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ARTICLE

New Zealand Teachers' Understanding of Childhood Mild Traumatic Brain Injury: Investigating and Enhancing Teacher Knowledge and Practice

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Abstract This two-phase study investigated New Zealand primary school teachers' knowledge and perceptions of childhood mild Traumatic Brain Injury (mTBI), and evaluated the effectiveness of a professional development workshop for enhancing teacher knowledge regarding mTBI. In phase one, 19 teachers from schools in the Waikato and Bay of Plenty engaged in interviews regarding their understanding of mTBI and their experiences of learning and professional development in regards to this topic. In phase two, 38 teachers across three schools participated in and evaluated a workshop that focused on increasing knowledge of possible mTBI effects and intervention strategies. The results of phase one found that teachers had a limited understanding of mTBI, its implications in childhood and how to manage its effects at school. Few had engaged in formal learning opportunities related to childhood TBI. In phase two, the brief professional development workshop resulted in a significant increase in TBI knowledge, with teachers identifying the need for practice adaptation. The findings enrich what is known regarding New Zealand teachers' knowledge of mTBI and demonstrates the potential usefulness of brief professional development approaches to inform classroom practice and enhance functional outcomes for children who have experienced mTBI.

Keywords Disability · Concussion · Teacher professional development · Intervention

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Introduction

Traumatic brain injury (TBI) is one of the leading causes of death and disability in childhood, with approximately 30% of children experiencing a TBI prior to age 18 (Borse et al. 2008; Feigin et al. 2010). While severe injuries result in the most significant disabilities, mild injuries (that is, injuries with a Glasgow Coma Scale score between 13 and 15) occur at much higher rates and account for 80–90% of childhood TBI (Bazarian et al. 2005; Feigin et al. 2013; McKinlay et al. 2008). Despite the lower severity of 'mild' injuries, it is increasingly recognised that mild TBI (mTBI; also commonly referred to as concussion) is associated with a range of persistent difficulties. These may include post-concussive physiological symptoms (e.g. headaches, fatigue), cognitive deficits (e.g. memory and attention impairments), emotional symptoms and externalising behavioural adjustment problems (Taylor et al. 2010; Yeates et al. 2012; McKinlay et al. 2009). While the majority of children are symptom-free between 6 and 12 months after an injury, post-concussive difficulties may persist for months or years in a significant proportion of children, with several studies indicating 20–30% of children evidence ongoing problems (e.g. Olsson et al. 2013; Taylor et al. 2010; Yeates et al. 2009). Lasting cognitive, emotional and behavioural problems cognitive the potential to impact on children's capacity to learn within educational settings, thus affecting overall academic achievement and school functioning (Feigin et al. 2013; Linden et al. 2013). However, research regarding post-injury support for children at school has tended to focus on those who have experienced severe injuries and significant disability, rather than those with mTBI (Linden et al. 2013). Nevertheless, there is a growing body of evidence regarding recommended practices to support the re-entry of a child to school following mTBI, such as including a transition plan or temporary individual education plan for gradual return to normal school tasks and demands, providing extension/waiver of assignments or exams, providing rest time or breaks during the day, excusing the child from intense physical activity, or using a preferential seating plan to reduce exposure to distractions or harsh lighting (Kirk et al. 2012).

An important factor in the provision of appropriate post-injury support is the level of teacher knowledge and understanding regarding mTBI and its potential effects (Keyser-Marcus et al. 2002). While there is a lack of research focused on mild injuries, several studies have investigated teacher perceptions of childhood TBI more generally (Adams et al. 2012; Farmer and Johnson-Gerard 1997; Linden et al. 2013; Molnar 2010). The consensus of these studies is that most teachers have a limited understanding of TBI due to limited exposure and education in this area, and are poorly equipped to support children returning to school after an injury (Adams et al. 2012; Farmer and Johnson-Gerard 1997; Linden et al. 2013; Molnar 2010). For example, a survey of 388 teachers in the United Kingdom found that the majority of respondents lacked understanding of TBI; however, those with experience working with children affected by TBI demonstrated greater knowledge of possible injury effects and educational strategies that could be used to ameliorate TBI-related difficulties (Linden et al. 2013). Teachers highlight a lack of formal training or professional development regarding TBI as factors contributing to their

knowledge gaps (Linden et al. 2013; Mohr and Bullock 2005; Molnar 2010). Poor understanding of the characteristics and consequences of TBI further contributes to a lack of knowledge amongst teachers regarding appropriate modification strategies and curriculum adaptation for TBI-affected children (Adams et al. 2012; Molnar 2010).

