers along with not being able to take time off from work. This information may be helpful for professionals with direct contact with the family to be

aware of so they can help problem solve these given the importance of adhering to guidelines (Hiploylee et al., 2017). The findings from this study could also be applied to identify more 'at-risk' families that may struggle to implement the guidance e.g., those with low concussion knowledge, low susceptibility perceptions and/or high perceived barriers. This could involve surveying families who access support to determine if additional follow up care is warranted e.g., a detailed conversation around concussion recovery and recommendations rather than just signposting to a leaflet, a follow up call to check on recovery progress to re-highlight recommendations or liaising with involved agencies such as the GP or school. Ideally, routine follow-up in a concussion clinic should be standardised so that children with persisting symptoms or those families struggling to implement guidance are supported as early as possible. In reality, many children are not seen again by a medical practitioner (Tarimala et al., 2019) despite some indication that more academic adjustments are made to children who are seen again in US outpatient clinics (Grubenhoff et al., 2015).

From the systematic review, psychological interventions that have been evaluated are presented using the TIDieR framework which allows the components of treatments to be easily accessed and reviewed by clinicians and commissioners. This is helpful for these individuals who are considering offering treatment for PPCS to be able to see if a certain intervention is feasible with regards to length of treatment, required materials and resources, who can deliver the intervention and what it entails. Considering the growing interest in managing concussion and PPCS, this is likely to be a valuable resource for services globally.

Future Research

Across this thesis portfolio, it is highlighted that there is a distinct need for high-quality studies with robust and homogenous methodology examining concussion recovery in children. These must be applicable to an array of concussive injuries and include diverse samples that allow findings to be generalisable. The thesis highlights additional studies investigating interventions for PPCS in children are required and

there should be a focus on standardising treatments, conducting RCTs and measuring if effects are maintainable long-term. Longitudinal studies should also be considered to explore concussion education interventions as the increase in knowledge, as seen in the second empirical study, have been documented to be time-limited (Ramsay & Dahinten, 2020).

Given the teacher sample recruited in the empirical paper was not sufficiently powered to conduct regression analysis, it would be useful to repeat this study using the same survey to determine if the HBM variables predicts likely adherence behaviour in the same way as parents. Additionally, whilst poor adherence by children to concussion guidance is linked to increased PPCS (Hiployee et al., 2017), the direct effect of parents and teachers following guidelines on child outcomes has not been examined. If guidelines are not implemented by a child's support system and they return to school, sports and activities too early then they are at risk of a prolonged recovery (NICE, 2014[b]) and experiencing a second, more serious head injury (van Ierssel et al., 2021). Given the scope of this doctoral project, actual adherence and the impact on child recovery could not be explored but is identified as the next sensible and useful step of research. Literature suggests that up to 25% of children experience PPCS after concussion (Fried et al., 2022) yet it is currently unknown what proportion of this could be prevented, if any, if interventions are implemented and/or guidance closely followed. It is also important to acknowledge that pre-injury variables may impact recovery trajectories (Gunstad, 2001; Iverson et al., 2010; Bellanger et al., 2013; Brooks et al., 2018) and therefore some children may continue to experience persisting symptoms despite high adherence. Evidently, this would also be a valuable area to examine when exploring adherence behaviour e.g., do certain characteristics (such as pre-injury anxiety/low mood) moderate PPCS when high adherence to guidelines is present? Understanding this will clarify if and how educational resources and training for teachers and parents should be tailored.

Following this, the impact of educational resources on concussion knowledge, adherence to guidelines and most importantly, the recovery from concussion in children, should be examined. Outcomes may include level of

additional support given in the classroom, length of recovery, type of symptoms and the prevalence on PPCS.

Practically, work needs to be done across healthcare services to ensure concussion information is given consistently at the point of access and is standardised (NICE, 2014). Additionally, research measuring the provider of this information may be useful given it has been suggested that who provides concussion resources may be important in how closely adhered to concussion guidelines are, with medical professionals shown to be influential with parents (Koo, 2013). Ninety-six percent of parents in the current empirical study indicated they would follow guidelines if told to by a healthcare provider and 82% would if told to by a teacher demonstrating both are important in their decision making.

Given the low internal consistency of some of the measures, further exploration of survey items is warranted. Some items may need to be removed and new items developed, and psychometrics re-examined to strengthen the measurement of the intended variables. In addition to this, exploratory factor analysis to identify which items load onto the factors of interest most strongly could be conducted, and the redundant variables removed (Fabrigar & Wegener, 2011). Criterion validity of the items and reliability assessment (e.g., test-retest) should also be considered to explore the psychometric properties and validate the survey (Burton & Mazerolle, 2011; Clark-Carter, 2018). The survey offers the potential for a new tool measuring knowledge and perceptions across concussive injuries and may be worth developing further to use with other UK populations such as medical professionals involved with the treatment of child concussion.

Personal Reflections

Given my own clinical experience working in neurological teams and witnessing first-hand the gap in services for persistent concussive symptoms, I was surprised by the bias of literature focused on sports-related concussion. Over several years, only a handful of clients I supported had sustained concussion from sporting accidents with most injured instead in road traffic accidents or from other causes e.g., abuse or accidental injuries.

From both a research point of view and clinical stance, there appears to be a need for more early support both in prevention information and intervention. The process of examining the literature base in detail has reinforced my passion to work towards making such changes in services that can directly benefit clients in need. It also emphasised the importance of being a scientist-practitioner in the production of clinically meaningful research.

The novelty of this area of research meant that it was a struggle to narrow down the variables of interest to examine on adherence behaviour. This meant that the survey and amount of data collected was quite overwhelming and resulted in the data on feasibility and acceptability being presented in the thesis portfolio as a separate empirical study. On reflection, some of the variables measured could have been streamlined which would have avoided the use of dummy coding which will have reduced the power of the regression model by introducing new variables. Overall, the process of completing a doctoral-level research project has been a valuable yet challenging experience that I know I will be able to draw upon during my many future years of working as a clinical psychologist.

Overall Conclusions

Improving awareness of concussion and PPCS and refining the support a child receives during their recovery is an area of growing interest globally. This thesis portfolio contributed to current research through bringing together literature on psychological interventions suitable for children with PPCS and considering the range of approaches and the effectiveness on symptomology, quality of life, depression, and anxiety. It also examined adherence behaviours among UK teachers and parents to following guidelines whilst supporting a child recovering from concussion. Findings suggest that effective interventions are limited, and current evidence indicates multimodal interventions with a psychological component, and psychoeducation may warrant further investigation. Parental adherence is predicted by perceived barriers, perceived susceptibility, and concussion knowledge. Educational interventions are a feasible and acceptable way for parents and teachers to learn about concussion recovery and may increase

concussion knowledge and adherence to guidelines. Limitations and areas for future research were discussed.

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Appendices

Appendix A: Neuropsychological Rehabilitation author submission guidelines

About the Journal

Neuropsychological Rehabilitation is an international, peer-reviewed journal publishing high-quality, original research. Please see the journal's Aims & Scope for information about its focus and peer-review policy.

Please note that this journal only publishes manuscripts in English.

Neuropsychological Rehabilitation accepts the following types of article: original articles, scholarly reviews, book reviews.

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Preparing Your Paper

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

Clinical trials: must conform to the Consort guidelines http://www.consort-statement.org. Submitted papers should include a checklist confirming that all of the Consort requirements have been met, together with the corresponding page number of the manuscript where the information is located. In addition, trials must be pre-registered on a site such as clinicaltrials.gov or equivalent, and the manuscript should include the reference number to the relevant pre-registration.

Systematic reviews: submitted papers should follow PRISMA http://www.prisma-statement.org/ guidelines and submission should also be accompanied by a completed PRISMA checklist, together with the corresponding page number of the manuscript where the information is located.

Single-case studies: submitted papers should follow SCRIBE guidelines (http://psycnet.apa.org/fulltext/2016-17384-001.html) and include a completed SCRIBE checklist together with the corresponding page number of the manuscript where the information is located.

Observational studies: submitted papers should follow the STROBE guidelines (https://www.strobe-statement.org/index.php?id=strobe-home) and also include a completed checklist of compliance, together with the corresponding page number of the manuscript where the information is located.

Qualitative studies: should follow the COREQ guidelines (http://www.equator-network.org/reporting-guidelines/coreq/) and be accompanied by a completed COREQ checklist of compliance, together with the corresponding page number of the manuscript where the information is located.

The EQUATOR Network (Enhancing the Quality and Transparency of Health Research) website provides further information on available guidelines.

Structure

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

Word Limits

Please include a word count for your paper. There are no word limits for papers in this journal.

Style Guidelines

Please refer to these quick style guidelines when preparing your paper, rather than any published articles or a sample copy.

Please use American spelling style consistently throughout your manuscript.

Please use single quotation marks, except where ‘a quotation is “within” a quotation’.

Please note that long quotations should be indented without quotation marks.

Alt Text

This journal is now including Alt Text (alternative text), a short piece of text that can be attached to your figure to convey to readers the nature or contents of the image. It is typically used by systems such as pronouncing screen readers to make the object accessible to people that cannot read or see the object, due to a visual impairment or print disability.

Alt text will also be displayed in place of an image, if said image file cannot be loaded. Alt Text can also provide better image context/descriptions to search engine crawlers, helping them to index an image properly.

To include Alt Text in your article, please follow our Guidelines

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Authors may submit their paper in any scholarly format or layout. Manuscripts may be supplied as single or multiple files. These can be Word, rich text format (rtf), open document format (odt), or PDF files. Figures and tables can be placed within the text or submitted as separate documents. Figures should be of sufficient resolution to enable refereeing.

There are no strict formatting requirements, but all manuscripts must contain the essential elements needed to evaluate a manuscript: abstract, author affiliation, figures, tables, funder information, and references. Further details may be requested upon acceptance.

References can be in any style or format, so long as a consistent scholarly citation format is applied. Author name(s), journal or book title, article or chapter title, year of publication, volume and issue (where appropriate) and page numbers are essential. All bibliographic entries must contain a corresponding in-text citation. The addition of DOI (Digital Object Identifier) numbers is recommended but not essential.

The journal reference style will be applied to the paper post-acceptance by Taylor & Francis.

Spelling can be US or UK English so long as usage is consistent.

Note that, regardless of the file format of the original submission, an editable version of the article must be supplied at the revision stage.

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Checklist: What to Include

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

Should contain an unstructured abstract of 200 words.

You can opt to include a video abstract with your article. Find out how these can help your work reach a wider audience, and what to think about when filming.

Between 5 and 5 keywords. Read making your article more discoverable, including information on choosing a title and search engine optimization.

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

For single agency grants

This work was supported by the [Funding Agency] under Grant [number xxxx].

For multiple agency grants

This work was supported by the [Funding Agency #1] under Grant [number xxxx]; [Funding Agency #2] under Grant [number xxxx]; and [Funding Agency #3] under Grant [number xxxx].

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

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

Data deposition. If you choose to share or make the data underlying the study open, please deposit your data in a recognized data repository prior to or at the time of submission. You will be asked to provide the DOI, pre-reserved DOI, or other persistent identifier for the data set.

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Figures. Figures should be high quality (1200 dpi for line art, 600 dpi for grayscale and 300 dpi for colour, at the correct size). Figures should be supplied in one of our preferred file formats: EPS, PS, JPEG, TIFF, or Microsoft Word (DOC or

DOCX) files are acceptable for figures that have been drawn in Word. For information relating to other file types, please consult our Submission of electronic artwork document.

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

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

Units. Please use SI units (non-italicized).

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Clinical Trials Registry

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(prior to patient enrolment). Trial registration numbers should be included in the abstract, with full details in the methods section. The registry should be publicly accessible (at no charge), open to all prospective registrants, and managed by a not-for-profit organization. For a list of registries that meet these requirements, please visit the WHO International Clinical Trials Registry Platform (ICTRP). The registration of all clinical trials facilitates the sharing of information among clinicians, researchers, and patients, enhances public confidence in research, and is in accordance with the ICMJE guidelines.

Complying With Ethics of Experimentation

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

Consent

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

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Please confirm that all mandatory laboratory health and safety procedures have been complied with in the course of conducting any experimental work reported in your paper. Please ensure your paper contains all appropriate warnings on any hazards that may be involved in carrying out the experiments or procedures you have described, or that may be involved in instructions, materials, or formulae.

Please include all relevant safety precautions; and cite any accepted standard or code of practice. Authors working in animal science may find it useful to consult the International Association of Veterinary Editors' Consensus Author Guidelines on Animal Ethics and Welfare and Guidelines for the Treatment of Animals in Behavioural Research and Teaching. When a product has not yet been approved by an appropriate regulatory body for the use described in your paper, please specify this, or that the product is still investigational.

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Authors are further encouraged to cite any data sets referenced in the article and provide a Data Availability Statement.

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

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

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Appendix B: Search strategy

Medline, CINAHL and PsychINFO

S1. “mild traumatic brain injury” OR “mild tbi” OR mtbi OR concuss* OR post-concuss* OR postconcuss* OR "post concuss*"

S2. (DE "Brain Injuries") OR (DE "Brain Concussion")

S3. Child* OR paed* OR ped* OR kid* or adolesc* OR school-age* OR youth* OR teen* OR boy* or girl* or preteen* or pre-teen* or or teen-age* or prepubescen* or pre-pubescen* or pubescen*

S4. intervention* or therap* or rehab* or manage* or treat* or strateg* or educat* or support*

S5. "Quality of life" or "well being" or well-being or QoL or Symptom* or Skill* or Function* or Abilit* or Outcome* or Recover*

S6. DE "Psychosocial Outcomes" or psych*

S7. S1 OR S2

S8. S7 AND S3 AND S4 AND S5 AND S6

S9. S8 NOT AB (veteran or military or soldier or servicemen)

Limiters - Human; Language: English

Web of Science

S1. “mild traumatic brain injury” OR “mild tbi” OR mtbi OR concuss* OR post-concuss* OR postconcuss* OR "post concuss*"

S2. Child* OR paed* OR ped* OR kid* or adolesc* OR school-age* OR youth* OR teen* OR boy* or girl* or preteen* or pre-teen* or or teen-age* or prepubescen* or pre-pubescen* or pubescen*

S3. intervention* or therap* or rehab* or manage* or treat* or strateg* or educat* or support*

S4. "Quality of life" or "well being" or well-being or QoL or Symptom* or Skill* or Function* or Abilit* or Outcome* or Recover*

S5. psych*

S6. S1 AND S2 AND S3 AND S4 AND S5

S7. S6 NOT AB (veteran or military or soldier or servicemen)

NeuroBITE (yielded only 129 results with the below terms, reviewed all titles for inclusion)

S1. mild traumatic brain injury OR mild tbi OR mtbi OR concuss OR post-concuss OR postconcuss OR post concuss

Appendix C: Quality assessment ratings. Quality assessment of controlled intervention studies and risk of bias

	Renaud et al., 2020	Chan et al., 2018	McCarty et al., 2016	McCarty et al., 2021	Gauvin-Lepage et al., 2020	Mortenson et al., 2016	Olsson et al., 2014	Ponsford et al., 2012	Tomfohr-Madsen et al., 2019	Worthen-chaudhari et al., 2017
Was the study described as randomized, a randomized trial, a randomized clinical trial, or an RCT?	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No
Was the method of randomization adequate (i.e., use of randomly generated assignment)?	Yes	Yes	Yes	Yes	N/A	Yes	Yes	No	Yes	N/A
Was the treatment allocation concealed (so that assignments could not be predicted)?	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No
Were study participants and providers blinded to treatment group assignment?	Yes	NR	Yes	Yes	No	Yes	Yes	No	Yes	No
Were the people assessing the outcomes blinded to the participants' group assignments?	Yes	Yes	CD	Yes	Yes	NR	NR	NR	Yes	No
Were the groups similar at baseline on important characteristics that could affect outcomes (e.g., demographics, risk factors, co-morbid conditions)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the overall drop-out rate from the study at endpoint 20% or lower of the number allocated to treatment?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NR
Was the differential drop-out rate (between treatment groups) at endpoint 15 percentage points or lower?	N/A	N/A	Yes	Yes	Yes	NR	Yes	Yes	Yes	NR
Was there high adherence to the intervention protocols for each treatment group?	NR	NR	CD	NR	NR	NR	NR	NR	NR	Yes
Were other interventions avoided or similar in the groups (e.g., similar background treatments)?	NR	CD	NR	NR	NR	NR	CD	NR	NR	NR
Were outcomes assessed using valid and reliable measures, implemented consistently across all study participants?	Yes	Yes	YES	Yes	Yes	Yes	Yes	CD	Yes	Yes
Did the authors report that the sample size was sufficiently large to be able to detect a difference in the main outcome between groups with at least 80% power?	NR	No	No	Yes	NR	NR	No	No	NR	No
Were outcomes reported or subgroups analysed prespecified (i.e., identified before analyses were conducted)?	Yes	Yes	YES	Yes	Yes	Yes	NR	Yes	Yes	Yes
Were all randomized participants analysed in the group to which they were originally assigned, i.e., did they use an intention-to-treat analysis?	Yes	Yes	YES	Yes	Yes	Yes	Yes	Yes	Yes	N/A
Quality rating (Good, Fair, Poor) Risk of bias rating (Low, Medium, High)	Good Low	Fair Med	Fair Med	Good Low	Fair Med	Good Low	Fair Med	Poor High	Fair Med	Poor High

Quality assessment of before-after (pre-post) intervention studies with no control group and risk of bias rating

	Dobney et al., 2017	O'Neill et al., 2021	Hunt et al., 2020	Cook et al., 2021	Kirkwood et al., 2016	McNally et al., 2017	Simpson et al., 2020	Gagnon et al., 2016
Was the study question or objective clearly stated?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were eligibility/selection criteria for the study population prespecified and clearly described?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were all eligible participants that met the prespecified entry criteria enrolled?	Yes	Yes	Yes	No	No	NR	Yes	Yes
Was the sample size sufficiently large to provide confidence in the findings?	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Was the test/service/intervention clearly described and delivered consistently across the study population?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the outcome measures prespecified, clearly defined, valid, reliable, and assessed consistently across all study participants?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the people assessing the outcomes blinded to the participants' exposures/interventions?	NR	NR	NR	NR	NR	NR	NR	N/A
Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in the analysis?	NR	Yes	Yes	NR	NR	Yes	No	Yes
Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post changes?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were outcome measures of interest taken multiple times before the intervention and multiple times after the intervention (i.e., did they use an interrupted time-series design)?	No	Yes	No	No	Yes	No	No	No
If the intervention was conducted at a group level (e.g., a whole hospital, a community, etc.) did the statistical analysis take into account the use of individual-level data to determine effects at the group level?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Quality rating (Good, Fair, Poor) Risk of bias rating (Low, Medium, High)	Good Low	Good Low	Good Low	Fair Med	Good Low	Good Low	Good Low	Fair Med

Quality assessment of case-series studies and risk of bias rating

	Gagnon et al., 2009
Was the study question or objective clearly stated?	Yes
Was the study population clearly and fully described, including a case definition?	Yes
Were the cases consecutive?	Yes
Were the subjects comparable?	Yes
Was the intervention clearly described?	Yes
Were the outcome measures clearly defined, valid, reliable, and implemented consistently across all study participants?	No
Was the length of follow-up adequate?	Yes
Were the statistical methods well-described?	No
Were the results well-described?	No
Quality rating (Good, Fair, Poor) Risk of bias rating (Low, Medium, High)	Fair Med

	Yes
	No
	CD (cannot determine)
	NA (not applicable)
	NR (not reported)

Guidance for Assessing the Quality of Controlled Intervention Studies

The guidance document below is organized by question number from the tool for quality assessment of controlled intervention studies.