Previous research regarding teacher knowledge has predominantly employed written surveys administered by post. This approach may have enabled some teachers to research their answers, such as in the case of Molnar's (2010) finding that a large proportion of teacher responses regarding the definition of TBI had been obtained from an online encyclopaedia and recorded verbatim. Consequently, responses may not have accurately reflected actual teacher knowledge. Further, the use of postal questionnaires limit the depth of qualitative information obtained, particularly in comparison to interview formats which allow for response spontaneity, and greater exploration and discussion of meaning (Babbie 2011).

To enhance students' learning and experiences when returning to school after sustaining a TBI, recommendations have highlighted the need for teacher training and professional development with a specific focus on TBI (Keyser-Marcus et al. 2002). The purpose of such training is to: (1) enhance teacher understanding and compassion towards children who have experienced TBI; (2) increase teacher readiness to make classroom adaptations for pupils; and (3) improve teachers' knowledge of specific teaching approaches and classroom strategies to further support children's learning following an injury (Molnar 2010; Keyser-Marcus et al. 2002). Gersten et al. (1997) highlighted factors that could help address barriers to teacher professional development implementation in terms of six principles: (1) reality (feasibility and fit); (2) scope (ensuring suggested changes are not so minor as to be seen as trivial but not so broad or extreme to be seen as too difficult or overwhelming); (3) technical (the need for feedback and ongoing support); (4) conceptual (understanding the significance and possible benefits of using new strategies); (5) linking practice changes to student learning, and; (6) collegial support (involvement and support from senior management; whole school approach). Other studies regarding the translation of teacher professional development to practice change have emphasised the importance of: enhancing content knowledge (Garet et al. 2001); the delivery of practical, concrete ideas that can be implemented in the classroom (Fullan and Miles 1992); teacher perceptions of acceptability and enthusiasm for change; seeking feedback regarding teachers' perceptions of the professional development and suggested strategies (Joyce et al. 1976), and engaging collective participation of teachers from the same school (Garet et al. 2001).

In summary, previous research suggests that teachers are unlikely to have a thorough understanding of the potential complications that might arise following childhood TBI, primarily due to a lack of exposure to the information regarding the implications of such injuries, and this may impact on their capacity to individually tailor curriculum delivery for affected children (Linden et al. 2013; Molnar 2010; Adams et al. 2012). However, much of the previous research regarding teacher knowledge has focused on moderate to severe injuries, with little focus on teacher knowledge of mTBI nor the potential impact on classroom functioning. Little is

known about teacher perceptions of mTBI, with no Australasian data available on this topic, and there is a dearth of literature regarding teacher education regarding mTBI and school-based modifications for affected children.

The objective of this project was to address this research gap by investigating teacher knowledge of mTBI in New Zealand, and exploring the feasibility and effectiveness of professional development regarding mTBI. As such, the current study was conducted in two phases. The aim of the first phase was to: (a) Explore teacher perceptions and knowledge of mTBI; and (b) Identify teachers' professional needs to support children's classroom learning. The aim of the second phase was to evaluate the efficacy of a pilot professional development workshop for teachers regarding childhood mTBI.

Method

Phase One

Design

A qualitative content analysis approach (Braun and Clarke 2006), which included a semi-structured interview, was employed to investigate teacher perceptions of mTBI.

Participants

Participants were 16 female and three male teachers from urban and regional schools in the Waikato and Bay of Plenty regions of New Zealand. Three schools in the Waikato and two in Bay of Plenty (representing a range of deciles) were selected to be approached for recruitment. Principals were invited to advertise the study in the school staffroom and potential participants contacted the researcher directly to arrange an interview. All participants were currently working as primary school teachers and had been employed for between one and 40 years. Participants were aged between 20 and 59 years with a median age of 39 years and had been employed as teachers for between one and 40 years (median = 9 years). All participants were teachers in mainstream education settings and none had certification or training in special education.