Question 1. Described as randomized

Was the study described as randomized? A study does not satisfy quality criteria as randomized simply because the authors call it randomized; however, it is a first step in determining if a study is randomized

Questions 2 and 3. Treatment allocation–two interrelated pieces

Adequate randomization: Randomization is adequate if it occurred according to the play of chance (e.g., computer generated sequence in more recent studies, or random number table in older studies).
Inadequate randomization: Randomization is inadequate if there is a preset plan (e.g., alternation where every other subject is assigned to treatment arm or another method of allocation is used, such as time or day of hospital admission or clinic visit, ZIP Code, phone number, etc.). In fact, this is not randomization at all–it is another method of assignment to groups. If assignment is not by the play of chance, then the answer to this question is no.
There may be some tricky scenarios that will need to be read carefully and considered for the role of chance in assignment. For example, randomization may occur at the site level, where all individuals at a particular site are assigned to receive treatment or no treatment. This scenario is used for group-randomized trials, which can be truly randomized, but often are "quasi-experimental" studies with comparison groups rather than true control groups. (Few, if any, group-randomized trials are anticipated for this evidence review.)

Allocation concealment: This means that one does not know in advance, or cannot guess accurately, to what group the next person eligible for randomization will be assigned. Methods include sequentially numbered opaque sealed envelopes, numbered or coded containers, central randomization by a coordinating center, computer-generated randomization that is not revealed ahead of time, etc.

Questions 4 and 5. Blinding

Blinding means that one does not know to which group–intervention or control–the participant is assigned. It is also sometimes called "masking." The reviewer assessed whether each of the following was blinded to knowledge of treatment assignment: (1) the person assessing the primary outcome(s) for the study (e.g., taking the measurements such as blood pressure, examining health records for events such as myocardial infarction, reviewing and interpreting test results such as x ray or cardiac catheterization findings); (2) the person receiving the intervention (e.g., the patient or other study participant); and (3) the person providing the

intervention (e.g., the physician, nurse, pharmacist, dietitian, or behavioral interventionist).

Generally placebo-controlled medication studies are blinded to patient, provider, and outcome assessors; behavioral, lifestyle, and surgical studies are examples of studies that are frequently blinded only to the outcome assessors because blinding of the persons providing and receiving the interventions is difficult in these situations. Sometimes the individual providing the intervention is the same person performing the outcome assessment. This was noted when it occurred.

Question 6. Similarity of groups at baseline

This question relates to whether the intervention and control groups have similar baseline characteristics on average especially those characteristics that may affect the intervention or outcomes. The point of randomized trials is to create groups that are as similar as possible except for the intervention(s) being studied in order to compare the effects of the interventions between groups. When reviewers abstracted baseline characteristics, they noted when there was a significant difference between groups. Baseline characteristics for intervention groups are usually presented in a table in the article (often Table 1).

Groups can differ at baseline without raising red flags if: (1) the differences would not be expected to have any bearing on the interventions and outcomes; or (2) the differences are not statistically significant. When concerned about baseline difference in groups, reviewers recorded them in the comments section and considered them in their overall determination of the study quality.

Questions 7 and 8. Dropout

"Dropouts" in a clinical trial are individuals for whom there are no end point measurements, often because they dropped out of the study and were lost to followup.

Generally, an acceptable overall dropout rate is considered 20 percent or less of participants who were randomized or allocated into each group. An acceptable differential dropout rate is an absolute difference between groups of 15 percentage points at most (calculated by subtracting the dropout rate of one group minus the dropout rate of the other group). However, these are general rates. Lower overall dropout rates are expected in shorter studies, whereas higher overall dropout rates may be acceptable for studies of longer duration. For example, a 6-month study of weight loss interventions should be expected to have nearly 100 percent followup (almost no dropouts–nearly everybody gets their weight measured regardless of whether or not they actually received the intervention), whereas a 10-year study testing the effects of intensive blood pressure lowering on heart attacks may be acceptable if there is a 20-25 percent dropout rate, especially if the dropout rate between groups was similar. The panels for the NHLBI systematic reviews may set different levels of dropout caps.

Conversely, differential dropout rates are not flexible; there should be a 15 percent cap. If there is a differential dropout rate of 15 percent or higher between arms, then there is a serious potential for bias. This constitutes a fatal flaw, resulting in a poor quality rating for the study.

Question 9. Adherence

Did participants in each treatment group adhere to the protocols for assigned interventions? For example, if Group 1 was assigned to 10 mg/day of Drug A, did most of them take 10 mg/day of Drug A? Another example is a study evaluating the difference between a 30-pound weight loss and a 10-pound weight loss on specific clinical outcomes (e.g., heart attacks), but the 30-pound weight loss group did not achieve its intended weight loss target (e.g., the group only lost 14 pounds on average). A third example is whether a large percentage of participants assigned to one group "crossed over" and got the intervention provided to the other group. A final example is when one group that was assigned to receive a particular drug at a particular dose had a large percentage of participants who did not end up taking the drug or the dose as designed in the protocol.

Question 10. Avoid other interventions

Changes that occur in the study outcomes being assessed should be attributable to the interventions being compared in the study. If study participants receive interventions that are not part of the study protocol and could affect the outcomes being assessed, and they receive these interventions differentially, then there is cause for concern because these interventions could bias results. The following scenario is another example of how bias can occur. In a study comparing two different dietary interventions on serum cholesterol, one group had a significantly higher percentage of participants taking statin drugs than the other group. In this situation, it would be impossible to know if a difference in outcome was due to the dietary intervention or the drugs.

Question 11. Outcome measures assessment

What tools or methods were used to measure the outcomes in the study? Were the tools and methods accurate and reliable–for example, have they been validated, or are they objective? This is important as it indicates the confidence you can have in the reported outcomes. Perhaps even more important is ascertaining that outcomes were assessed in the same manner within and between groups. One example of differing methods is self-report of dietary salt intake versus urine testing for sodium content (a more reliable and valid assessment method). Another example is using BP measurements taken by practitioners who use their usual methods versus using BP measurements done by individuals trained in a standard approach. Such an approach may include using the same instrument each time and taking an individual's BP multiple times. In each of these cases, the answer to this assessment question would be "no" for the former scenario and "yes" for the latter. In addition, a study in which an intervention group was seen more

frequently than the control group, enabling more opportunities to report clinical events, would not be considered reliable and valid.

Question 12. Power calculation

Generally, a study's methods section will address the sample size needed to detect differences in primary outcomes. The current standard is at least 80 percent power to detect a clinically relevant difference in an outcome using a two-sided alpha of 0.05. Often, however, older studies will not report on power.

Question 13. Prespecified outcomes

Investigators should prespecify outcomes reported in a study for hypothesis testing–which is the reason for conducting an RCT. Without prespecified outcomes, the study may be reporting ad hoc analyses, simply looking for differences supporting desired findings. Investigators also should prespecify subgroups being examined. Most RCTs conduct numerous post hoc analyses as a way of exploring findings and generating additional hypotheses. The intent of this question is to give more weight to reports that are not simply exploratory in nature.

Question 14. Intention-to-treat analysis

Intention-to-treat (ITT) means everybody who was randomized is analyzed according to the original group to which they are assigned. This is an extremely important concept because conducting an ITT analysis preserves the whole reason for doing a randomized trial; that is, to compare groups that differ only in the intervention being tested. When the ITT philosophy is not followed, groups being compared may no longer be the same. In this situation, the study would likely be rated poor. However, if an investigator used another type of analysis that could be viewed as valid, this would be explained in the "other" box on the quality assessment form. Some researchers use a completers analysis (an analysis of only the participants who completed the intervention and the study), which introduces significant potential for bias. Characteristics of participants who do not complete the study are unlikely to be the same as those who do. The likely impact of participants withdrawing from a study treatment must be considered carefully. ITT analysis provides a more conservative (potentially less biased) estimate of effectiveness.

General Guidance for Determining the Overall Quality Rating of Controlled Intervention Studies

The questions on the assessment tool were designed to help reviewers focus on the key concepts for evaluating a study's internal validity. They are not intended to create a list that is simply tallied up to arrive at a summary judgment of quality.

Internal validity is the extent to which the results (effects) reported in a study can truly be attributed to the intervention being evaluated and not to

flaws in the design or conduct of the study–in other words, the ability for the study to make causal conclusions about the effects of the intervention being tested. Such flaws can increase the risk of bias. Critical appraisal involves considering the risk of potential for allocation bias, measurement bias, or confounding (the mixture of exposures that one cannot tease out from each other). Examples of confounding include co-interventions, differences at baseline in patient characteristics, and other issues addressed in the questions above. High risk of bias translates to a rating of poor quality. Low risk of bias translates to a rating of good quality.

Fatal flaws: If a study has a "fatal flaw," then risk of bias is significant, and the study is of poor quality. Examples of fatal flaws in RCTs include high dropout rates, high differential dropout rates, no ITT analysis or other unsuitable statistical analysis (e.g., completers-only analysis).

Generally, when evaluating a study, one will not see a "fatal flaw;" however, one will find some risk of bias. During training, reviewers were instructed to look for the potential for bias in studies by focusing on the concepts underlying the questions in the tool. For any box checked "no," reviewers were told to ask: "What is the potential risk of bias that may be introduced by this flaw?" That is, does this factor cause one to doubt the results that were reported in the study?

NHLBI staff provided reviewers with background reading on critical appraisal, while emphasizing that the best approach to use is to think about the questions in the tool in determining the potential for bias in a study. The staff also emphasized that each study has specific nuances; therefore, reviewers should familiarize themselves with the key concepts.

Guidance for Assessing the Quality of Before-After (Pre-Post) Studies With No Control Group

The guidance document below is organized by question number from the tool for quality assessment of controlled intervention studies.

Question 1. Study question

Did the authors describe their goal in conducting this research? Is it easy to understand what they were looking to find? This issue is important for any scientific paper of any type. Higher quality scientific research explicitly defines a research question.

Question 2. Eligibility criteria and study population

Did the authors describe the eligibility criteria applied to the individuals from whom the study participants were selected or recruited? In other words, if the investigators were to conduct this study again, would they know whom to recruit, from where, and from what time period?

Here is a sample description of a study population: men over age 40 with type 2 diabetes, who began seeking medical care at Phoenix Good Samaritan Hospital, between January 1, 2005 and December 31, 2007. The population is clearly described as: (1) who (men over age 40 with type 2 diabetes); (2) where (Phoenix Good Samaritan Hospital); and (3) when (between January 1, 2005 and December 31, 2007). Another sample description is women who were in the nursing profession, who were ages 34 to 59 in 1995, had no known CHD, stroke, cancer, hypercholesterolemia, or diabetes, and were recruited from the 11 most populous States, with contact information obtained from State nursing boards.

To assess this question, reviewers examined prior papers on study methods (listed in reference list) when necessary.

Question 3. Study participants representative of clinical populations of interest

The participants in the study should be generally representative of the population in which the intervention will be broadly applied. Studies on small demographic subgroups may raise concerns about how the intervention will affect broader populations of interest. For example, interventions that focus on very young or very old individuals may affect middle-aged adults differently. Similarly, researchers may not be able to extrapolate study results from patients with severe chronic diseases to healthy populations.

Question 4. All eligible participants enrolled

To further explore this question, reviewers may need to ask: Did the investigators develop the I/E criteria prior to recruiting or selecting study participants? Were the same underlying I/E criteria used for all research participants? Were all subjects who met the I/E criteria enrolled in the study?

Question 5. Sample size

Did the authors present their reasons for selecting or recruiting the number of individuals included or analyzed? Did they note or discuss the statistical power of the study? This question addresses whether there was a sufficient sample size to detect an association, if one did exist.

An article's methods section may provide information on the sample size needed to detect a hypothesized difference in outcomes and a discussion on statistical power (such as, the study had 85 percent power to detect a 20 percent increase in the rate of an outcome of interest, with a 2-sided alpha of 0.05). Sometimes estimates of variance and/or estimates of effect size are given, instead of sample size calculations. In any case, if the reviewers determined that the power was sufficient to detect the effects of interest, then they would answer "yes" to Question 5.

Question 6. Intervention clearly described

Another pertinent question regarding interventions is: Was the intervention clearly defined in detail in the study? Did the authors indicate that the intervention was consistently applied to the subjects? Did the research participants have a high level of adherence to the requirements of the intervention? For example, if the investigators assigned a group to 10 mg/day of Drug A, did most participants in this group take the specific dosage of Drug A? Or did a large percentage of participants end up not taking the specific dose of Drug A indicated in the study protocol?

Reviewers ascertained that changes in study outcomes could be attributed to study interventions. If participants received interventions that were not part of the study protocol and could affect the outcomes being assessed, the results could be biased.

Question 7. Outcome measures clearly described, valid, and reliable

Were the outcomes defined in detail? Were the tools or methods for measuring outcomes accurate and reliable–for example, have they been validated or are they objective? This question is important because the answer influences confidence in the validity of study results.

An example of an outcome measure that is objective, accurate, and reliable is death–the outcome measured with more accuracy than any other. But even with a measure as objective as death, differences can exist in the accuracy and reliability of how investigators assessed death. For example, did they base it on an autopsy report, death certificate, death registry, or report from a family member? Another example of a valid study is one whose objective is to determine if dietary fat intake affects blood cholesterol level (cholesterol level being the outcome) and in which the cholesterol level is measured from fasting blood samples that are all sent to the same laboratory. These examples would get a "yes."

An example of a "no" would be self-report by subjects that they had a heart attack, or self-report of how much they weight (if body weight is the outcome of interest).

Question 8. Blinding of outcome assessors

Blinding or masking means that the outcome assessors did not know whether the participants received the intervention or were exposed to the factor under study. To answer the question above, the reviewers examined articles for evidence that the person(s) assessing the outcome(s) was masked to the participants' intervention or exposure status. An outcome assessor, for example, may examine medical records to determine the outcomes that occurred in the exposed and comparison groups. Sometimes the person applying the intervention or measuring the exposure is the same person conducting the outcome assessment. In this case, the outcome assessor would not likely be blinded to the intervention or exposure status. A reviewer would note such a finding in the comments section of the assessment tool.

In assessing this criterion, the reviewers determined whether it was likely that the person(s) conducting the outcome assessment knew the exposure status of the study participants. If not, then blinding was adequate. An example of adequate blinding of the outcome assessors is to create a separate committee whose members were not involved in the care of the patient and had no information about the study participants' exposure status. Using a study protocol, committee members would review copies of participants' medical records, which would be stripped of any potential exposure information or personally identifiable information, for prespecified outcomes.

Question 9. Followup rate

Higher overall followup rates are always desirable to lower followup rates, although higher rates are expected in shorter studies, and lower overall followup rates are often seen in longer studies. Usually an acceptable overall followup rate is considered 80 percent or more of participants whose interventions or exposures were measured at baseline. However, this is a general guideline.

In accounting for those lost to followup, in the analysis, investigators may have imputed values of the outcome for those lost to followup or used other methods. For example, they may carry forward the baseline value or the last observed value of the outcome measure and use these as imputed values for the final outcome measure for research participants lost to followup.