Measures

Interview Schedule A semi-structured, study-specific interview schedule was developed by the primary researcher. The first section covered topics such as teachers' understandings of the definitions of traumatic brain injury and concussion, mechanisms of injury, mTBI effects in children and symptom duration. The second section focused on teachers' perspectives of how mTBI might impact children in a school setting, programme adaptations and classroom/playground management strategies, accessing information and training and perceived support barriers.

Procedure Ethics approval was obtained from the University of Waikato Human Research Ethics Committee. Emails and information sheets were sent to school principals requesting that the study be advertised amongst teaching staff, who were invited to contact the primary investigator if they were interested in participating. Individual interviews took place in mutually agreed upon locations that were convenient to the researcher and participants. All participants opted to be interviewed in their place of work, either in their classroom before or after school hours or in another room on school premises. Written informed consent was obtained prior to each interview. Participants were interviewed once. Interviews ranged between approximately 25 and 50 min in length and were audio-recorded.

Analysis Thematic content analysis was conducted in accordance with the procedures recommended by Braun and Clarke (2006). Audio recordings were transcribed verbatim. Two researchers independently read and re-read the transcripts, generating preliminary codes which were then collapsed into thematic categories. Codes were combined into candidate themes to reflect the data and the text was then re-examined to ensure that evidence for each theme was present. Following axial coding, the final superordinate themes were constructed. A third reviewer independently cross-checked the data codes to ensure inter-rater agreement.

Results

Participants used the terms 'mild TBI' and 'concussion' interchangeably, as reflected in the results below. Four superordinate categories emerged as a result of the thematic content analysis. These are described below along with details of the identified themes within those categories.

Knowledge of Mild TBI/Concussion

There was wide variation amongst teacher responses regarding mTBI definitions, causes, characteristics and risk factors. While the majority of participants identified external force as a causal component of mTBI, a significant proportion considered it to be a result of pathogenesis. For many, the relationship between mTBI and more severe TBI was confused.

> Concussion is perhaps an initial symptom, although it can be delayed. Not sure. I think it's under the umbrella as part of what happens.

While most participants were able to accurately identify several causes of TBI (e.g. falls, sport and recreation, motor vehicle accidents), a number of participants seemed to confuse TBI with acquired brain injury (ABI), reporting causes such as prenatal drug and alcohol exposure or vaccines. The majority of teachers in the study perceived that certain children may be at increased risk of experiencing mTBI and were able to accurately identify risk factors reflected in the literature. Innate,

developmental or temperamental factors (e.g. impulsivity, motor skill impairment, and higher activity levels) were most commonly noted as likely to increase a child's risk. In particular, the 'active' or sporty child was identified as being at higher risk of mTBI.

However, for many, mTBI was considered to be an 'equal opportunity' injury that any child might experience due to the accidental nature of most injuries. TBI was described as a phenomenon that may occur at any time to any person.

> I don't know what the research is but I would have thought any child. Obviously, if they are not strapped in a car then they are more prone to traffic accidents, or if they are not closely supervised they might be more prone to accidents on the playground or outside. But I wouldn't have thought that [some might be at higher risk] because if you allow a child … they should be climbing trees. Any of them could fall. They could come off their bikes.

Despite clear evidence in the literature that socioeconomic factors are associated with TBI (Feigin et al. 2013), socio-economic deprivation factors, including poverty and educational disengagement, were not identified by participants as possible risk factors.

Perception of Injury Consequences

Most participants were able to describe several immediate symptoms of mTBI. These typically included headaches, dizziness, vomiting and blurred vision. Many also included cognitive and affective symptoms as possible immediate effects.

> They may blank out a little bit, seem confused really easily, seem like they're listening but not picking up on things. Not able to follow more than one instruction at once.

> You can get angry, so it affects your personality, but I don't know if it goes past the first 24 h to be honest.

While the majority were able to describe some symptoms of mTBI several participants stated that they perceived their knowledge regarding initial symptoms to be very limited.

In terms of symptom duration, there was wide variation in participants' expectations regarding the persistence of mTBI symptoms. A large proportion (40%) expected all symptoms to be resolved within three days. Several of those reported an expected symptom duration of 24 h. When asked if they might expect to see ongoing symptoms in a child who had experienced mTBI two weeks earlier, one participant stated:

> Definitely not. Probably not two days later, if I was honest.

While the majority of participants perceived that mTBI symptoms would be short- term, resolving within days or weeks, seven (36.8%) said that they perceived that mTBI may have longer-lasting impacts, possibly persisting for months or years. Those that considered mTBI effects to be potentially ongoing reported a number of

cognitive, behavioural and affective changes that might occur post-injury and impact on school performance.

> We know that if concentration is affected, you don't know what that child is missing. You might not even realize what that child is missing. And if that's happening several times over several days or weeks, there is a gap there which then could cause further gaps further on because you can't scaffold. And then, if it affects behaviour, behaviour has a real correlation to process in learning.

Teaching Adaptations

Participants were asked to discuss the strategies and approaches that they thought should be employed by teachers working with a child who has ongoing (>3 months) mTBI effects, e.g. cognitive, affective or behavioural changes. Innate qualities and personality styles were identified, such as empathy, compassion and patience.

> There may be a period where that child is not performing at the level that he or she previously was performing. So that child will need patience and understanding, and maybe that little bit more support to get them back to where they were.

The majority of participants perceived that some degree of 'scaffolding' would be required to support a child's learning following mTBI. For some, this referred to monitoring and making adaptations in the initial hours and days following an injury. Most who discussed the need for short-term monitoring or class routine changes highlighted the importance of minimising the risk of a subsequent mTBI while the child was still recovering from an initial injury. In this regard, adaptations were framed as safety measures rather than being related to the specifically addressing impairments in order to enhance learning.

> I'm not sure that I would make any teaching adjustments but I would just be more aware of what had happened, get feedback from the parents and just monitor their condition in case they deteriorated.

Those who perceived mTBI to have the potential to cause longer-term problems tended to speak more broadly about changes that could be made to teaching and assessment approaches in order to enhance performance and support recovery. Such participants also discussed a need for program flexibility in order to accommodate physiological problems such as fatigue and headaches.

> Because I teach the little ones, it means that if we are doing a writing exercise I would write it down so they can copy over. Just being aware that they could be a lot more tired, so getting later on in the week just letting them out to have an afternoon in the sandpit, a quiet afternoon doing something else. And not trying to push them hard doing movement things in the morning.

Most participants advocated here for responsivity; that is, understanding and consideration of each individual's post-injury strengths and limitations, coupled

with a reflexive teaching approach that was considerate of and adapted to each child's needs.

Professional Needs of Teachers

The majority of participants discussed a need for information that could inform the way in which they might manage and adapt the curriculum to suit the needs of a post-concussive child. Most perceived that the education field had a responsibility to address their knowledge gap, such as government education departments and special education services.

> I think the teacher would need to have information from those who specialise in extra help for children, to help them put together some sort of programme—what the child needs, what you need to do for this child, what the classroom needs to do for this child, what the school needs to do. That would be my expectation—information so you can put a plan in place.

All participants reported they were not satisfied with their current level of knowledge and training as it pertained to mTBI, its effects and teaching strategies for affected children. All participants also highlighted the need for professional development that would increase their knowledge regarding mTBI and enhance their ability to deliver evidence-based teaching strategies to children experiencing neuropsychological impairment post-injury. None had received previous training or education in the area of mTBI, either within their undergraduate teacher training or subsequently by way of professional development opportunities.

> We would really love more information, more professional development, a greater understanding. Because we do want to do our best for these children but, speaking personally, I know I haven't got the skills I need and the understanding that I need. I know that I have been floundering a bit and going by trial and error because, without the professional development, you don't know whether you're doing right for that child.

Phase Two

In phase two, a brief professional development workshop was developed on the basis of the findings of the first phase, and with reference to the current research regarding child mTBI effects and suggested ameliorations (e.g. Taylor et al. 2010; McKinlay et al. 2009; Swaine et al. 2008). This was followed by a small-scale evaluation of the acceptability and usefulness of the workshop to groups of teachers.

Method

Participants Ethics approval was obtained from the University of Waikato Human Research Ethics Committee. Participants were 38 teaching staff newly recruited from three primary-schools in Hamilton and Tauranga, New Zealand. None of the participants involved in phase 2 had previously participated in phase 1 of the study.