Question 10. Statistical analysis

Were formal statistical tests used to assess the significance of the changes in the outcome measures between the before and after time periods? The reported study results should present values for statistical tests, such as p values, to document the statistical significance (or lack thereof) for the changes in the outcome measures found in the study.

Question 11. Multiple outcome measures

Were the outcome measures for each person measured more than once during the course of the before and after study periods? Multiple measurements with the same result increase confidence that the outcomes were accurately measured.

Question 12. Group-level interventions and individual-level outcome efforts

Group-level interventions are usually not relevant for clinical interventions such as bariatric surgery, in which the interventions are applied at the individual patient level. In those cases, the questions were coded as "NA" in the assessment tool.

General Guidance for Determining the Overall Quality Rating of Before-After Studies

The questions in the quality assessment tool were designed to help reviewers focus on the key concepts for evaluating the internal validity of a study. They are not intended to create a list from which to add up items to judge a study's quality.

Internal validity is the extent to which the outcome results reported in the study can truly be attributed to the intervention or exposure being evaluated, and not to biases, measurement errors, or other confounding factors that may result from flaws in the design or conduct of the study. In other words, what is the ability of the study to draw associative conclusions about the effects of the interventions or exposures on outcomes?

Critical appraisal of a study involves considering the risk of potential for selection bias, information bias, measurement bias, or confounding (the mixture of exposures that one cannot tease out from each other). Examples of confounding include co-interventions, differences at baseline in patient characteristics, and other issues throughout the questions above. High risk of bias translates to a rating of poor quality; low risk of bias translates to a rating of good quality. Again, the greater the risk of bias, the lower the quality rating of the study.

In addition, the more attention in the study design to issues that can help determine if there is a causal relationship between the exposure and outcome, the higher quality the study. These issues include exposures occurring prior to outcomes, evaluation of a dose-response gradient, accuracy of measurement of both exposure and outcome, and sufficient timeframe to see an effect.

Generally, when reviewers evaluate a study, they will not see a "fatal flaw," but instead will find some risk of bias. By focusing on the concepts underlying the questions in the quality assessment tool, reviewers should ask themselves about the potential for bias in the study they are critically appraising. For any box checked "no" reviewers should ask, "What is the potential risk of bias resulting from this flaw in study design or execution?" That is, does this factor lead to doubt about the results reported in the study or doubt about the ability of the study to accurately assess an association between the intervention or exposure and the outcome?

The best approach is to think about the questions in the assessment tool and how each one reveals something about the potential for bias in a study. Specific rules are not useful, as each study has specific nuances. In addition, being familiar with the key concepts will help reviewers be more comfortable with critical appraisal. Examples of studies rated good, fair, and poor are useful, but each study must be assessed on its own

Appendix D: Intervention components using the Template for Intervention Description and Replication (TIDieR)

Author	Brief name (*Item 1*)	Rationale/Theory (*Item 2*)	What (procedures and materials; Items *3 and 4*)	Who provided (*Item 5*)	How and Where (*Items 6 and 7*)	When and how much (*Item 8*)	Tailoring and modifications (*Items 9 and 10*)	Adherence (*Items 11 and 12*)
Gagnon et al (2009)	Active rehabilitation for sports related concussion in children	▪There is an understanding from research that 1) symptoms of post-concussion are non-specific, 2) the impact of concussion is multidimensional and 3) exercise can have positive effects on many of the reported symptoms of post-concussion e.g., sleep, mood and relationships. ▪As a result, a programme was developed that consists of gradual, closely monitored physical conditioning, general coordination exercises, visualization, as well as education and motivation activities. ▪Detailed rationale for each component of the intervention can be found in Table 1 of the additional Figures and Data.	▪The intervention consists of three components including aerobic training (15 mins), light coordination exercises tailored to the adolescent's favourite activity/main sport (10 mins), and visualization/positive imagery (10 mins) aiming to promote positive experiences in relation to the physical exercise. ▪Children then complete an individualised home programme with these 3 components. ▪The programme is "performed in the presence of persistent symptoms in order to contribute to their resolution as well as to improve children's general physical condition and mood." ▪Materials: Consent forms, daily log for intervention completion.	▪Physiotherapist. ▪Ongoing team management with physiotherapist, psychologist, and medical doctor.	▪Appointments were weekly in clinic until the participant could independently carry out the home treatment programme. ▪Montreal, Canada	▪The programme is designed to last until complete symptom resolution at rest. At that point, children can resume to the standard return to activity guidance. ▪The mean number of weeks of intervention was 4.4 (SD = 2.6).	▪The programme is individualised depending on symptom presentation. ▪No modifications to study reported.	▪Not reported.
Gagnon et al (2016)	Active rehabilitation for sports related concussion in children	▪Gradual resumption of activities in the first month following injury, with active rehabilitation for those with ongoing symptoms is recommended commonly in the literature (Silverberg and Iverson; 2012). ▪A detailed rationale for each component of the intervention can be found in Table 1 of the additional Figures and Data (Gagnon et al, 2009).	▪Participants balance and cognitive ability was assessed in the first appointment and reassessed 6 weeks after treatment. ▪The intervention consists of three components including aerobic training (15 mins), light coordination exercises tailored to the adolescent's favourite activity/main sport (10 mins), and visualization/positive imagery (10 mins) aiming to promote positive experiences in relation to the physical exercise. ▪Children then complete an individualised home programme with these 3 components. ▪"During clinic visits, families are provided with general coping strategies, education and reassurance relating to persistent symptoms and recovery." ▪Materials: Daily logbook for participants to record activity.	▪Physiotherapist. ▪Re-assessment of balance and cognition is completed by an independent evaluator.	▪Appointments were weekly in clinic until the participant could independently carry out the home treatment programme. ▪Montreal, Canada	▪The home programme is completed daily for 20-30 minutes. ▪At approximately 10-day intervals, the clinical team assess participants for PCS. ▪Once the child is symptom free for one week during rest, they begin a standard return to activity protocol.	▪The programme is adjusted (in duration and intensity) according to post-concussion symptoms reported by families at 10-day intervals. ▪Some participants continued the intervention past the 6 weeks as they continued to experience symptoms. ▪No modifications to study reported.	▪Not reported.
Chan et al (2018)	Active rehabilitation for sports related concussion in children	▪Prolonged rest is no longer understood to be an effective treatment option for concussion. ▪An alternative treatment approach for adolescents who are slow to recover from concussion has been developed by Gagnon and colleagues. ▪Two case series designs (Gagnon et al, 2009; 2016) have shown participants experienced symptom improvement and returned to normal activities with this protocol.	▪The same intervention procedure as described in Gagnon et al (2016) was followed. ▪Materials: Daily logbook for participants to record activity. A written manual was used by the research team to deliver the program.	▪Physiotherapist. ▪A blinded research assistant telephoned participants weekly to administer a concussion measure and check for adverse events.	▪Appointments were weekly in clinic until the participant could independently carry out the home treatment programme. ▪Vancouver, Canada	▪The intervention period was 6 weeks long. The follow up appointment took place after the intervention finished. ▪The mean number of sessions in-person with the physiotherapist was 3.4. This is decided by the clinician. ▪The home treatment programme is	Some patients received manual therapy and vestibular rehabilitation, neither are part of the Gagnon intervention protocol but are consistent with evidence for treatment of concussion. ▪No modifications to study reported.	▪ The program was administered according to a written manual to ensure fidelity.

						recommended for 20-30 minutes per day.		
Dobney et al (2017)	Active rehabilitation for concussion in children and adolescents	▪Physical exercise is well documented to have a positive effect on general wellbeing as well as on mood, sleep, and cognition. These are common areas of difficulty after concussion. Therefore, physical exercise as a treatment for concussion is of interest. ▪"Studies to date have demonstrated that individualized, physical activity strategies appear safe, feasible (Gagnon et al, 2015) and may promote recovery (Gagnon et al, 2009; Hugentobler et al, 2015; Kurowski et al, 2016).	▪The same intervention procedure as described in Gagnon et al (2016) was followed. ▪Materials: Daily logbook for participants to record activity. A written manual was used by the research team to deliver the program.	▪Physiotherapist.	▪Appointments were weekly in clinic until the participant could independently carry out the home treatment programme. ▪Montreal, Canada	▪Participants started the intervention within three to four weeks of their injury. The intervention period was 6 weeks long. They received a follow up appointment between four- and eight-weeks post injury. ▪The home treatment programme is recommended for 20-30 minutes per day.	▪Some patients were referred for neuropsychological or psychological services and this was determined by the clinical care team based on the presence of existing mental health diagnoses or if difficulties were present in school. ▪No modifications to study reported.	▪Not reported.
Reed et al (2015)	Active rehabilitation for children with PPCS (paper 1)	▪Prolonged rest and extended periods of activity restriction may contribute to symptom maintenance (Schneider et al, 2013; Silverberg and Iverson, 2013; Thomas et al, 2015). ▪Exercise protocols can reduce post-concussive symptoms and recovery time (Leddy et al, 2010).	▪PROTOCOL PAPER ▪The same intervention procedure as described in Gagnon et al (2016) will be followed. ▪Materials: Daily logbook for participants to record activity. A written manual will be used by the research team to deliver the program.	▪Not described for intervention group. ▪An occupational therapist will deliver 'Usual Care'.	▪Appointments were weekly in clinic until the participant could independently carry out the home treatment programme. ▪Toronto, Canada.	▪Daily exercise programme lasting 6 weeks. ▪Weekly telephone checks-ins will occur at weeks 1, 2, and 4. ▪Participants will be seen in person at weeks 5 and 6.	▪All participants will receive individualised treatment depending on their presentation. ▪Protocol paper so no modifications to study reported as yet.	▪Participants will be asked to make up any missed sessions as soon as possible. ▪To reduce co-intervention bias, participants will be asked not to participate in any concurrent physical rehabilitation for PPCS during the study. A member of the research team would check this at Weeks 0, 3 and 6.
Gauvin Le Page et al (2020)	Active rehabilitation for children slow to recover from concussion	▪Interventions often cater towards the group of concussed individuals who follow the expected recovery. ▪Broader guidelines are required for those with persistent symptoms. Therefore, novel interventions need to be evaluated in this specific group compared with standard recommendations of rest-based/symptom-limiting activities.	▪The treatment intervention is similar to that described by Gagnon (2016) but with the addition of “education” as an official component ▪Aerobic activity (15 minutes), co-ordination/sport specific activity (10 minutes), mental imagery (5 minutes), education (on the recovery and coping strategies provided verbally in clinic appointments), and the home programme (all of the other components completed at home daily by participant). ▪Materials: Heart rate monitor in clinic. Activity diary for home treatment programme.	▪Physiotherapist.	▪All treatment sessions took place in clinic along with assessment 1. ▪Assessment 2 took place over the phone and assessment 3 took place in the youth's home. ▪Montreal, Canada.	▪The intervention period was 6 weeks long. ▪The home treatment programme is recommended for 20-30 minutes per day.	▪All participants will receive individualised treatment depending on their presentation. ▪No modifications to study reported.	▪Not reported.

Hunt et al (2020)	Active rehabilitation for children with PPCS (paper 2: focused on mood changes)	▪Active rehabilitation has been evidenced to be an effective intervention for symptom reduction after concussion in children. Often the focus of these interventions is to reduce physical symptoms. ▪Gauvin-Lepage et al (2018) found that adolescents that received active rehabilitation also reported higher QOL and less anger. ▪Mood changes are also commonly reported following a concussion and therefore this intervention may be able to target these symptoms, alongside physical complaints.	▪The intervention procedure was adapted from the protocols described in Gagnon et al (2016) and Gauvin Le Page et al (2018). "Participants were prescribed an individualized active rehabilitation program and provided with concussion education." ▪Materials: Daily logbook for participants to record activity. A written manual was used by the research team to deliver the program.	▪Trained research assistants.	▪Appointments were weekly in clinic until the participant could independently carry out the home treatment programme. ▪Children were recruited from a rehabilitation hospital in Toronto, Canada.	▪Daily exercise programme lasting 6 weeks. ▪Weekly telephone checks-ins will occur at weeks 1, 2, and 4. ▪Participants will be seen in person at weeks 5 and 6.	▪All participants will receive individualised treatment depending on their presentation. ▪No modifications to study reported.	▪Not reported.
O'Neill et al (2021)	Multidisciplinary Care intervention for PPCS	▪The most recent consensus statement on concussion in sport recommends that multidisciplinary care be used for the treatment of persistent PCS (McCory et al 2018). ▪Dobney et al (2017) state that psychological interventions utilising concussion education, sleep hygiene, relaxation training, activity scheduling and cognitive restructuring have been shown to improve QOL and concussion symptoms (McNally et al, 2018). ▪In addition, physical exercise has been evidenced to reduce symptoms in both the acute and chronic phase of concussion recovery (Leddy et al, 2010; Kurowski et al, 2017; Chan et al, 2018).	▪MDT care includes neuropsychology, physiotherapy, neurology and athletic training specialties. ▪Neuropsychology input typically involved formal cognitive assessment, feedback on their performance, recommendations for school reintegration and stress management. Follow-up (FU) involved components of CBT targeting symptom reduction and relaxation techniques. ▪Physiotherapy included assessment of cervical spine, motion sensitivity and balance. FU sessions included manual therapy, stretching, and strengthening, balance exercises, gaze stability and/or habituation exercises and otolith repositioning techniques. Home exercises were also provided. ▪The neurology visits involved confirmation of the concussion diagnosis, a review of their medical history, medication recommendations and prescriptions if required. FU would involve medication management and symptom monitoring. ▪The Athletic Trainer (AT) assessed balance and movement and provided a tailored exercise workout of cardio and body-weight exercises. Adjustments based on their presentation were made at FUs. The SCAT5 was completed at the start and finish of every AT visit. ▪Materials: Neuropsychological tests and some formal physio and athletic trainer assessment tools.	▪Sessions delivered by a licensed, board-certified paediatric neuropsychologist or a postdoctoral fellow in neuropsychology, a licensed physical therapist with certification in Vestibular Rehabilitation, a licensed, board-certified paediatric neurologist, and a certified athletic trainer.	▪Appointments were face to face in clinic. Participant also engages in workout routines at home. ▪Ohio, USA.	▪The frequency of follow up appointments was determined by each specialty based on assessment of clinical need. ▪The mean days of intervention was 55.39 (SD =25.18). ▪The median number of sessions for psychology was 2, for physiotherapy was 3, neurology was 2 and AT was 4.	▪All participants will have received individualised treatment depending on their presentation. ▪No modifications to study reported.	▪Not reported.
Anderson et al (2021)	Multimodal post-concussion symptom treatment: The concussions essential study	▪Unimodal interventions do not take into account the wide variation of PPCS profiles or the interaction between symptoms (e.g. fatigue impacts on mood). Some studies have shown that multimodal	▪PROTOCOL PAPER ▪Treatment modules include concussion education, physiotherapy, and psychology. All participants receiving the intervention are given "generic" concussion education and physiotherapy topics in week 1. Subsequent	▪Multidisciplinary team consisting of neuropsychologist, psychologist, and physiotherapist. No	▪Appointments are clinician led and take place face to face in clinic. ▪Melbourne, Australia	▪Weekly individual sessions for up to 8 weeks or until symptom resolution. ▪Each topic within the modules is designed as 30-minute session and all	▪Each participant will receive individualised treatment. ▪Protocol only. The data safety monitoring board will meet every	▪"To optimise treatment adherence and minimise therapist drift, clinicians will

		interventions for youth with PPCS can be effective in reducing symptoms (Gagnon, 2016 and 2009; Chan et al, 2018). ▪The intervention aims to accelerate symptom recovery and increase the proportion of children who are symptom free at 3-months post-concussion.	module topics are selected weekly by clinicians. ▪Generic modules cover return to school and physical activity, sleep, headaches, and fatigue. Physiotherapy modules include support for vestibular, ocular motor, cervical spine and physiological symptoms. Psychological modules include delivery of a manualised Cognitive Behavioural Therapy programme (COPE; Creating Opportunities for Personal Empowerment). ▪Materials: handouts on symptom-targeted education and strategies (see online supplemental material 3).	formal qualifications listed.		participants complete a 1-hour intervention session per week. Therefore, each session may compose of two topics from the same module or two topics from two different modules. ▪The team meets weekly to discuss the child's progress and determine the next intervention modules.	12 months and it is their responsibility to provide recommendations about any modifications to the intervention.	receive regular supervision within their discipline. ▪Ten percent of sessions will be video recorded for fidelity checking by a senior clinician. ▪Specific CE modules delivered throughout treatment will be logged to quantify PCS cluster treatment dose as well as overall treatment dose."
McCarty et al (2016)	Collaborative care for PCS in children: CARE4PCS-I	▪Large-scale RCTs have established the effectiveness of collaborative care (CC) interventions that combine care management, CBT, and evidence-based pharmacotherapy in treating mood disorders in children and adults (Zatzick et al, 2004; Katon et al, 2010; Richardson et al, 2014). ▪Given the constellation of somatic, cognitive and sleep difficulties experienced with post-concussion symptoms, CC as a treatment should be explored as it can facilitate care between primary care, rehabilitation, and school-based services.	▪Participants received care management, CBT, and psychopharmacological consultation, where appropriate. ▪CBT aimed to target post concussive depressive and anxiety symptoms by teaching participants coping skills, relaxation strategies, sleep hygiene, activity pacing and positive thinking in the face of symptoms. ▪A care manager co-ordinated participants care between health professionals. They also offered motivational interviewing to help maintain the participants engagement in treatment and provided advocacy and recommendations to schools. ▪Materials: Not described.	▪CBT was delivered by 1 of 5 study therapists (4 PhD level psychologists and 1 licensed therapist). ▪ The care manager was educated to bachelors-level. ▪An “expert” in paediatric Psychopharmacology.	▪Appointments took place at the regional children’s hospital. ▪Seattle Children’s Hospital and the Sports Concussion Program at Harborview Medical Centre, Washington, USA.	▪The intervention lasts until symptoms have resolved or for 6 months when the treatment ends. ▪A weekly case review was held with an MDT. ▪The median number of CBT sessions was 8, with 88% of participants receiving 4 or more sessions. ▪A third of participants had psychopharmacological consultation and subsequent medication.	▪All participants will receive individualised treatment depending on their presentation. ▪No modifications to study reported.	▪Not reported.
McCarty et al (2021)	Collaborative care for PCS in children: CARE4PCS-II	▪A pilot study (McCarty et al, 2016) found that a collaborative care model used with adolescents with PPCS resulted in sustained improvements in PPCS and QOL at 6 months of follow-up, compared to treatment as usual. ▪Whilst the results were promising, the intervention required an in-person care model that demanded substantial effort by families to access treatment. ▪To improve accessibility to treatment, the intervention described by McCarty (2016) has	▪Intervention procedure same as described by McCarty et al (2016) except sessions could be offered in person or by video telehealth. ▪Materials: Online surveys meaning patient requires access to computer system.	▪"All care management and CBT were delivered by 1 of 2 study care managers, who were master’s level trained mental health professionals.”	▪Overall, 60.4% received collaborative care entirely via telehealth, 37.6% received hybrid care, and 2% received care entirely in person. ▪CBT was primarily delivered in individual sessions with adolescents, although parental involvement was encouraged.	▪Mean number of CBT sessions provided was 8.4 (range = 2-22 sessions) ▪Every patient received some level of collaborative care treatment over the 6 months. ▪Families received a mean of 3 sessions of care management and 38.6% of patients received enhanced care in the form of medical consultation.	▪All participants will receive individualised treatment depending on their presentation. ▪No modifications to study reported.	▪“Care managers were provided with weekly supervision with a supervising psychologist (C.A.M.) to discuss and review the modular CBT delivery."

		been modified to allow for delivery via videoconferencing. ▪The timeframe for intervention remained at 6 months however, a 12-month follow up was added to allow follow-up to continue throughout the period for which functional impairment is known to occur in children with PPCS (Lumba-Brown et al, 2018; Valovich et al, 2017).			▪Washington, USA.			
McNally et al (2018)	Brief CBT for PPCS	▪ "A biopsychosocial model has been proposed to explain the aetiology of persistent post-concussive symptoms. According to this framework, a concussion starts as a biological event, and concomitant psychological factors, emotional reactions, and changes to the broader social system interact to drive persisting symptoms." ▪Therefore, a therapeutic approach to target these factors may be effective in reducing PPCS.	▪The intervention program involves sessions on psychoeducation, cognitive restructuring techniques, building coping skills (e.g. relaxation) and activity and sleep management. Detailed information about each treatment module can be found within the paper on pages 400-402. Materials: Not described.	▪"Treatment sessions were conducted by a licensed clinical psychologist specializing in neuropsychology, or by doctoral and post-doctoral-level neuropsychology trainees under supervision."	▪Treatment sessions took place in clinic. ▪Nationwide Children's Hospital in Columbus, Ohio, US.	▪Participants underwent an initial assessment session and then began treatment approximately two weeks later. ▪Participants were seen once a week for 2-5 treatment sessions, lasting 45-60 mins each. Length of overall treatment was dependent on individual needs. Average number of sessions was 3.8, range 2-7.	▪Individualized treatment goals were set, and sessions typically included a combination of individual and joint parent–child work. ▪No modifications to study reported.	▪Not reported.
Simpson et al (2021)	Brief CBT for PPCS (C-STEP; Concussion Symptom Treatment and Education Programme)	▪"Pre-existing emotional-behavioural problems, cognitive biases, secondary gain and motivational factors, prolonged rest, parental factors, and disrupted sleep patterns are considered to drive persisting difficulties after concussion." ▪A therapeutic approach targeting some of these factors may support those with delayed concussion recovery. Specifically, CBT has been shown to reduce symptoms in a pilot study (McNally et al, 2018). ▪The intervention from the pilot was manualised for this study so that all components were delivered to every participant rather than modules selected by the clinician.	▪The intervention program lasts 6 sessions and includes (1) diagnostic intake and introduction to treatment structure and rationale, (2) concussion psychoeducation and sleep hygiene, (3) activity scheduling and diaphragmatic breathing, (4) relaxation training, (5) cognitive errors and restructuring, and (6) wrap-up and review. ▪Materials: Session handouts but no further details.	▪Treatment sessions were conducted by a licensed clinical psychologist or by doctoral- and postdoctoral-level psychology trainees under supervision of a licensed clinical psychologist.	▪Treatment sessions were in clinic. ▪Nationwide Children's Hospital and Children's Hospital Colorado, US.	▪Average number of sessions was 6, lasting 45 to 60 minutes each, usually weekly. ▪Sessions included a combination of individual and joint parent-child work.	▪Some patients received additional sessions due to clinical needs. ▪No modifications to study reported.	▪Treatment should last 6 sessions minimum. ▪Average number of sessions was 6 (range of 3-9, SD = 1.3). ▪Authors acknowledged no formal fidelity measure as a limitation but report adherence to treatment components was closely monitored and documented in session notes.
Tomfohr-Madsen et al (2020)	CBT for insomnia after concussion	▪Sleep difficulties are commonly reported following a concussion including falling asleep and sleeping less than usual. Sleep difficulties are further associated with other post-concussive symptoms such as headaches and depression. ▪CBT for insomnia is an effective treatment for adolescents and has	▪All participants completed a 7-day sleep diary prior to treatment group allocation. ▪Those in the intervention group received manualised CBT-I which consisted of six modules: (1) introduction; (2) relaxation training; (3) stimulus, sleep consolidation, and medication use; (4) cognitive therapy; (5) sleep hygiene; and (6) mindfulness and relapse prevention. ▪At the end of treatment or after 7 weeks since baseline measures	▪"Treatment was delivered by PhD students in clinical psychology, all of whom underwent a two-day training in delivery of CBT-I by the first author and were supervised weekly by a licensed	▪Screening took place over the phone. If suitable, assessment and subsequent treatment sessions took place in a university setting. ▪Alberta Children's Hospital Brain Injury	▪Participants in the intervention group received 6, weekly sessions of CBT-I. ▪The average number of sessions attended was 4.9 (SD = 2.2), with 9 of 12 (75%) participants attending all 6 sessions.	▪No tailoring or modifications to study reported.	▪Not reported.

		been evidenced for use with adults with brain injury. It has not been explored with children with brain injury.	were taken, another sleep diary was completed online with participants. Those in the treatment group also received a further online follow up 4 weeks later and completed another sleep diary. ▪Materials: Online sleep diaries.	PhD level clinical psychologist with experience in delivery of CBT-I and group supervision."	Clinic, Calgary, Canada.			
Worthen-Chaudhari et al (2017)	Mobile phone app using positive psychology	▪Mobile health apps are already used to track concussion symptoms and evidence has indicated mobile games as a way to support health recovery (McGonigal, 2011; 2015).	▪The intervention group had the mobile app "SuperBetter" loaded onto their devices which displayed concussion specific content that the research team developed called "Battle Royal Power Park". The app applies principles of positive psychology and social interaction during game play and aims to increase optimism, creativity, courage and determination in real life. The app reframes negative factors (poor sleep, bright lights) as "bad guys" and positive factors (resting, avoiding bright lights) as "power ups". It allows children to add "allies" who are supportive individuals who can log in to the app and provide encouraging prompts and monitor their recovery. The research co-ordinator was always added as an "ally". ▪Materials: The mobile phone app needed to be downloaded on to participants own devices.	▪Research co-ordinator, not further described.	▪Initial appointment in clinic and then daily interaction with app independently at home. ▪Cincinnati Children's Hospital Medical Center, Ohio, US.	▪Participants were asked to use the app at least once a day, 5 days a week. ▪The total length of intervention is not explicitly stated but a target does of 15 logged activities in the app in the first 3 weeks indicates app use was recommended for at least 3 weeks.	▪Each participant will have interacted with the app and added different people to their 'allies' list. The messages of encouragement would be different dependent on their 'allies'. ▪No modifications to study reported.	▪Target dose of 15 logged activities on the app in the first 3 weeks. ▪If participants were not logging activity for 4 consecutive days, they were contacted to address any barriers.
Cook et al (2021)	VR deep breathing exercise for concussion rehabilitation	▪Pre-existing mental health difficulties are associated with worse outcomes after concussion (Iverson et al, 2017). ▪Additionally, evidence has shown that 72% youth who require further support after 30 days report at least one emotional symptom (Ellis et al, 2015). ▪Virtual Reality (VR) interventions have been shown to be effective in reducing anxiety (Parsons and Rizzo, 2008) and a useful intervention for children with severe brain injury (Shen et al 2020). VR, specifically deep breathing to reduce stress and anxiety, has not yet been used in paediatric concussion rehabilitation.	▪Participants completed a 5-minute VR deep breathing exercise in a private room. During the exercise, participants viewed a meadow on a mountain top. They are presented with a breathing bubble and instructed to follow it as it inflates (3 seconds) and deflates (7 seconds). They practise this for one and a half minutes and then proceed to the 5 minute deep breathing exercise. Soft music plays in the background throughout. ▪Materials: The VR deep breathing exercise and the VR headset apparatus is purchasable from Rendever (www.rendever.com). The researcher also had a tablet computer available so they could view what the participant was viewing in VR to monitor their breathing with the 'breath bubble' in the exercise.	▪A research co-ordinator (no further details provided).	▪The session took place following a pre-scheduled clinic visit. ▪Tertiary care medical centre in the north-eastern USA.	▪ One off appointment, 5-minute exercise.	▪No tailoring or modifications to study reported.	▪Not reported.
Kirkwood et al (2016)	Neuropsychological consultation and psychoeducation as an intervention for mTBI	▪Neuropsychological assessment is frequently used following TBI. It allows difficulties to be identified and rehabilitation to be tailored. Its use as an intervention has not been directly examined.	▪"The neuropsychological consultation included record review, interviews with parents and children, and a battery of standardized tests." ▪Tests of estimated IQ, single word reading, processing speed, attention, executive functioning, memory, fine-motor functioning, and psychosocial adjustment, as well as a test of effort were completed.	▪Telephone data was collected by a research assistant who answered procedural questions only. ▪The assessment was completed by a neuropsychologist.	▪Outcome measures completed over the phone at multiple time points. ▪Neuropsychological assessment took place in person. ▪Colorado, USA.	▪One-off appointment lasting approximately 3 hours.	▪All participants received the same neuropsychological assessment. On some rare occasions, the neuropsychologist may have engaged in brief telephone contact with families after the	▪Not reported.

			▪Results of the assessment were fed back to families by the treating paediatric neuropsychologist. "The feedback included general education about concussion, information about injury and noninjury factors contributing to the child's specific symptoms, and recommendations to address any concerns". A report was sent to the family summarizing the results. ▪Materials: Neuropsychological tests				assessment was completed. ▪No modifications to study reported.	
Ponsford et al (2002)	Neuropsychological assessment and psychoeducation as an intervention for mTBI	▪Some children experience ongoing symptoms after mTBI) but these may often be difficult to detect. This means that others have the expectation that they should be performing at school as usual. ▪Some studies have shown a positive impact on recovery outcomes by providing adults with mTBI information on the expected symptoms, coping strategies and sometimes a screening assessment (Miinderhoud et al, 1980; and Wade et al, 1998). ▪Providing families with information on the expected recovery timeframe may help to reduce stress and reduce the likelihood of pre-existing symptoms being attributed to brain injury as they are better informed.	▪A detailed interview and neuropsychological assessment was completed, though no specific feedback was provided. ▪Those with a mTBI in the intervention group were given an information booklet outlining common symptoms, expected recovery timeframe and suggestions on how to cope. Advice is also given on returning to school and sports. ▪Materials: An information booklet was provided to those in the intervention group. This was adapted for children from the original by Dorothy Gronwall and Phillip Wrightson from the Auckland Hospital, New Zealand.	▪A research neuropsychologist completed the assessments.	▪Appointments took place in clinic. ▪Two major hospitals in Australia.	Children were seen within one week of their attendance at A & E. ▪Children with mTBI in the intervention group were assessed at one week and 3 months after injury. ▪The booklet was given at the one-week appointment.	▪No tailoring or modifications to study reported.	▪Not reported.
Olssen et al (2014)	Neuropsychological assessment, information booklet and website for PCS management	▪"The provision of information is often cited by families as a key need following a TBI (Murray, Maslany, & Jeffery, 2006). "Despite this, one study found that only 69% of families felt the information they were given met their needs for mTBI (Falk, von Wendt, & Soderkvist, 2009). ▪If families do not receive adequate information, there is a risk they will turn to more unreliable sources which may impact on recovery expectations. ▪Whilst it is well documented that psychoeducation is effective at reducing symptoms of PCS in adults, the impact on children is less understood.	▪Baseline assessment including neuropsychological assessment was completed with children. ▪Families were posted an information booklet called "Mild traumatic brain injury: Information for parents". It provided information on common emotional reactions of parents following their child's injury and the theoretical rationale for providing education-based resources. ▪Families were also given a leaflet with details on how to access an age-appropriate website for children called, "So you have had a mild head injury". ▪The booklet and website also included information on risk and maintaining factors of PPCS, expected recovery, long-term impact, strategies and guidelines for returning to learn and play, and information on when to access further support (e.g. at hospital).	▪Not reported.	▪First appointment in clinic, and then resources mailed to them. ▪Royal Children's Hospital in Brisbane, Australia.	▪Initial assessment and brief neuropsychological assessment took place within 3 weeks of injury. ▪Resources were mailed after this. It is not recorded if They were then mailed the intervention resources. ▪Families were not monitored on if they accessed the information and therefore the amount that each family read from the resources will have varied.	▪No tailoring or modifications to study reported.	▪Not reported.

			▪Materials: "The parent booklet was an 18-page, A3 size, colour-printed information booklet.					
Mortenson et al (2016)	Educational, early-follow up as an intervention	▪Research has demonstrated that providing information to families about concussion, family stress can be minimised, along with lowering the presence of ongoing symptoms in children (Ponsford et al, 2002). ▪Despite this knowledge, many children are discharged without this important information (Dematteo et al, 2010; De Maio et al, 2014). ▪As parents play a significant role in structuring their children's day to day activities during recovery, and it has been indicated that their own parental distress can contribute to a child's concussive symptoms, an intervention to explore the possibility of providing a short telephone follow-up and symptom counselling with parents was carried out.	▪Parents received a structured follow up call and symptom counselling after their child sustained a concussion. During the call the parents were asked about the impact of concussive symptoms on day-to-day functioning. If symptoms were ongoing, recommendations were given based on standard clinical guidelines. Reassurance was provided about concussion recovery and if parents were interested, they were signposted to further educational resources on return to school, return to activity and return to sports. ▪Materials: Interested parents were signposted to websites for more information: the Centres for Disease Control and Prevention, Can Child, and Montreal Children's Hospital (The MCH trauma concussion kit).	▪Telephone calls were completed by an occupational therapist. ▪For the 3-month follow-up a different occupational therapist (unaware of group allocation) telephoned to complete final treatment measures.	▪Telephone. ▪Tertiary, paediatric hospital in Vancouver, Canada.	▪Parents in the intervention group received a structured follow up call and symptom counselling at one week and one-month post-injury. The same parent was talked to at both appointments. ▪For children who were recovering quickly, telephone calls were short, typically 20-30 minutes at 1 week and 5-10 minutes at 1 month. Other calls lasted 30-60 minutes. ▪All participants received a call at 3 months post-injury for final assessment.	▪No tailoring during intervention but children with ongoing symptoms at the final appointment were referred on for more support. ▪No modifications to study reported.	▪Not reported.
Renaud et al (2020) *Additional information collated from protocol and evaluation papers: Renaud et al. (2016); Renaud et al. (2018)	Brains Ahead!	▪Developed to prevent or minimize long-term problems with activities and participation after mTBI. ▪Psychoeducation has been found to be effective in reducing long-term symptoms (Ponsford et al, 2002) as has providing a follow up appointment (Bell et al, 2008).	▪One-hour initial appointment identifying symptoms from an inventory (10 mins) and providing reassurance and individualized psychoeducation (45 mins) to the family. ▪Follow up appointment (20-40 mins) reviewing symptoms, psychoeducation, take-home booklets and signposting to further support. ▪Materials: Age adjusted information booklets for patients and caregivers, and take-home handouts of symptoms.	▪Professionals experienced and educated in child rehab after mTBI.	▪Appointments were face to face at two participating hospitals. ▪Rotterdam and Breda, Netherlands	▪Initial appointment 4 weeks after discharge. Follow up appointment offered 6-8 weeks after discharge. ▪On-demand telephone support offered for 6 months following injury with each contact typically lasting 5-15 mins.	▪Based on reported symptoms, psychoeducation and advice was tailored for each participant. ▪No modifications to study reported.	▪Attendance and adherence of patients/ caregivers, and the extent to which the intervention was performed according to protocol (fidelity and dose delivered), were obtained. ▪58/60 participated in at least 1 session. ▪Components were delivered according to protocol 79-100% of the cases.