The recruitment method involved emailing school principals in 14 Waikato and two Bay of Plenty schools, offering to provide a free professional development workshop to be evaluated by consenting teachers, which was followed up with a telephone call. Seven (44%) principals were successfully contacted via email or follow-up telephone contact. Four declined to be involved. Reasons for declining included the perception that teachers wouldn't have time due to upcoming Education Review Office audits (n = 2), that TBI was not a current learning priority (n = 1) and that staff did not perceive mTBI to be a common enough problem in their classrooms to warrant professional development in the area (n = 1). Of those schools that responded to contact attempts, three (43%) provided verbal consent to proceed with concussion workshops at a mutually agreed time and location.

The three schools that agreed to participate in the workshop and evaluation formed three groups of participants. Group 1 was from a Decile 8 school (decile refers to the socioeconomic status of the school community, with 1 = poorest and 10 = wealthiest) and was comprised of 10 females and three males. Group 2 was from a Decile 2 school and was comprised of seven females and two males. Group 3 was from a Decile 4 school and was comprised of 14 females and two males. Participants were aged between 24 and 66 years with a median age of 46 years. They had been employed as teachers or special education support for between one and 40 years, with a median teaching duration of 20 years.

Materials The following study-specific materials were developed by the primary researcher.

Childhood mTBI Workshop: Delivery was guided by the presentation of 47 PowerPoint slides (available on request) covering World Health Organisation definitions and classifications of TBI (World Health Organisation 2006), mTBI epidemiological data (e.g. McKinlay et al. 2008; World Health Organisation 2006), possible behavioural, social, emotional and academic consequences (McKinlay 2009; Yeates et al. 2012; Yeates 2010; Moore et al. 2006; Kirkwood and Yeates 2010) and suggested intervention strategies for teachers. This included reference to the post-concussion 'safety net' approach recommended for educators (Iverson et al. 2012; Kirk et al. 2012), involving a school team meeting, sharing of concussion education resources, and development of a student support plan procedure. Evidence-based strategies and modifications were also suggested to address specific types of neuropsychological impairment (e.g. minimising distraction for children with attention deficits, the use of instructional chunking, repetition and written cues/reminders for children with memory problems, providing extra time and slowing down the delivery of information for children with slow information processing) (Dise-Lewis et al. 2009). Opportunities for reflection and questioning were built in throughout the seminar.

Teacher Background Questionnaire: The teacher background questionnaire collected information regarding the teacher's gender, age, ethnicities, years and type of teaching experience (i.e. Special education or mainstream). Additional information regarding the school's socioeconomic rating ('school decile') and geography (urban/rural) was also obtained.

Knowledge Assessment Scale: The knowledge assessment scale was designed specifically for the study as a measure of mTBI knowledge, as no existing measure of mTBI knowledge was identified. It contained nine statements regarding mTBI that were rated by respondents as True or False (e.g. 'you have to lose consciousness to be diagnosed with concussion'; 'symptoms of a concussion are very obvious and happen immediately after the injury'). Items reflected commonly debated and disputed facts from the literature with reference to some common myths about concussion (Bickerstaff 2010; Brady and Brady 2011).

Workshop Evaluation Form: The workshop evaluation form focused on evaluation of the workshop with emphasis placed on participants' reactions and learning (Guskey 2000). Subsequent to participating in the workshop, teachers rated their satisfaction (e.g. "how satisfied were you with the content of this workshop?"), the perceived usefulness (e.g. "how useful do think the information in the workshop was?"), relevance (e.g. "how relevant to your practice was the information in this workshop?"), novelty of the content (e.g. "how much of the workshop content was new information for you?"), and the likelihood of implementation (e.g. "how likely is it that you will apply some of the strategies you have learnt today in your practice?" five 5-point Likert scales. Space for qualitative responses regarding these areas was included in the form.

Procedure

Principals at all three participating schools selected their school staffroom as the location for delivery of the workshop. As agreed, the researcher attended each school and presented the study objectives verbally to teachers before providing them with another copy of the teacher information sheet. Written consent was then obtained from all participants.

Prior to delivery of the workshop seminar, participants completed the demographic questionnaire and a knowledge assessment scale regarding concussion facts which was administered as a pre-intervention measure. The seminar itself was subsequently delivered, taking approximately 90–120 min (dependent on level of teacher participation and questions). Upon completion of the seminar, teachers completed the knowledge assessment scale again as a post-intervention measure along with the workshop and brochure evaluation forms.

Data Analysis

Quantitative data analysis was carried out by using SPSS (version 22). Descriptive statistics were used to assess the demographic characteristics of participants and ratings of their responses to the workshop material. A repeated measures ANOVA was conducted to determine whether knowledge of concussion facts improved as a result of attending the workshop, and a Mann–Whitney test of comparison was computed to assess whether there were demographic group differences in test scores.