Appendix E: After Concussion, Return to Normality (ACoRN) leaflet

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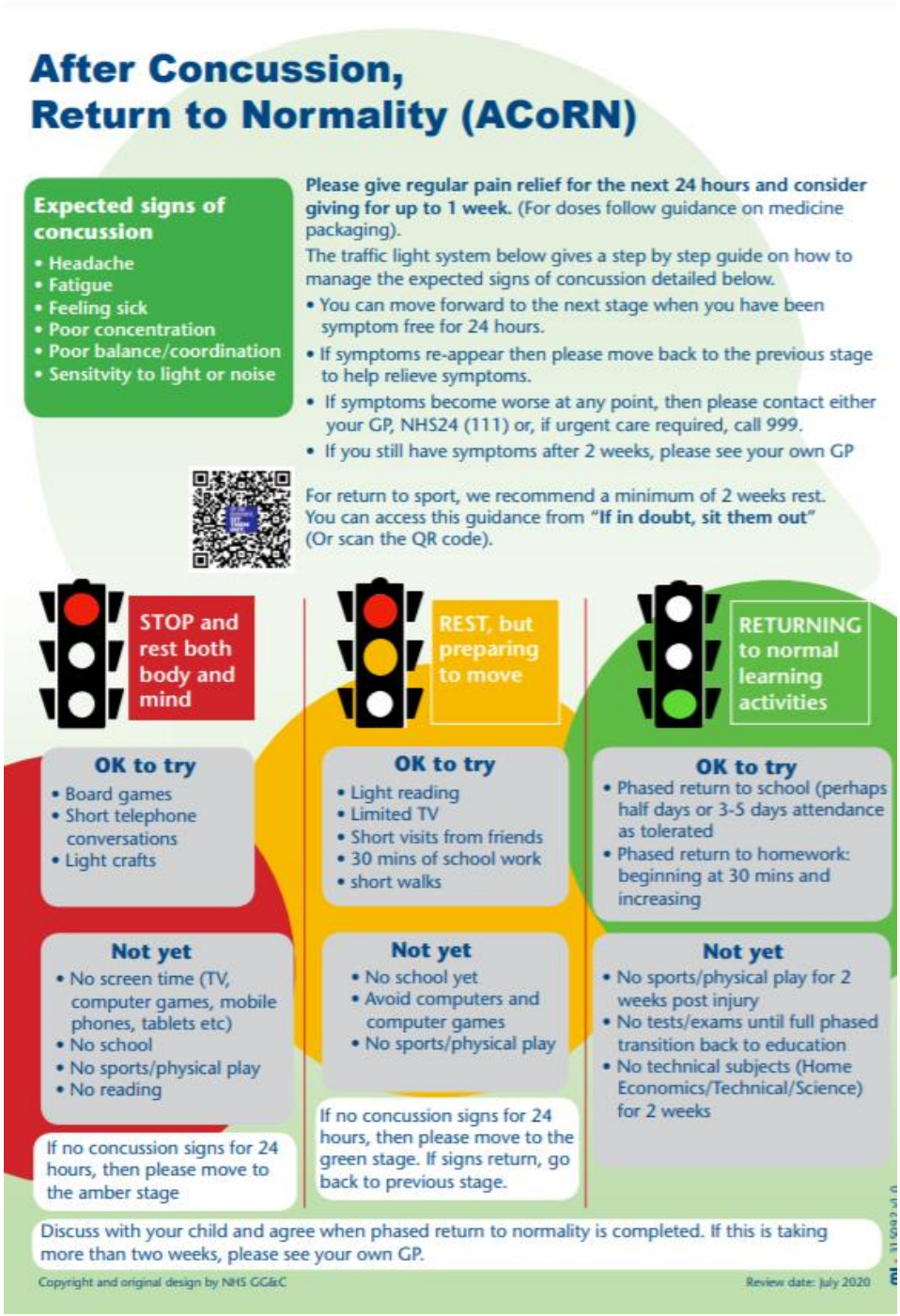


Information for parents and guardians after a Head Injury

Following a head injury an adult should supervise your child for the next 24 hours. They should also receive regular pain relief (for example, Paracetamol). If you are concerned that they are developing a problem, please telephone this Emergency Department and, if necessary, bring them back to hospital.

The signs that you should look out for are:

- If your child becomes unusually sleepy or is hard to wake up
- Headache all the time, which painkillers don't help.
- Repeated vomiting
- Weakness of arms or legs, e.g. unable to hold things
- Difficulty in seeing, walking, or acts clumsy and uncoordinated.
- Confusion (not knowing where they are, getting things muddled up).
- Fluid or blood coming from ear or nose.
- Fits (convulsions or seizures)
- Any other abnormal behaviour.

Allow your child to sleep as normal. We would encourage you to check on them a couple of times overnight to check:

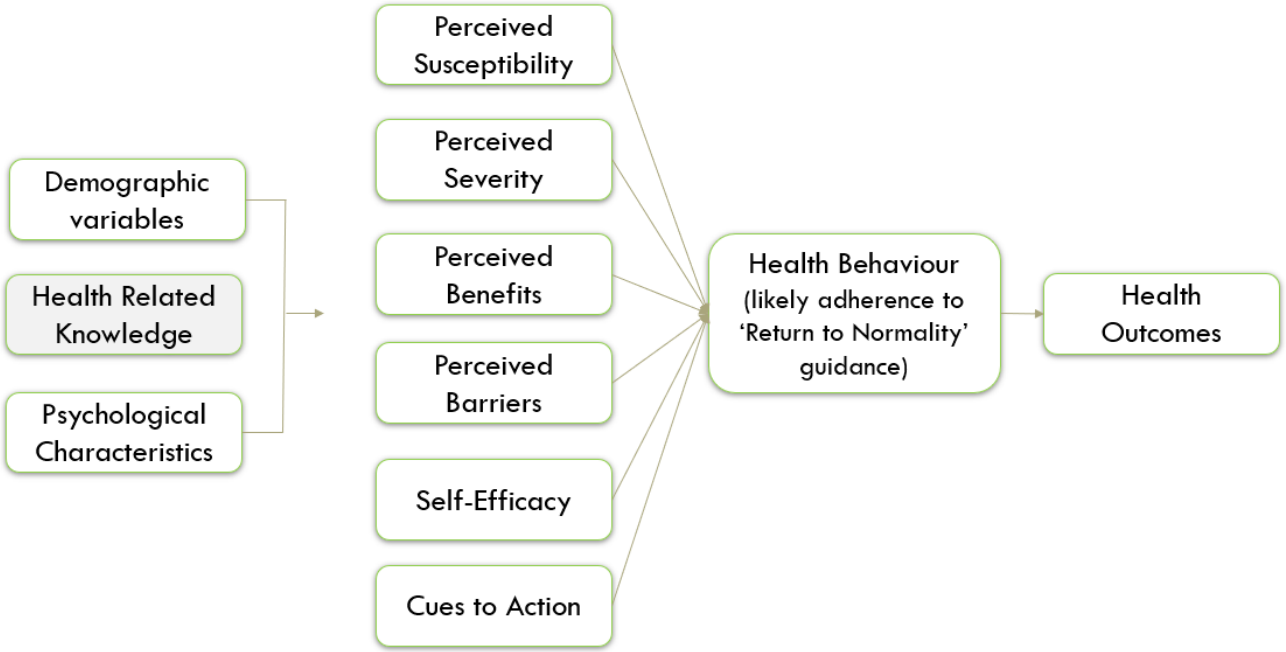
- Do they appear to be breathing normally?
- Are they sleeping in a normal posture?
- Do they make the expected response when you rouse them gently? (E.g. pulling up sheets, cuddling teddy-bear)
- If you cannot satisfy yourself that your child is sleeping normally, then waken them fully to check.

If you have any concerns about any of the above please contact the Emergency Department.

The vast majority of children who receive this advice leaflet will not develop signs of concussion. However, if signs of concussion are apparent after the first 24 hours, please use the guidance overleaf.

For further advice, information and support around Childhood Acquired Brain Injury, please also contact the **Child Brain Injury Trust online at childbraininjurytrust.org.uk or via email: info@cbituk.org**

Appendix F: Health Belief Model (HBM) diagram



Perceived susceptibility (belief that a person is susceptible to a concussion)

Perceived severity (belief that concussion can incur serious consequences)

Perceived benefits (belief that taking action would reduce susceptibility and severity)

Perceived barriers (belief that there are obstacles/negative consequences of taking action)

Cues to action (exposure to internal and/or external signals that prompt individual to take action)

Self-efficacy (confidence in ability to perform an action successfully)

Appendix G: Ethical approval for empirical study

Faculty of Medicine and Health Sciences Research Ethics Committee

University of East Anglia

NORWICH MEDICAL SCHOOL
Bob Champion Research & Educational Building
Rosalind Franklin Road
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Norwich Research Park
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Stephanie Casey
Norwich Medical School
University of East Anglia
Norwich Research Park
Norwich
NR4 7TJ

15th March 2021

Dear Stephanie

Title: Using the Health Belief Model to explore factors that impact adherence behaviour in parents and teachers after child concussion

Reference: 2020/21-058

Thank you for your email of 8th March 2021 notifying us of the amendments you would like to make to your above proposal. These have been considered and I can confirm that your amendments have been approved.

Please can you ensure that any further amendments to either the protocol or documents submitted are notified to us in advance, and that any adverse events which occur during your project are reported to the Committee.

Approval by the FMH Research Ethics Committee should not be taken as evidence that your study is compliant with GDPR and the Data Protection Act 2018. If you need guidance on how to make your study GDPR compliant, please contact your institution's Data Protection Officer.

Please can you arrange to send us a report once your project is completed.

Yours sincerely

Dr Jackie Buck
Chair
FMH Research Ethics Committee

COVID-19: The FMH Research Ethics Committee procedures remain as normal. Please note that our decisions as to the ethics of your application take no account of changes in Government measures and UEA guidelines relating to the coronavirus pandemic and all approvals granted are, of course, subject to these.

Appendix H: Survey template for parents

Please note "Part A" refers to study one (main empirical study) and "Part B" refers to study two (feasibility study)

The survey was proceeded by the information sheet and demographic questions. This first section is the knowledge measure.

THE GUNNING FOG INDEX IS 5.776. For reference, a gunning fog index score of 12 requires the reading level of an average 18-year-old.

Please note, the above is for information purposes only and will not be visible to participants.

The following section includes questions on what you know about concussion and its recovery.

Please tick six of the following symptoms that you think commonly occur within the first hour when a child has a concussion:

Headache □	Hearing voices □	Memory loss □	Difficulty breathing □
Poor balance □	Facial droop □	Nausea □	Seizures □
Unexplained pain □	Colour blindness □	Unable to smell □	Repeating words □
Complete paralysis □	Drowsiness □	Unable to speak □	Poor concentration □
A change in taste □	Difficulty showing emotion □	Unable to recognise familiar faces □	Seeing things that are not there □

Most symptoms associated to concussion resolve within a few weeks. When symptoms continue after this time, this may be referred to as Persistent Post-Concussion Symptoms (PPCS). Are you aware of the symptoms of Persistent Post-Concussion Symptoms?

Yes/No

Please tick six of the following difficulties that you think a child may commonly experience long-term as a result of concussion:

Reoccurring bruising across the body □	Weight loss □	A heightened sensitivity to touch □	Fear of the dark □
Depression □	Anxiety □	Muscle weakness □	Ongoing panic attacks □
Poor hygiene □	Tremor in limbs □	Unusual beliefs □	Talks about events that have not happened □
Irritability and emotional outbursts □	Ongoing weight gain □	Disrupted sleep □	Inability to keep up with schoolwork □
Dislike to certain foods □	Reduced appetite □	Frequent stomach aches □	Difficulties with social interaction □

At what time point do you think is the <u>soonest</u> a child should return to the below activities after a concussion?

You can only choose one response per row.

	Straight away after concussion	Between 1 and 7 days after concussion	Between 1 to 2 weeks after concussion
Homework □	□	□	□
Physical play with friends □	□	□	□
Easy crafts □	□	□	□
Full school lessons □	□	□	□
Light reading □	□	□	□
Exams □	□	□	□
Playing competitive sports □	□	□	□
Short conversations □	□	□	□
Some TV □	□	□	□

Reduced school lessons □	□	□	□
Playing video games □	□	□	□
Playing board games □	□	□	□

NEXT

(This section is the Psychosocial Variable: Perceived Stress Scale (PSS; Cohen, Kamarck & Mermelstein, 1983)

This part of the survey is not directly related to concussion. Please answer the questions based on yourself.

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

0 = Never	1 = Almost never	2 = Sometimes	3 = Fairly often	4 = Very often

In the last month, how often have you been upset because of something that happened unexpectedly?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you felt that you were unable to control the important things in your life?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you felt nervous and 'stressed'?	0 □	1 □	2 □	3 □	4 □

In the last month, how often have you felt confident about your ability to handle your personal problems?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you felt that things were going your way?	0 □	1 □	2 □	3 □	4 □
In the last month how often have you found that you could not cope with all the things you had to do?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you been able to control irritation in your life?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you felt that you were on top of things?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you been angered because of things that were outside if your control?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	0 □	1 □	2 □	3 □	4 □

NEXT

(This section is the Perceived severity and susceptibility measures)

Please rate the extent to which you believe the following:

Strongly disbelieve = 1	Disbelieve = 2	Neither believe nor disbelieve = 3	Believe = 4	Strongly believe = 5

There is a possible risk of death if a second concussion occurs before there is a full recovery from the first.	1 □	2 □	3 □	4 □	5 □

A full recovery from concussion is typically complete within one week for children.	1 □	2 □	3 □	4 □	5 □
A child is less likely to sustain another concussion if they've already had one.	1 □	2 □	3 □	4 □	5 □
Concussion can sometimes result in problems lasting more than 4 weeks for children.	1 □	2 □	3 □	4 □	5 □
A child can have concussion without a direct hit to their head.	1 □	2 □	3 □	4 □	5 □
Girls are more likely to experience concussion than boys.	1 □	2 □	3 □	4 □	5 □
Concussion is a minor brain injury.	1 □	2 □	3 □	4 □	5 □
Concussion can only occur if a child blacks out or loses consciousness.	1 □	2 □	3 □	4 □	5 □
Concussion is only serious if a child loses consciousness/blacks out.	1 □	2 □	3 □	4 □	5 □
Concussion is a common injury in children.	1 □	2 □	3 □	4 □	5 □
Concussion is likely to lead to dementia.	1 □	2 □	3 □	4 □	5 □
Returning to activities should be decided based on how hard the child was hit.	1 □	2 □	3 □	4 □	5 □
Concussion in children should be taken seriously by others.	1 □	2 □	3 □	4 □	5 □
Concussion is a serious brain injury.	1 □	2 □	3 □	4 □	5 □
Concussion only happens during sporting activities such as rugby or football.	1 □	2 □	3 □	4 □	5 □

NEXT

(This section is the Vignette-based questionnaire to measure likelihood to adhere)

Please read this scenario.

You are a parent to James who is 8 years old. He was out riding his bike in the garden when he fell and hit his shoulder and head on the patio. You saw what happened and know that he did not lose consciousness. James tells you he is feeling sick and wobbly and has a pain on his head. You take him to the doctor the same day and James is diagnosed with a concussion.