Qualitative responses to evaluation questions were read and analysed separately by two investigators, and themes identified. As in phase one, a third reviewer

independently cross-checked the data codes to ensure inter-rater agreement. The qualitative and quantitative data were then integrated in order to generate a more comprehensive account workshop's usefulness, relevance and applicability to teaching practice.

Results

Workshop Evaluation

Thirty-eight participants rated their satisfaction with the workshop and its usefulness. In regards to satisfaction, 20 (52.6%) rated themselves as 'very' satisfied, 14 (36.8%) as 'quite' satisfied and 4 (10.5%) as 'somewhat' satisfied. No participants rated themselves as 'not at all' satisfied.

In regards to usefulness, 16 (42.1%) rated the workshop as being 'very' useful in their teaching practice, 17 (44.7%) as 'quite' useful and 5 (13.2%) as 'somewhat' useful. No participants rated the workshop as being 'not at all' useful. Thirty-seven participants rated the relevance of workshop topic (mTBI) to their work as a teacher. Eighteen (48.6%) rated it as 'very' relevant, 14 (36.8%) as 'quite' relevant, and five (13.5%) as 'somewhat' relevant.

Participants were asked to report how much of the content of the workshop new information for them was personally. Fifteen (39.5%) reported that 'most' of the material was new information, while the remaining 23 (60.5%) rated 'some' of the information as new. When asked to rate the likelihood that they would attempt some of the suggested strategies in their practice, 17 (44.7%) reported it was 'very' likely, 19 (50%) 'quite' likely, one (2.6%) 'somewhat' likely, and one (2.6%) 'not at all' likely.

Repeated Measures ANOVA

A one-way within subjects ANOVA was conducted to compare the effect of the workshop on concussion assessment scale scores in the pre-delivery and post-delivery conditions. Participants obtained higher mean test scores of concussion knowledge subsequent to engaging in the workshop ($M = 8.5$, $SD = 0.69$) than at baseline ($M = 7.4$, $SD = 1.58$). This increase was statistically significant, $F(1,37) = 16.97$, $p = 0.01$, $\eta^2 = .314$.

In order to assess whether there were demographic differences in the baseline and post-workshop scores, two tests of comparison were conducted. Due to the non-normal distribution of the data, two non-parametric tests (Mann–Whitney U) were computed. The first test of comparison examined whether there were gender differences in workshop scores. The results were not significant (baseline $p = .282$, post $p = .234$). Secondly, the years of teaching experience variable was transformed into a dichotomous variable based on the distribution of responses (0–15 years = lower; 16–40 years = higher). This new categorical variable was included in a second Mann–Whitney U analysis to assess whether teachers with lower or higher levels of experience demonstrated significant differences in

knowledge assessment scores. The score differences were not found to be significant (baseline $p = .601$, post $p = .432$). The results of these analyses indicate that gender and years of teaching experience were not significantly associated with knowledge assessment scores.

Qualitative Results

Workshop Evaluation

Usefulness Participants were asked to consider the most useful piece of learning that they obtained from participation in the workshop. Many participants reported that learning about concussion symptoms was the most useful aspect. In particular, it was noted that it was most helpful to learn about the wide range, complexity and potential seriousness of some of the symptoms.

> Knowing the symptoms that children may have and as a teacher, how I may help.

> That any blow/knock to the head or form of brain shake is to be taken seriously and that the child needs close monitoring for some time. Changes may occur for that child in learning, emotions, behaviour.

A large proportion of participants stated that the most useful aspect of the workshop was learning about teaching strategies and in-class modifications that could be made for children. Strategies noted included giving children shorter tasks and including rest breaks upon return to school after mTBI.

Practice Changes Thirty-five (92%) participants reported that they expected to make changes to their teaching practice as a result of attending the workshop. When asked what they might do differently in future, several themes emerged. Many participants described a heightened awareness of TBI that they suspected would lead to increased vigilance and caution around managing students injuries at school. This included consideration of how seriously injuries that occurred at school might be taken.

> Be a lot more careful and take note after any bang to a head.

> Monitor suspected TBI much more closely.