Below is a selection of possible actions. We appreciate that there may be additional or alternative actions you may also take if presented with this situation in real life but for the purpose of this survey, please consider the below statements only and indicate how likely you are to complete them:

Very unlikely = 1	Unlikely = 2	Neutral = 3	Likely = 4	Very likely = 5

	Very unlikely = 1	Unlikely = 2	Neutral = 3	Likely = 4	Very likely = 5
I would keep James off school for one to two full days only.	1 □	2 □	3 □	4 □	5 □
I would encourage James to keep on top of his schoolwork over the next few days.	1 □	2 □	3 □	4 □	5 □
I would only let James friends over after two days had passed.	1 □	2 □	3 □	4 □	5 □
I would monitor James daily to see if he is improving.	1 □	2 □	3 □	4 □	5 □
I would let James watch as many films as he likes whilst he recovers.	1 □	2 □	3 □	4 □	5 □
I would send James back to school with no sickness days.	1 □	2 □	3 □	4 □	5 □

I would restrict James from physical games for the first 24 hours but let him re-join after that.	1 □	2 □	3 □	4 □	5 □
I would let James read his favourite books straight away.	1 □	2 □	3 □	4 □	5 □
I would let James play in his football match tomorrow.	1 □	2 □	3 □	4 □	5 □
I would keep James off school for two weeks.	1 □	2 □	3 □	4 □	5 □
I would try to minimise screen time for James over the next few days.	1 □	2 □	3 □	4 □	5 □
I would let James play his computer games after a day of rest.	1 □	2 □	3 □	4 □	5 □
I would support James to have a 'phased return' to school over one to two weeks, meaning some half days at school.	1 □	2 □	3 □	4 □	5 □
I would have some concerns about James completing his maths test in four days' time.	1 □	2 □	3 □	4 □	5 □

NEXT

(This section is the Perceived barriers, benefits, cues to action and self-efficacy measures)

After a child has a concussion, there are health recommendations available on how to best support the child whilst they recover. Please indicate the extent to which you agree/disagree with the following statements:

Strongly Disagree = 1	Disagree = 2	Neutral = 3	Agree = 4	Strongly Agree = 5

If my child sustained a concussion, I would find it easy to take up to 1 week off work to support my child.	1 □	2 □	3 □	4 □	5 □

If my child sustained a concussion, I know enough information already about concussion recovery to effectively support them.	1 □	2 □	3 □	4 □	5 □
If my child sustained a concussion, I would find it difficult to limit my child's activities e.g. watching tv, video games, playing sports	1 □	2 □	3 □	4 □	5 □
If my child sustained a concussion, I would be able to seek the right help from professionals.	1 □	2 □	3 □	4 □	5 □
If my child sustained a concussion, my ability to support them would be dependent on their age.	1 □	2 □	3 □	4 □	5 □
If my child sustained a concussion, it would be difficult to provide a quiet environment at home.	1 □	2 □	3 □	4 □	5 □
If my child sustained a concussion, it would be easy for me to liaise with schoolteachers regularly.	1 □	2 □	3 □	4 □	5 □
If my child sustained a concussion, it would be difficult to implement changes in their daily routine due to my own health difficulties.	1 □	2 □	3 □	4 □	5 □

We are interested to know what you perceive to be the benefits of following concussion guidelines. Please consider how beneficial <u>you</u> perceive each of the following statements to be if you were to adhere to the recommended guidelines for supporting a child after concussion:

Not at all beneficial = 1	Not very beneficial = 2	Neutral = 3	Somewhat beneficial = 4	Very beneficial = 5

My child could safely return to sports sooner.	1 □	2 □	3 □	4 □	5 □
My child could recover without long term problems.	1 □	2 □	3 □	4 □	5 □
My child is less likely to have mental health difficulties.	1 □	2 □	3 □	4 □	5 □
I will need to take off less time in the future months to look after them.	1 □	2 □	3 □	4 □	5 □

My child is less likely to sustain a more serious second concussion within the first few weeks of recovery.	1 □	2 □	3 □	4 □	5 □
My child could return to school fulltime sooner.	1 □	2 □	3 □	4 □	5 □
I will be positively thought of by others e.g. family, friends and professionals.	1 □	2 □	3 □	4 □	5 □
My child would learn the importance of following health guidelines.	1 □	2 □	3 □	4 □	5 □
My child would be able to share information with other children on how to manage after concussion.	1 □	2 □	3 □	4 □	5 □

Do you perceive there to be other benefits, not already listed above, to following the recommended guidelines?

If yes, please state (maximum characters set):

These questions are about the guidelines following concussion in children and the support they might need. Please indicate the extent to which you agree/disagree with the following statements:

Strongly Disagree = 1	Disagree = 2	Neutral = 3	Agree = 4	Strongly Agree = 5

I would follow the recommended guidelines for child concussion if I was told to by a health professional.	1 □	2 □	3 □	4 □	5 □
I would follow the recommended guidelines for child concussion if their teacher was noticing problems at school.	1 □	2 □	3 □	4 □	5 □
I would feel confident supporting a child after concussion.	1 □	2 □	3 □	4 □	5 □
I would be able to identify when a child needed more breaks or quiet time.	1 □	2 □	3 □	4 □	5 □

I would follow the recommended guidelines for child concussion if I noticed their behaviour was different to 'normal'.	1 □	2 □	3 □	4 □	5 □
I would be able to identify when they were ready to return to school fulltime.	1 □	2 □	3 □	4 □	5 □
I would follow the recommended guidelines for child concussion if I was told about the long-term consequences of child concussion.	1 □	2 □	3 □	4 □	5 □
I would follow the recommended guidelines for child concussion if I was told to by a teacher.	1 □	2 □	3 □	4 □	5 □
I would be able to ask my GP for help if I needed further guidance on how to follow the recommendations.	1 □	2 □	3 □	4 □	5 □
I would need further training in supporting a child to return to activities after a concussion.	1 □	2 □	3 □	4 □	5 □

NEXT

(This section will provide information on PART B and provide respondents with two options)

Thank you for taking part in the first section of this study. We have a second, shorter part to the study that we would like to invite you to complete in four weeks' time. This part will take 15 minutes and will involve reading a short leaflet on how a child should return to activity after a concussion. There will be a few more tick box questions and one more scenario-based question. If you choose to complete Part B, you will be sent an automatic email in four weeks' time with a link which will take you to a website to complete Part B. By completing Part B, you will have the option to receive an additional entry into the prize draw of winning one of four £25 Love2shop vouchers.

Please indicate how you would like to proceed:

I WOULD LIKE TO BE CONTACTED TO COMPLETE PART B

I DO NOT WANT TO COMPLETE PART B IN 4

(These following sections will be dependent on option chosen from previous page)

i. I WOULD LIKE TO BE CONTACTED TO

a. Debrief information sheet for Part A shown and option to enter email address for Part A prize draw. (An automatic email will be sent to them in 4 weeks' time.)

b. "Thank you for your time, you may now close the browser"

c. When they access the link sent to them by email, they will view the information sheet for Part B.

d. After consenting to take part, participants will then view the ACORN NEXT leaflet.

e. Participants will then be shown the following questions:

i. Did you read the leaflet? Yes □ No □

ii. Do you feel you learned anything new about recovery after concussion? Yes □ No □

NEXT

f. The knowledge section from Part A will be repeated.

NEXT

g. New vignettes to measure likelihood to adhere to guidelines

You are a parent to Zach who is 10 years old. He was out playing football with his siblings when the ball hit him on the head and knocked him to the ground. His siblings tell you that he did not 'black out' but was sick once. Zach tells you his head hurts and is feeling dizzy. You take him to the GP who states that

Zach has concussion. Please look at the following statements and indicate how likely you are to complete them:

Very unlikely = 1	Unlikely = 2	Neutral = 3	Likely = 4	Very likely = 5

	Very unlikely = 1	Unlikely = 2	Neutral = 3	Likely = 4	Very likely = 5
I would keep Zach off school for one to two full days only.	1 □	2 □	3 □	4 □	5 □
I would encourage Zach to keep on top of his schoolwork over the next few days.	1 □	2 □	3 □	4 □	5 □
I would only let Zach friends over after two days had passed.	1 □	2 □	3 □	4 □	5 □
I would monitor Zach daily to see if he is improving.	1 □	2 □	3 □	4 □	5 □
I would let Zach watch as many films as he likes whilst he recovers.	1 □	2 □	3 □	4 □	5 □
I would send Zach back to school with no sickness days.	1 □	2 □	3 □	4 □	5 □
I would restrict Zach from physical games for the first 24 hours but let him re-join after that.	1 □	2 □	3 □	4 □	5 □
I would let Zach read his favourite books straight away.	1 □	2 □	3 □	4 □	5 □
I would let Zach play in his football match tomorrow.	1 □	2 □	3 □	4 □	5 □
I would keep Zach off school for two weeks.	1 □	2 □	3 □	4 □	5 □
I would try to minimise screen time for Zach over the next few days.	1 □	2 □	3 □	4 □	5 □
I would let Zach play his computer games after a day of rest.	1 □	2 □	3 □	4 □	5 □

I would support Zach to have a 'phased return' to school over one to two weeks, meaning some half days at school.	1 □	2 □	3 □	4 □	5 □
I would have some concerns about Zach completing his spelling test in four days' time.	1 □	2 □	3 □	4 □	5 □

NEXT

h. Communication questions

If your child sustained a concussion at home, please indicate below when and how often you would communicate with the following people, if at all. Please assume your child plays sports outside of school and is under the local mental health team.

	Select one answer. I would contact my child's…				Select one answer. I would contact my child's…			
	As soon as possible after concussion	Between 1 and 7 days	After my child had recovered	Not at all	Once only to notify them	Every few days to provide updates	Every few weeks to provide updates	Not at all
Headteacher	□	□	□	□	□	□	□	□
School nurse	□	□	□	□	□	□	□	□
GP	□	□	□	□	□	□	□	□
Sports coach	□	□	□	□	□	□	□	□
PE teacher								

School receptionist	□	□	□	□	□	□	□	□
Main classroom teacher	□	□	□	□	□	□	□	□
Pastoral team	□	□	□	□	□	□	□	□
Local mental health team	□	□	□	□	□	□	□	□

NEXT

i. Acceptability questions

- Do you think the leaflet would be applicable to children of all ages under 18?

  Yes □ No □

- Do you think the leaflet guidance would need to be adjusted for different age groups?

  Yes □ No □

  If yes, how? _____(free text)

- What would be your preferred way to learn about Return to Normality guidance?

  Online leaflet □ Paper leaflet □ Video □ Website □

  App □ Other □

  If other, what? _____(free text)

- Do you think you have the knowledge to implement the guidance suggested by the leaflet?

Very unlikely = 1	Unlikely = 2	Neutral = 3	Likely = 4	Very likely = 5

- Do you think your answers to the imaginary scenarios were reflective of the actions you would truly take if your own child or a child you teach experienced concussion?

Yes □ No □

NEXT

j. Debrief information sheet and option to enter email address for prize draw for Part B

NEXT

k. "Thank you for your time, you may now close the browser"

ii.

I DO NOT WANT TO COMPLETE PART B IN 4

a. Debrief information sheet and option to enter email address for prize draw Part A.

b. "Thank you for your time, you may now close the browser"

Appendix I: Survey template for teachers

Please note "Part A" refers to study one (empirical study) and "Part B" refers to study two (feasibility study)

The survey will be proceeded by the information sheet and demographic questions.

This first section is the knowledge measure. THE GUNNING FOG INDEX IS 6.069.

For reference, a gunning fog index score of 12 requires the reading level of an average 18 year old.

(Please note, the above is for information purposes only and will not be visible to participants).

The following section includes questions on what you know about concussion and its recovery.

Please tick six of the following symptoms that you think commonly occur within the first hour when a child has a concussion:

Headache □	Hearing voices □	Memory loss □	Difficulty breathing □
Poor balance □	Facial droop □	Nausea □	Seizures □
Unexplained pain □	Colour blindness □	Unable to smell □	Repeating words □
Complete paralysis □	Drowsiness □	Unable to speak □	Poor concentration □
A change in taste □	Difficulty showing emotion □	Unable to recognise familiar faces □	Seeing things that are not there □

Most symptoms associated to concussion resolve within a few weeks. When symptoms continue after this time, this may be referred to as Persistent Post-Concussion Symptoms (PPCS). Are you aware of the symptoms of Persistent Post-Concussion Symptoms?

Yes/No

Please tick six of the following difficulties that you think a child may commonly experience long-term as a result of concussion:

Reoccurring bruising across the body □	Weight loss □	A heightened sensitivity to touch □	Fear of the dark □
Depression □	Anxiety □	Muscle weakness □	Ongoing panic attacks □
Poor hygiene □	Tremor in limbs □	Unusual beliefs □	Talks about events that have not happened □
Irritability and emotional outbursts □	Ongoing weight gain □	Disrupted sleep □	Inability to keep up with schoolwork □
Dislike to certain foods □	Reduced appetite □	Frequent stomach aches □	Difficulties with social interaction □

At what time point do you think is the <u>soonest</u> a child should return to the below activities after a concussion?

You can only choose one response per row.

	Straight away after concussion	Between 1 and 7 days after concussion	Between 1 to 2 weeks after concussion
Homework □	□	□	□
Physical play with friends □	□	□	□
Easy crafts □	□	□	□
Full school lessons □	□	□	□
Light reading □	□	□	□
Exams □	□	□	□
Playing competitive sports □	□	□	□
Short conversations □	□	□	□
Some TV □	□	□	□

Reduced school lessons □	□	□	□
Playing video games □	□	□	□
Playing board games □	□	□	□

NEXT

(This section is the Psychosocial Variable: Perceived Stress Scale (PSS; Cohen, Kamarck & Mermelstein, 1983)

This part of the survey is not directly related to concussion. Please answer the questions based on yourself.

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

0 = Never	1 = Almost never	2 = Sometimes	3 = Fairly often	4 = Very often

In the last month, how often have you been upset because of something that happened unexpectedly?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you felt that you were unable to control the important things in your life?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you felt nervous and 'stressed'?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you felt confident about your ability to handle your personal problems?	0 □	1 □	2 □	3 □	4 □

In the last month, how often have you felt that things were going your way?	0 □	1 □	2 □	3 □	4 □
In the last month how often have you found that you could not cope with all the things you had to do?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you been able to control irritation in your life?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you felt that you were on top of things?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you been angered because of things that were outside if your control?	0 □	1 □	2 □	3 □	4 □
In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	0 □	1 □	2 □	3 □	4 □

NEXT

(This section is the Perceived severity and susceptibility measures)

Please rate the extent to which you believe the following:

Strongly disbelieve = 1	Disbelieve = 2	Neither believe nor disbelieve = 3	Believe = 4	Strongly believe = 5

There is a possible risk of death if a second concussion occurs before there is a full recovery from the first.	1 □	2 □	3 □	4 □	5 □

A full recovery from concussion is typically complete within one week for children.	1 □	2 □	3 □	4 □	5 □
A child is less likely to sustain another concussion if they've already had one.	1 □	2 □	3 □	4 □	5 □
Concussion can sometimes result in problems lasting more than 4 weeks for children.	1 □	2 □	3 □	4 □	5 □
A child can have concussion without a direct hit to their head.	1 □	2 □	3 □	4 □	5 □
Girls are more likely to experience concussion than boys.	1 □	2 □	3 □	4 □	5 □
Concussion is a minor brain injury.	1 □	2 □	3 □	4 □	5 □
Concussion can only occur if a child blacks out or loses consciousness.	1 □	2 □	3 □	4 □	5 □
Concussion is only serious if a child loses consciousness/blacks out.	1 □	2 □	3 □	4 □	5 □
Concussion is a common injury in children.	1 □	2 □	3 □	4 □	5 □
Concussion is likely to lead to dementia.	1 □	2 □	3 □	4 □	5 □
Returning to activities should be decided based on how hard the child was hit.	1 □	2 □	3 □	4 □	5 □
Concussion in children should be taken seriously by others.	1 □	2 □	3 □	4 □	5 □
Concussion is a serious brain injury.	1 □	2 □	3 □	4 □	5 □
Concussion only happens during sporting activities such as rugby or football.	1 □	2 □	3 □	4 □	5 □

NEXT

(This section is the Vignette-based questionnaire to measure likelihood to adhere)

Please read this scenario.

James is 8 years old and has been off school for two days. His dad informed the school on James' first day of sickness that he had fallen off

his bike and hit his head. James' dad also told the school that a doctor had diagnosed him with concussion. James returns to school after two days sickness. You notice James' concentration is poor and he is quieter than usual.

Below is a selection of possible actions. We appreciate that there may be additional or alternative actions you may also take if presented with this situation in real life but for the purpose of this survey, please consider the below statements only and indicate how likely you are to complete them:

Very unlikely = 1	Unlikely = 2	Neutral = 3	Likely = 4	Very likely = 5

	Very unlikely = 1	Unlikely = 2	Neutral = 3	Likely = 4	Very likely = 5
I would offer one to one support for James in my classroom	1 □	2 □	3 □	4 □	5 □
I would let James continue to sit in his usual seat with his five friends on the middle table	1 □	2 □	3 □	4 □	5 □
I would provide James with extra breaks during the day	1 □	2 □	3 □	4 □	5 □
I would encourage James to attend his lessons full time	1 □	2 □	3 □	4 □	5 □
I would feedback to his parents daily about his progress	1 □	2 □	3 □	4 □	5 □
I would suggest that James requires a phased return to school over the next one to two weeks	1 □	2 □	3 □	4 □	5 □
I would expect James to join in during physical education lessons	1 □	2 □	3 □	4 □	5 □

I would make space for James in a quieter corner of the classroom	1 □	2 □	3 □	4 □	5 □
I would set James the same tasks as all the other children	1 □	2 □	3 □	4 □	5 □
I would encourage James to play physical games at breaktime as soon as he was back at school	1 □	2 □	3 □	4 □	5 □
I would give James some additional homework to ensure he keeps up with the class	1 □	2 □	3 □	4 □	5 □
I would encourage James to play sitting down games at break time for the first two weeks e.g. board games	1 □	2 □	3 □	4 □	5 □
I would be happy for James to participate in music class	1 □	2 □	3 □	4 □	5 □
I would ask James to complete any missed homework as soon as possible	1 □	2 □	3 □	4 □	5 □

NEXT

(This section is the Perceived barriers, benefits, cues to action and self-efficacy measures)

After a child has a concussion, there are health recommendations available on how best to support a child whilst they recover. Please indicate the extent to which you agree/disagree with the following statements:

Strongly Disagree = 1	Disagree = 2	Neutral = 3	Agree = 4	Strongly Agree = 5

If a child in my class sustained a concussion, I would find it easy to offer one to one support.	1 □	2 □	3 □	4 □	5 □

If a child in my class sustained a concussion, I know enough information already about concussion recovery to effectively support them in the classroom.	1 □	2 □	3 □	4 □	5 □
If a child in my class sustained a concussion, I would find it difficult to provide a quiet workspace for them to learn.	1 □	2 □	3 □	4 □	5 □
If a child in my class sustained a concussion, I would be able to seek the right help from my school.	1 □	2 □	3 □	4 □	5 □
If a child in my class sustained a concussion, my ability to support them would be dependent on their age.	1 □	2 □	3 □	4 □	5 □
If a child in my class sustained a concussion, I would be able to increase the amount of time given for classroom activities and homework tasks.	1 □	2 □	3 □	4 □	5 □
If a child in my class sustained a concussion, it would be difficult for me to liaise with their parents regularly.	1 □	2 □	3 □	4 □	5 □
If a child in my class sustained a concussion, I would find it difficult to facilitate a phased return to school including late arrivals or early finishes	1 □	2 □	3 □	4 □	5 □

We are interested to know what you perceive to be the benefits of following concussion guidelines. Please consider how beneficial <u>you</u> perceive each of the following statements to be if you were to adhere to the recommended guidelines for supporting a child at school after concussion:

Not at all beneficial = 1	Not very beneficial = 2	Neutral = 3	Somewhat beneficial = 4	Very beneficial = 5

The child could safely return to sports sooner.	1 □	2 □	3 □	4 □	5 □
The child may recover without long term problems.	1 □	2 □	3 □	4 □	5 □
The child is less likely to have mental health difficulties related to their concussion.	1 □	2 □	3 □	4 □	5 □
I will be more positively thought of by the child's parents.	1 □	2 □	3 □	4 □	5 □

I will need to make fewer classroom adjustments in the long run.	1 □	2 □	3 □	4 □	5 □
I will be more positively thought of by health professionals.	1 □	2 □	3 □	4 □	5 □
The child could return to school fulltime sooner.	1 □	2 □	3 □	4 □	5 □
I will be positively thought of by teaching colleagues.	1 □	2 □	3 □	4 □	5 □
The child is less likely to sustain a more serious second concussion within the first few weeks of recovery.	1 □	2 □	3 □	4 □	5 □
The child would learn the importance of following health guidelines.	1 □	2 □	3 □	4 □	5 □
The child would be able to share information with other children on how to manage after concussion.	1 □	2 □	3 □	4 □	5 □

Do you perceive there to be other benefits, not already listed above, to following the recommended guidelines?

If yes, please state (maximum characters set):

These questions are about the guidelines following concussion in children and the support they might need. Please indicate the extent to which you agree/disagree with the following statements:

Strongly Disagree = 1	Disagree = 2	Neutral = 3	Agree = 4	Strongly Agree = 5

I would follow the recommended guidelines for child concussion if I was told to by a health professional.	1 □	2 □	3 □	4 □	5 □
I would follow the recommended guidelines for child concussion if another teacher was noticing problems at school.	1 □	2 □	3 □	4 □	5 □

I would feel confident supporting a child after concussion.	1 □	2 □	3 □	4 □	5 □
I would follow the recommended guidelines for child concussion if I was informed by a parent of the guidelines.	1 □	2 □	3 □	4 □	5 □
I would be able to identify when a child needed more breaks or quiet time.	1 □	2 □	3 □	4 □	5 □
I would follow the recommended guidelines for child concussion if I noticed their behaviour was different to 'normal'.	1 □	2 □	3 □	4 □	5 □
I would be able to identify when they were ready to return to school full time.	1 □	2 □	3 □	4 □	5 □
I would follow the recommended guidelines for child concussion if I was informed by a parent that the child had suffered a concussion.	1 □	2 □	3 □	4 □	5 □
I would follow the recommended guidelines for child concussion if I was told about the long-term consequences of child concussion.	1 □	2 □	3 □	4 □	5 □
I would be able to ask for professional help if I needed further guidance on how to follow the recommendations.	1 □	2 □	3 □	4 □	5 □
I would need further training in supporting a child to return to activities after a concussion.	1 □	2 □	3 □	4 □	5 □
I would follow the recommended guidelines for child concussion if I was informed by my school of the guidelines.	1 □	2 □	3 □	4 □	5 □

NEXT

(This section will provide information on PART B and provide respondents with two options)

Thank you for taking part in the first section of this study. We have a second, shorter part to the study that we would like to invite you to complete in four weeks' time. This part will take 15 minutes and will involve reading a short leaflet on how a child should return to activity after a concussion. There will be a few more tick box questions and one more scenario-based question. If you choose to complete Part B, you will be sent an automatic email in four weeks' time with a link which will take you to a website to complete Part B. By completing Part B, you will have the option to receive an additional entry into the prize draw of winning one of four £25 Love2shop vouchers.

Please indicate how you would like to proceed:

I WOULD LIKE TO BE CONTACTED TO COMPLETE PART B

I DO NOT WANT TO COMPLETE PART B IN 4

(These following sections will be dependent on option chosen from previous page)

i. I WOULD LIKE TO BE CONTACTED TO

a. Debrief information sheet for Part A shown and option to enter email address for Part A prize draw. (An automatic email will be sent to them in 4 weeks' time.)
b. "Thank you for your time, you may now close the browser"
c. When they access the link sent to them by email, they will view the information sheet for Part B.
d. After consenting to take part, participants will then view the ACORN leaflet.

NEXT

e. Participants will then be shown the following questions:

- Did you read the leaflet? Yes □ No □

- Do you feel you learned anything new about recovery after concussion? Yes □ No □

NEXT

f. The knowledge section from Part A will be repeated.

NEXT

g. New vignettes to measure likelihood to adhere to guidelines

Zach is 9 years old and has been off school for two days after being knocked to the ground by a football which hit his head. His mum tells you he likely had concussion but that he is better now and can come back to school. You notice Zach's attention is poor and that he becomes quickly frustrated with others, more so than usual for him. Please look at the following statements and indicate how likely you are to complete them:

Very unlikely = 1	Unlikely = 2	Neutral = 3	Likely = 4	Very likely = 5

	Very unlikely = 1	Unlikely = 2	Neutral = 3	Likely = 4	Very likely = 5
I would offer one to one support for Zach in my classroom	1 □	2 □	3 □	4 □	5 □
I would let Zach continue to sit in his usual seat with his five friends on the middle table	1 □	2 □	3 □	4 □	5 □
I would provide Zach with extra breaks during the day	1 □	2 □	3 □	4 □	5 □
I would encourage Zach to attend his lessons full time	1 □	2 □	3 □	4 □	5 □

I would feedback to his parents daily about his progress	1 □	2 □	3 □	4 □	5 □
I would suggest that Zach requires a phased return to school over the next one to two weeks	1 □	2 □	3 □	4 □	5 □
I would expect Zach to join in during physical education lessons	1 □	2 □	3 □	4 □	5 □
I would make space for Zach in a quieter corner of the classroom	1 □	2 □	3 □	4 □	5 □
I would set Zach the same tasks as all the other children	1 □	2 □	3 □	4 □	5 □
I would encourage Zach to play physical games at breaktime as soon as he was back at school	1 □	2 □	3 □	4 □	5 □
I would give Zach some additional homework to ensure he keeps up with the class	1 □	2 □	3 □	4 □	5 □
I would encourage Zach to play sitting down games at break time for the first two weeks e.g. board games	1 □	2 □	3 □	4 □	5 □
I would be happy for Zach to participate in music class	1 □	2 □	3 □	4 □	5 □
I would ask Zach to complete any missed homework as soon as possible	1 □	2 □	3 □	4 □	5 □

NEXT

h. Communication questions

If a child in your class returned to school after sustaining a concussion at home, please indicate below when and how often you would communicate with the following people, if at all. Please assume the child plays sports outside of school and is under the local mental health team.

	Select one answer. I would contact the child's…	Select one answer. I would contact the child's…

	As soon as possible after concussion	Between 1 and 7 days	After the child had recovered	Not at all	Once only to notify them	Every few days to provide updates	Every few weeks to provide updates	Not at all
Headteacher	□	□	□	□	□	□	□	□
School nurse	□	□	□	□	□	□	□	□
GP	□	□	□	□	□	□	□	□
Sports coach	□	□	□	□	□	□	□	□
PE teacher								
Parents	□	□	□	□	□	□	□	□
Other teachers who teach the child	□	□	NEXT		□	□	□	□
Pastoral team	□	□	□	□	□	□	□	□
Local mental health team	□	□	□	□	□	□	□	□

i. Acceptability questions

- Do you think the leaflet would be applicable to children of all ages under 18?

  Yes □ No □

- Do you think the leaflet guidance would need to be adjusted for different age groups?

Yes □ No □

If yes, how? _____(free text)

- What would be your preferred way to learn about Return to Normality guidance?

  Online leaflet □ Paper leaflet □ Video □ Website □

  App □ Other □

  If other, what? _____(free text)

- Do you think you have the knowledge to implement the guidance suggested by the leaflet?

Very unlikely = 1	Unlikely = 2	Neutral = 3	Likely = 4	Very likely = 5

- Do you think your answers to the imaginary scenarios were reflective of the actions you would truly take if your own child or a child you teach experienced concussion?

  Yes □ No □

NEXT

j. Debrief information sheet and option to enter email address for prize draw for Part B

NEXT

k. "Thank you for your time, you may now close the browser"

ii. I DO NOT WANT TO COMPLETE PART B IN 4

a. Debrief information sheet and option to enter email address for prize draw for Part A

b. "Thank you for your time, you may now close the browser"

Appendix J: Perceived Stress Scale- 10 items (PSS-10)

PERCEIVED STRESS SCALE

by Sheldon Cohen

The *Perceived Stress Scale* (PSS) is the most widely used psychological instrument for measuring the perception of stress. It is a measure of the degree to which situations in one's life are appraised as stressful. Items were designed to tap how unpredictable, uncontrollable, and overloaded respondents find their lives. The scale also includes a number of direct queries about current levels of experienced stress. The PSS was designed for use in community samples with at least a junior high school education. The items are easy to understand, and the response alternatives are simple to grasp. Moreover, the questions are of a general nature and hence are relatively free of content specific to any subpopulation group. The questions in the PSS ask about feelings and thoughts during the last month. In each case, respondents are asked how often they felt a certain way.

Evidence for Validity: Higher PSS scores were associated with (for example):

- failure to quit smoking
- failure among diabetics to control blood sugar levels
- greater vulnerability to stressful life-event-elicited depressive symptoms
- more colds

Health status relationship to PSS: Cohen et al. (1988) show correlations with PSS and: Stress Measures, Self-Reported Health and Health Services Measures, Health Behavior Measures, Smoking Status, Help Seeking Behavior.

Temporal Nature: Because levels of appraised stress should be influenced by daily hassles, major events, and changes in coping resources, predictive validity of the PSS is expected to fall off rapidly after four to eight weeks.

Scoring: PSS scores are obtained by reversing responses (e.g., 0 = 4, 1 = 3, 2 = 2, 3 = 1 & 4 = 0) to the four positively stated items (items 4, 5, 7, & 8) and then summing across all scale items. A short 4 item scale can be made from questions 2, 4, 5 and 10 of the PSS 10 item scale.

Norm Groups: L. Harris Poll gathered information on 2,387 respondents in the U.S.

Norm Table for the PSS 10 item inventory

Category	N	Mean	S.D.
Gender			
Male	**926**	**12.1**	**5.9**
Female	**1406**	**13.7**	**6.6**
Age			
18-29	**645**	**14.2**	**6.2**
30-44	**750**	**13.0**	**6.2**
45-54	**285**	**12.6**	**6.1**
55-64	**282**	**11.9**	**6.9**
65 & older	**296**	**12.0**	**6.3**
Race			
white	**1924**	**12.8**	**6.2**
Hispanic	**98**	**14.0**	**6.9**
black	**176**	**14.7**	**7.2**
other minority	**50**	**14.1**	**5.0**

PERCEIVED STRESS SCALE

The questions in this scale ask you about your feelings and thoughts during the last month. **In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.**

Name _____ Date _____

Age _____ Gender (*Circle*): **M F** Other _____

	0 = Never	**1 = Almost Never**	**2 = Sometimes**	**3 = Fairly Often**	**4 = Very Often**
1. In the last month, how often have you been upset because of something that happened unexpectedly?	0	1	2	3	4
2. In the last month, how often have you felt that you were unable to control the important things in your life?	0	1	2	3	4
3. In the last month, how often have you felt nervous and "stressed"?	0	1	2	3	4
4. In the last month, how often have you felt confident about your ability to handle your personal problems?	0	1	2	3	4
5. In the last month, how often have you felt that things were going your way?	0	1	2	3	4
6. In the last month, how often have you found that you could not cope with all the things that you had to do?	0	1	2	3	4
7. In the last month, how often have you been able to control irritations in your life?	0	1	2	3	4
8. In the last month, how often have you felt that you were on top of things?	0	1	2	3	4
9. In the last month, how often have you been angered because of things that were outside of your control?	0	1	2	3	4
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	0	1	2	3	4

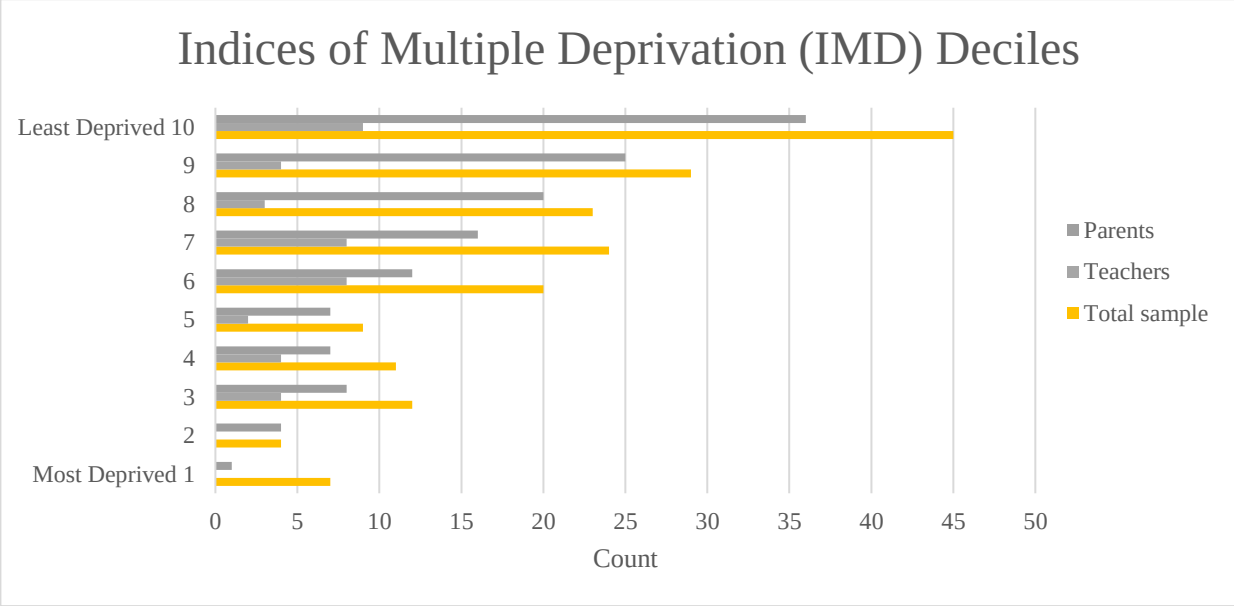
info@mindgarden.com
www.mindgarden.com

References

The PSS Scale is reprinted with permission of the American Sociological Association, from Cohen, S., Kamarck, T., and Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24,* 386-396.

Cohen, S. and Williamson, G. Perceived Stress in a Probability Sample of the United States. Spacapan, S. and Oskamp, S. (Eds.) *The Social Psychology of Health.* Newbury Park, CA: Sage, 1988.

Appendix K: Graph showing Indices of Multiple Deprivation Deciles



Appendix L: Correlation matrices showing correlations amongst HBM variables

Full correlational matrix between Health Belief Model variables reported by teachers

	IMDD	YQ	TCKS	PSS	TAS	PS	PSu	PB	PBe	CA[1]	SE
IMDD	-	-.064	.110	-.364*	-.041	.177	.094	-.065	.088	.126	-.277
YQ		-	-.131	.029	.186	.179	.004	.099	-.099	-.249	.166
TCKS			-	.084	-.168	-.266	.159	-.246	-.247	-.075	.056
PSS				-	-.060	-.306	.044	-.391*	.173	-.296	.091
TAS					-	.315	.017	.497**	.079	.238	.339*
PS						-	.142	.347*	.189	.301	.066
PSu							-	.067	-.128	-.020	.232
PB								-	.028	.237	.375*
PBe									-	.547**	-.117
CA[1]										-	.107
SE											-

Note. IMDD = Indices of Multiple Deprivation Decile, YQ = Years qualified, TKS = Total Concussion Knowledge Score, PSS = Perceived Stress Scale, TAS = Total Adherence Score, PS = Perceived Severity, PSu = Perceived Susceptibility, PB = Perceived Barriers, PBe = Perceived Benefits, CA = Cues to Action, SE = Self-efficacy, [1]non-parametric correlation used, * = correlation significant at 0.05, ** correlation significant at 0.01

Full correlational matrix between Health Belief Model variables reported by parents

	IMDD	TCKS	PSS	TAS	PS	PSu	PB	PBe	CA*	SE
IMDD	-	.042	-.252**	-.008	-.125	.068	.077	.061	.118	-.041
TCKS		-	-.005	.267**	-.024	-.064	.028	.008	.107	-.033
PSS			-	.067	.057	-.062	-.014	-.095	-.116	-.070
TAS				-	.066	-.146	.294**	.014	.086	.179*
PS					-	.068	.184*	.090	.112	.161
PSu						-	.196*	-.025	.116	.070
PB							-	-.006	.116	.447**
PBe								-	.176*	.119
CA*									-	.260**
SE										-

Note. IMDD = Indices of Multiple Deprivation Decile, YQ = Years qualified, TKS = Total Concussion Knowledge Score, PSS = Perceived Stress Scale, TAS = Total Adherence Score, PS = Perceived Severity, PSu = Perceived Susceptibility, PB = Perceived Barriers, PBe = Perceived Benefits, CA = Cues to Action, SE = Self-efficacy, [1]non-parametric correlation used, * = correlation significant at 0.05, ** correlation significant at 0.01

Appendix M: Example email to schools for recruitment

Gunning Fog Index = 11.40. For reference, a gunning fog index score of 12 requires the reading level of an average 18-year-old.