Participants also suggested that they would increase their observation and monitoring of students' symptoms and possible performance issues, particularly in the initial period following an injury, with heightened awareness of the possibility that TBI may impact on a child's functioning in a variety of ways. They reported that they would be more alert to persistent symptoms or behavioural changes. Several reported that their empathy and tolerance towards students with difficulties increased from participation in the workshop.

Many participants noted particular strategies or modifications suggested in the workshop that they intended to employ in their future practice. In particular, they

highlighted suggested techniques for adapting their communication style to meet the needs of children with cognitive processing, memory or attention difficulties. These included keeping instructions 'clear and in small chunks', considering different ways of giving instructions and presenting information, and taking extra time to explain activities.

The need for cognitive rest and low-stimuli activities post-injury was also emphasised by several participants, with an expectation that they would attempt to support such adaptations in the classroom and facilitate rest periods for children after sustaining a concussion. Examples of adaptations included lightening workloads, including rest periods, and giving greater consideration to the types of activities children were required to do. Several others reported that they now intended to develop and utilise Individual Education Plans or care plans with all children with known injuries (as suggested in the workshop with reference to the Concussion Safety Net approach) and considered this to be a significant practice change.

Another significant theme emerged in respect of the topic of communication with families, with a large proportion of participants highlighting this issue as an area of likely practice change. For some, this referred to the contacting of parents if a child has an injury at school. For others, the need for increased communication was related to concern about changes in a child's functioning or poor academic performance, in order to establish whether TBI might be a background factor.

Discussion

The purpose of this research was to investigate teacher perceptions and knowledge of mTBI in New Zealand, identify teacher education and support needs in regards to supporting children affected by mTBI, and evaluate the efficacy of a pilot professional development workshop for teachers regarding childhood mTBI and relevant classroom adaptations. It is the first of its kind to investigate mTBI knowledge among New Zealand teachers and to evaluate the usefulness of an educational intervention aimed at enhancing teacher knowledge and awareness of the potential effects of childhood mTBI. It provides a platform for the ongoing development of mTBI-related professional development and the use of supportive practices by teachers.

Teacher Perceptions and Knowledge

The findings of phase one highlight the limited nature of teachers' professional engagement with the topic of child mTBI. There is wide variation in perceptions and understanding of the basic epidemiology and consequences of mTBI, and a number of misconceptions were evident. This finding reflects previous research that has indicated that teachers tend to have a limited understanding of childhood TBI and its possible effects (Adams et al. 2012; Farmer and Johnson-Gerard 1997; Linden et al. 2013; Molnar 2010). Participants in the current study reported a lack of knowledge

regarding possible injury effects or the types of modifications that might be indicated when a child has experienced mTBI (Linden et al. 2013).

Teacher Learning Needs

The need for professional development was discussed at length by many participants. All of those interviewed reported that they had no exposure to the topic of TBI during their undergraduate teacher training and subsequently had not been made aware of any professional development opportunities relating to TBI. This finding reflects that of Mohr and Bullock (2005) which showed that teachers were unlikely to have received any prior education relating to TBI, especially during their undergraduate training. Participants in the current study with a background in special education services or RTLB indicated that they had knowledge regarding other disabilities that they perceived could be generalised to work with students that have experienced TBI, however all acknowledged that their knowledge of TBI was limited by a lack of training. Similar results have been found in previous studies in which educators have express concern about their lack of TBI knowledge (Adams et al. 2012; Linden et al. 2013).

While most participants expressed a desire to engage in professional development regarding TBI to enhance their capacity to identify students' difficulties and make relevant accommodations, there was some disagreement as to whether such training should be pre-emptively obtained or instead accessed when a teacher becomes aware that a student in their class has experienced TBI. Those who considered advance training to be important highlighted the need for increased awareness in order to identify difficulties and implement management strategies early on, reflecting recommendations in the literature that highlight the importance of prior TBI knowledge and increased teacher awareness in the enhancement of students' return to school (Keyser-Marcus et al. 2002; Linden et al. 2013).