Email Subject Line: Research Study – Recovery after child concussion. – Teachers and parents needed

CONCUSSION ACTION PROGRAMME

UEA University of East Anglia | HEALTH & SOCIAL CARE PARTNERS

Exploring factors that impact adherence behaviour in parents and teachers after child concussion.

Dear (Headteacher name),

I am emailing with regards to a doctoral research project from the University of East Anglia that is being conducted within the Department of Clinical Psychology. The survey will explore what factors may impact teachers and parents use of the recommended guidelines to support a child at home and at school in their recovery following a concussion. The study has been approved by the ethics committee in the Faculty of Medicine and Health Sciences at UEA.

We are currently looking for support from head teachers and all other interested parties who would be willing to disseminate an online survey link to **teaching staff and parents** via email, newsletter or other means. All teaching staff will be eligible to take part if they choose, including teaching assistants and support staff. We would also be

keen to recruit parents via their child's school. All participation will be voluntary. The study has two stages; Stage 1 taking 20 minutes to complete an online survey and a second, optional Stage 2 four weeks later that takes 15 minutes to complete. The survey will consist of a variety of questions aimed to access information about health behaviours. Attached is a short summary of the project and a poster advert for further understanding.

It is essential that we recruit widely so that the results of this study are meaningful and can be applied across services and schools. If you would be happy to be involved, please share the study link with staff and parents: *SURVEY LINK*

We know that it is a busy time for schools, and we are keen to ensure supporting this study is as easy as possible. I have also attached a template email that can be used by schools to send out to staff and teachers to save time. Please use if you wish.

We would appreciate the link being disseminated at your earliest convenience. If you would like further information or have any questions, please do not hesitate to email me on s.casey1@uea.ac.uk.

Kind regards,

Stephanie Casey
Trainee Clinical Psychologist
Doctorate in Clinical Psychology
Faculty of Medicine and Health Sciences
University of East Anglia

Appendix N: Example poster for recruitment

University of East Anglia

HEALTH & SOCIAL CARE PARTNERS

CONCUSSION ACTION PROGRAMME

Are you a parent or teacher of a child under 18?

If so, please volunteer to help us explore what might impact your decision to follow advice after a child experiences concussion.

You do not need any prior experience of concussion.

What's involved?

Stage 1: You will be asked to complete an online survey that takes around 20 minutes. At the end, you will be asked if you are happy to be contacted to complete Stage 2, four weeks later.

Stage 2: If you agree to take part, you will be sent a link for another online survey which will involve reading a leaflet on recovery after concussion and answering some more multiple choice questions. It is expected to take 15 minutes in total.

Will I receive anything for my time?

If you complete Stage 1 of the study, you will have the option to be entered into a prize draw to win one of four £25 Love2Shop vouchers. If you choose to complete Stage 1 and 2, you will be eligible for two entries for the prize draw.

What will be the benefit of participating?

We hope that the findings from this study may inform what and how information about concussion recovery is provided to parents and teachers. This will help to ensure children are successfully supported based on recommended advice.

How do I volunteer to take part?

Please access the online survey using this address: http://bit.ly/PATCH-survey

If you would like further information, please contact s.casey1@uea.ac.uk

Appendix O: Information sheet and consent

GUNNING FOG INDEX = 10.69. For reference, a gunning fog index score of 12 requires the reading level of an average 18-year-old.

University of East Anglia | HEALTH & SOCIAL CARE PARTNERS | CONCUSSION ACTION PROGRAMME

Exploring factors that impact adherence behaviour in parents and teachers after child concussion.

Thank you for clicking on the survey link to take part in our research study. Before you decide to take part or not, please read the following information carefully.

What is this research looking at?

We want to learn more about what parents and teachers may or may not know about child concussion and their recovery. We also want to know what impacts teachers and parent's decision to apply health advice after child concussion.

Do I have to take part?

Your participation is voluntary. You are free to withdraw your responses from the survey at any point during the online completion by closing the browser. You do not need to give a reason for withdrawing. Due to the anonymous nature of the data it is not possible to withdraw your responses once you have submitted your answers at the end of the survey.

What will happen if I agree to take part?

If, after reading this information page you agree to take part, you will be asked to complete an online survey. There are two parts to the survey, and it is your decision whether you want to complete both sections. Part A will take around 20 minutes and Part B will take 15 minutes. You will have the option to finish the survey after Part A is complete. Part B will take place 4 weeks' after Part A and if you agree to complete Part B you will be sent an automatic email with a survey link 4 weeks after completing Part

A. Most questions on both parts are multiple choice. There will be some questions about yourself followed by questions on concussion recovery in children. In Part B, there is a short leaflet to read on concussion recovery and some additional multiple-choice questions. Participation in the study is anonymous and we would encourage your honesty.

If you complete both sections of the survey, as a thank you for taking part you will receive two entries into the prize draw to win one of four £25 Love2shop vouchers. If you complete the first section only, you will receive one entry.

What are the benefits to taking part?

Participating in the current study will help us to understand what impacts a parent or teacher to follow guidelines to support a child after concussion. Improved understanding in this area will help to inform how to best support children, families and schools following child concussion.

What are the possible disadvantages of taking part?

Throughout the study, you will be presented with symptoms of concussion and asked to think about how you, as a parent or teacher, would support a child if they experienced a concussion. It is unlikely that the content of this survey will cause distress, however, for a small number of individuals who may already have experience of concussion and the long-term symptoms of concussion, some of the topics may be upsetting. At the end of the survey, you will be provided with advice on seeking support for yourself or for anyone you may think might have experienced a concussion.

Where will my information be stored?

Answers you provide are anonymously collected and stored on a server which is in keeping with the Data Protection Act (2018). Once the survey is closed, all data will be removed from the server and the account deleted. The anonymous data will be moved to a secure folder on the UEA network and stored securely for no less than 10 years. Access to these files will be restricted to the research team. If you choose to enter your email address at the end of the survey, this data will be stored separately to your survey responses to ensure confidentiality. Email addresses will be deleted after the summary of findings are sent and the prize draw completed.

How will the data be used?

The data will be analysed and written up as part of a doctoral thesis project at the University of East Anglia. The data may be presented in a scientific journal. Your identity will not be shared in any report or communication about the results of this study.

Who has reviewed this project?

The Research Ethics Committee of the Faculty of Medicine and Health Sciences at the University of East Anglia has reviewed and approved the project. The Research Ethics Committee is an independent group that reviews research to protect the dignity, rights, safety, and well-being of participants and researchers. Project number: XXXXXXXXXXX

How can you contact us?

The research team can be contacted as below:

Stephanie Casey Norwich Medical School Queen's Building, University of East Anglia S.casey@uea.ac.uk	Dr Michael J. Grey School of Health Sciences, Queen's Building, University of East Anglia M.grey@uea.ac.uk

What if I have a complaint about the project or its content?

If you have any concerns about the project or its conduct, please contact:

Professor Niall Broomfield Head of Department of Clinical Psychology and Psychological Therapies Norwich Medical School, Queen's Building, University of East Anglia N.Broomfield@uea.ac.uk

By clicking START SURVEY, I understand that I consent to my responses being used within this study and that I can withdraw at any point during the online survey by closing the browser.

START

Appendix P: Demographic questions

Demographic information

Please select from the following:

Gender identity: Male □ Female □ Other □ Prefer not to say □

Age group: 18-24 □ 25-34 □ 35-44 □ 45-54 □ 55-64 □
65-74 □ 75-84 □ 85-94 □

Ethnicity: Arab □ Asian □ Black/African/Caribbean □
Mixed/Multiple ethnic groups □ White □ Other □ Prefer not to say □

Geographical region: Scotland □ Northern Ireland □ Wales □ North East □
North West □ Yorkshire and Humber □ West Midlands □ East Midlands □
South West □ South East □ East of England □ Greater London □

Highest education qualification:
(Please tick the nearest equivalent)

□ No qualifications

□ Secondary school qualifications e.g. CSE, O-levels, GCSEs, NVQs levels 1-3

□ Further education e.g. A-levels, NVQ levels 4 and 5, Foundation degree, Diploma in higher education, HNC/HND, BTEC higher, nursing qualification, other higher education below degree level

□ Bachelors level e.g. University/CNAA Bachelor Degree, Teaching qualification, NVQ level 6

□ Masters level or above e.g. Higher degree, Graduate member of professional institute, Doctorate, PhD

Employment status:

(Tick option that accounts for largest proportion of time)

Employed full-time □ Employed part-time □ Self-employed full-time □ Self-employed part-time □ Unemployed □ Retired □ Homemaker □ Student □ Unable to work □

Postal code: _ _ _ _ _ _ _ (Postcode used to determine socioeconomic status using the Indices for Multiple Deprivation for England, Northern Ireland, Scotland and Wales.)

Have you been trained in first aid? Yes □ No □

Have you heard the term <u>concussion</u> before this study? Yes □ No □

Have you previously received formal training about concussion? Yes □ No □

Please indicate if you have had any indirect or direct experience with concussion and/or traumatic brain injury (TBI):

	Indirect e.g. close family or friends have experienced a…		Direct e.g. I have experienced a…	
Concussion	Yes □	No □	Yes □	No □
Traumatic brain injury	Yes □	No □	Yes □	No □

Where did you find out about this study?

School I work at □ School I am a parent at □ Social media □ UEA Sportspark □ Active Norfolk □ Word of mouth □

What is your role?

Teacher □ Parent □ Both □

(Only shown if "both" selected) **If both, please now choose which role you would like to answer the survey as:**

Parent □ Teacher □

(Additional questions shown dependent on option selected)

Teacher

How many years have you been qualified as a teacher?

Under 1 year □ 1 to 5 years □ 5 to 10 years □ 10 years + □

Teaching assistant □ Trainee teacher □ Other support staff □

Have you worked in an educational setting within the last 10 years?

Yes □ No □

Have you supported a child with suspected concussion symptoms at school?

Yes □ No □

Have you supported a child return to school following a concussion?

Yes □ No □

Are you aware of any guidelines from your school regarding supporting a child to return to the classroom following concussion?

Yes □ No □

Parent

Parental role: Mother □ Father □ Guardian □ Other □

NEXT

Appendix Q: Debrief information sheet

THE GUNNING FOG INDEX IS 7.857. For reference, a gunning fog index score of 12 requires the reading level of an average 18-year-old.

University of East Anglia | HEALTH & SOCIAL CARE PARTNERS

CONCUSSION ACTION PROGRAMME

Thank you for completing this survey.

By taking part in this survey, you have helped to inform research about the factors that impact on adherence behaviour in parents and teachers after child concussion.

[If you have agreed to be contacted for Part B of the survey, you will receive an automatic email in 4 weeks' time with an online survey link. Clicking on the link in the email will allow you to complete Part B.] *Please note, this sentence will only appear on the debrief sheet following Part A.*

Sources of support

If you were upset by any of the contents of this study, please take the time to look at the following resources for well-being and consider contacting your GP for further support. If you are concerned that someone you know may have experienced a concussion and is still feeling unwell, we would recommend visiting your GP or calling NHS direct on 111.

MIND

Leading mental health charity in England and Wales. Tel. 0845 766 0163; website: www.mind.org.uk

Samaritans

National organisation offering support to those in distress and who need someone to talk to. 24-hour Helpline: 08457 90 90 90; website: www.samaritans.org.uk

To learn more about brain injury including concussion, please access the following:

Child Brain Injury Trust

Offer support to families who have experience brain injury or provides information and advice to others hoping to learn more. Website: www.childbraininjurytrust.org.uk

UK Acquired Brain Injury Forum

Aim to promote better understanding of all aspects of acquired brain injury. Website: www.ukabif.org.uk

Thank you

As a way of saying thank you for participating in our study we would like to offer you the opportunity to enter a prize draw for a chance to win one of four £25 Love2Shop vouchers. By providing your email address, you consent to us sending you a summary of the findings of our research as well as contacting you should you be drawn the winner. If you have completed Part A only, you will receive one entry to the draw and if you completed both Part A and B, you will receive two entries to the draw.

If you would like to provide your email address for the stated reasons, please enter your email address here:

…….

For any further information about the study please email: s.casey1@uea.ac.uk

Thank-you for your participation, you may now close the browser.

Appendix R: Empirical study lay summary

Gunning Fog Index = 11.18. For reference, a gunning fog index score of 12 requires the reading level of an average 18-year-old.

University of East Anglia | HEALTH & SOCIAL CARE PARTNERS

CONCUSSION ACTION PROGRAMME

Exploring factors that impact adherence behaviour in parents and teachers after child concussion.

Concussion is a type of brain injury that can happen after we have been in an accident. This might happen after a fall in the playground or after an event more serious such as a car accident. Concussion can happen without the head being directly hit and without 'blacking out'. It can make a person feel dizzy, sick, confused, tired, forgetful, have a headache and/or have trouble with their balance and eyesight. Often, a person will feel better in a few days or weeks. Sometimes, people will have problems that last longer. Ongoing problems might include changes in their mood such as feeling worried or sad, problems with memory or concentrating for long periods of time.

Children can take longer than adults to feel better after concussion. To help, there is information to say what a child should or shouldn't do. As the child begins to feel better, they will be allowed to do more and more tasks such as reading, watching TV and going back to school. Some studies have found that children do not follow this advice. This is worrying as children who do not follow it are more likely to have ongoing problems linked to their concussion. So, parents and teachers have a key role to

play in helping children to follow the advice. So far there has been little research to show how likely parents and teachers are to follow these guidelines. In fact, research has shown that many teachers do not know that there are guidelines and that they do not know much about the longer-term problems linked to concussion. Therefore, this study aims to understand more about whether parents and teachers are likely to follow guidelines to support a child after concussion.

It will also aim to explore what impacts this behaviour. For example, what they do or don't know about concussion recovery. Often what we know about a subject will impact the decisions we make and what action we take. This study will include a short survey made up of tick box questions to find out more about what teachers and parents know about concussion and recovery in children. The study will take between 20 and 35 minutes depending on whether people choose to complete one or both parts of the study. The second part of the study also involves reading a short leaflet on recovery after concussion.

It is hoped that the information we find out from this study may help us to improve the support and guidance teachers and families receive if a child they know has a concussion.

Appendix S: Email from the NHS Greater Glasgow and Clyde Library Network regarding consent to use ACoRN leaflet

From: XXXXXXX

Sent: 29 June 2021 12:31

To: Stephanie Casey (MED - Postgraduate Researcher)

Subject: [NHS Greater Glasgow and Clyde] Re: Hi, I am emailing with regards to using the ACORN leaflet in my doctoral research project at the University of East Anglia. The leaflet can be fou...

Warning: This email is from outside the UEA system. Do not click on links or attachments unless you expect them from the sender and know the content is safe.

##- Please type your reply above this line -##

Your request (#27138) has been updated. To add additional comments, reply to this email or click the link below:
https://www.quest.scot.nhs.uk/hc/requests/27138

NAME ANONYMISED (The Library Network)

29 Jun 2021, 12:31 BST

Dear Stephanie

I do apologise, I only recently came across this enquiry.

If it is still a resource you wish to use, you need only credit us as the original owners of the work, no further permission is required for the purpose you need it for.

XXXXX

XXXX
The NHSGGC Library Network

STEPHANIE CASEY (MED - POSTGRADUATE RESEARCHER)

7 Dec 2020, 11:07 GMT

Hi,

I am emailing with regards to using the ACORN leaflet in my doctoral research project at the University of East Anglia. The leaflet can be found here: https://childbraininjurytrust.org.uk/after-concussion-return-to-normality-acorn/

I am completing my doctorate in clinical psychology and exploring concussion recovery in children and factors that impact their recovery e.g. parental and teacher knowledge and how this then impacts on their likelihood to adhere to health recommendations.

I am hoping to present the ACORN leaflet to parents and teachers within this study to provide them with information on concussion recovery in children. The leaflet has an excellent visual representation of the stages of recovery and is very easy to read making it appropriate for our study.

I have had a read of the copyright information on the site here: https://www.nhsggc.org.uk/about-us/corporate-communications/website-training-and-guides/copyright/# and it seems like permission is granted for using materials if it is for non-commercial research and study.

Please could it be confirmed that there is no additional permissions required to use this leaflet as part of my research study?

Many kind wishes,

Stephanie

Stephanie Casey
Trainee Clinical Psychologist
University of East Anglia
Faculty of Medicine and Health Sciences

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