Professional Development Workshop

The findings of phase two suggest that a brief workshop regarding the characteristics and effects of mTBI, and possible classroom interventions, is an effective approach to improving teacher knowledge of mTBI. Alongside increased teacher knowledge (Garet et al. 2001), establishing satisfaction amongst participants was a key learning objective of the workshop (Guskey 2000). Furthermore, perception of relevance is seen to be an important aspect of fit and feasibility for teachers looking to implement new learning from professional development activities (Fullan and Miles 1992; Gersten et al. 1997). Both the quantitative and qualitative findings of this study suggest that participant satisfaction levels were high, increasing the likelihood that teachers would subsequently make changes to their teaching approach on the basis of the workshop's recommendations.

Over 90% of participants reported that they expected to utilise strategies learnt in the workshop and adapt their teaching practice when working with children with mTBI or other special needs. Participants suggested that they would be more likely to take a concussion seriously, obtain medical attention more promptly, and engage

in careful monitoring and observation in the days and weeks following an injury. This change in response seemed to be related to participants' heightened awareness of the prevalence and symptoms of mTBI in childhood.

Participants also reported that they would be more likely to engage in management strategies such as monitoring for fatigue and allowing rest time/s and opportunities to engage in low-stimuli activities were noted by participants. Participants emphasised specific techniques such as adapting the communication of instructions and information to meet the needs of children with information processing, memory or attention problems. Several teachers also indicated that they intended to develop an individual education or care plan to assist with the facilitation of these strategies. This finding regarding uptake of suggested strategies is interesting, in that it could be argued that none of these techniques might be considered particularly novel or complicated in terms of special education modifications. While it follows that this might enhance the likelihood that teachers will implement the strategies, due to their perceived applicability and a lack of barriers (Gersten et al. 1997), this finding also highlights the possibility that the level of knowledge of strategies for use with children with disabilities may not be sufficient among the general teaching population to address such children's' learning needs. When considered in light of inclusive education approaches, this this raises a significant issue in relation to mainstream teacher education regarding special education practices.

Limitations

This study has several limitations. In phase one, the sample was limited to a small cohort of interested teachers who self-selected for the study, potentially impacting on the representativeness of the sample. In phase two, a limited range of schools participated in the workshop. The knowledge assessment scale was developed for the purposes of the study and was not a validated measure. The use of a longer measure may have strengthened the reliability of the findings regarding the improvement of teacher knowledge and reduced the likelihood of any ceiling effect. While the evaluative component of phase two employed the primary levels of Guskey's (2000) guidelines for the development and evaluation of teacher professional development, time constraints precluded the examination of longer-term outcomes of the professional development workshop. Longitudinal follow-up may have elucidated whether participation in the workshop led to changes in teacher practice and school culture, knowledge improvements were maintained over time, or if student outcomes were ultimately improved. Investigation of such longitudinal changes would have strengthened the validity of the current findings.

Phase One and Two Conclusions

Children who have experienced mTBI may be at increased risk of experiencing emotional, behavioural, intellectual, or academic problems that impact on their school functioning. In order for such problems to be properly identified and

addressed, this research demonstrates that it is crucial for teachers to be supported and educated regarding child mTBI, post-concussive symptoms, and the relationship of these variables to classroom functioning. The contributions of teachers to this research have indicated that they are aware of their personal learning needs and desire increased opportunities to address those needs.

Professional development regarding TBI for teachers is a potentially low-cost, brief and easily-administered intervention that has the potential to impact on children's outcomes after mTBI by improving symptom identification and enhancing classroom management of related learning and behavioural problems. Delivering professional development for experienced teachers is key to enhancing their knowledge and practice in this area. However, it remains unclear whether a workshop setting is the most effective and cost-efficient mode of delivery for such education. It is possible that teachers may equally benefit from the use of written information, educational software and applications, or public awareness campaigns. It may also be useful for tertiary teacher training programmes to consider how to build the topic of TBI into teacher education in university settings, so that future generations of teachers do not experience the knowledge gaps that their predecessors report. Future research should focus on comparing the efficacy of different types of teacher education activities, and would benefit from including longer-term follow-up in order to assess translational effectiveness.

As it is now well-established that children with mTBI are in a higher risk group that is more likely to experience persistent cognitive, emotional, behavioural, and academic problems, it is appropriate now for our focus to shift to the consideration of how best to ameliorate such problems in the setting where children spend most of their waking hours—that is, at school. A combined, multi-disciplinary approach to the development of consistent guidelines and educational resources for teachers and parents regarding mTBI is the next step in addressing this significant public health issue, so that mTBI-related difficulties can be identified and appropriately addressed and good educational outcomes achieved.

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