Exploring the Relationships between Self-reported Physical Activity Levels, Fatigue and Return to Work following Mild Traumatic Brain Injury

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university of other institution of higher learning.

Signed

Mark Shirley
20 June 2011

Acknowledgements

On my fridge I have a magnet which reads “Believe nothing, no matter where you read it or who has said it, not even if I have said it, unless it agrees with your own reason and common sense” (Buddha). This quote has often made me stop and think, just because we have historically been providing rehabilitation a certain way, does not mean we should continue to do it that way – especially if it doesn’t make sense!

I would like to thank Professor Kath McPherson who once told me that common sense is not very common; for inspiring me to look deeper into my own practice and giving me the confidence to critique literature.

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Statement of Approval

This study received ethical approval on the 17th December 2009 from the Multi-region Ethics Committee, which reviews national and multi-regional studies, reference number MEC/09/82/EXP.

This study also received ethical approval on the 11th of December from the ACC Research Ethics Committee.

Abstract

The aim of this study was to identify if there was an association between physical activity levels and fatigue following Mild Traumatic Brain Injury (MTBI). A secondary aim was to establish if either of these two variables, physical activity and fatigue, was associated with the functional outcome of achieving a return to work.

Participants were recruited through the Accident Compensation Corporation (ACC) research unit via an internal service code, which identified potential participants as having sustained a MTBI within the last six months, currently receiving rehabilitation services and having had a referral for assessment at a MTBI clinic. A total of 216 individuals were subsequently sent a questionnaire via post. The questionnaire pack included:

- The New Zealand Physical Activities Questionnaire – Short Form (NZPAQ-SF), to measure self-reported physical activity levels.
- The Checklist Individual Strength (CIS) Questionnaire, to measure self-reported fatigue levels.
- Demographic questions including; age, gender, ethnicity, date of injury, where the injury occurred, how the injury occurred, previous brain injuries, history of mood disorders and any outcome of a return to work.

Following a response rate of 47% (n = 101) data analysis identified a significant negative association between fatigue and physical activity (r_s = 0.38, p<0.01); indicating that higher levels of fatigue were associated with lower levels of physical activity following a MTBI.

A significant association was also identified between fatigue and the likelihood of being at work (OR 1.03, $p<0.01$), indicating that higher levels of fatigue were associated with a lower chance that an individual will be at work following MTBI.

A non-significant association (OR 0.96, $p = 0.12$), was identified between physical activity and the likelihood of an individual being at work.

Further, 30.7% of the population reported severe fatigue based on their scores on the CIS. Despite this, overall activity levels were comparable to a general non-MTBI population.

This research has extended understanding of the complex relationship between fatigue, exercise and work post MTBI. Further research is needed to identify the direction of the relationship between these variables and thus the optimum focus for interventions. However, the findings here have indicated that the advice clinicians give about rest and activity potentially plays a crucial role in recovery and adaptation after MTBI. In particular, the role improved activity management might have in ameliorating fatigue post MTBI, must be identified if return to work rates for this population are to improve.

1. Introduction

1.1 Outline of the Study

It has been estimated that in New Zealand there are approximately 24,000 cases of Mild Traumatic Brain Injury (MTBI) per year (Accident Compensation Corporation [ACC], 2006a). The majority of individuals who sustain a MTBI will gradually recover within the first seven to 10 days (McCrea, 2008); however, several authors (ACC, 2006c; Anderson, Heitger & Macleod, 2006; Ryan & Warden, 2003; Wood, 2004) report variable rates of symptoms even three months after injury.

Ingebrigtsen, Waterloo, Marup-Jensen, and Att (1998) reviewed 100 consecutive individuals following MTBI and reported 62% of the population were continuing to experience one or more symptoms 3 months after injury. This is in contrast to McCrea (2008), who reported the incidence of persisting symptoms following MTBI are grossly overestimated and are more likely to be approximately 5% of the population. McCrea cited methodological issues in previous studies such as sample selection, recruitment techniques, and diagnosis issues as being confounding factors for the higher rates reported in previous literature.

This example of conflicting data is common within the literature and is compounded as the academic debate surrounding MTBI develops further from incidence rates, towards whether the actual presence of persisting symptoms are due to neurologic, psychological or even other non-injury related factors (McCrea, 2008).

Regardless of the ongoing disagreement surrounding the incidence rates, or cause of persisting symptoms post MTBI, one clear underlying issue is that the cost of managing the effects of MTBI are significant. In 2002 data collected by ACC (2006a) revealed that the cost of new MTBI cases was over $12 million in a single year; this did not include the cost of ongoing claims from previous years. In the United States, present day estimates for total lifetime costs of MTBI are over $16 billion (McCrea, 2008). The values are not easily comparable due to differing inclusion criteria and calculation methods; however, given the difficulty in extrapolating and analysing the varying categories of TBI, both values are probably underestimated. While these figures seem significant in themselves, when the cost of lost productivity and the indirect costs borne by families/whanau and the patients are added to the equation, it becomes clear that having high quality evidence based rehabilitation services available to these individuals should be a priority. Unfortunately this is not the case and is highlighted in a recent review of the diagnosis, management and rehabilitation of TBI by the New Zealand Guideline Group which noted that in dealing with fatigue, one of the most frequently reported symptoms following MTBI, “there is virtually no good quality evidence relating to its extent, impact, and effective treatment” (ACC, 2006a, p. 110).

Taking into consideration the previously mentioned issues surrounding the conflicting incidence rates of persisting symptoms following MTBI, it is not surprising that the literature also disagrees on effective management. Specific intervention strategies for persisting symptoms are not well defined and appear to be based on individual clinical or conceptual opinion, rather than from evidence. In the absence of clear clinical guidelines, individuals can consequently be given advice on managing their symptoms which could range from complete rest and removal from the workplace, to a progressive return to normal activity levels (Kozlowski, 2008).

Within a clinical context, physiotherapists often provide advice and education on exercise and return to activity following injury. While it is accepted that acute MTBI symptoms should be managed with rest, McCrea (2008) provided evidence that the brain returns to a normal physiologic state within days to weeks following injury. McCrea further suggested that individuals should return to normal occupational, social and independent functioning within similar timelines. With this in mind, and the knowledge that prolonged reduction in activity levels and removal from the workplace have both been shown to have detrimental effects on an individual's mood, financial and social situations (ACC, 2006b), clinicians need to carefully consider the prescription of rest, extended time away from work and removal from social responsibilities. A careful balancing act is required to ensure that acute symptoms are managed carefully with appropriate rest, and a return to activity is actively promoted within an appropriate timeframe.

To better understand the impact of rest or reduced activity on individuals post MTBI, this study aimed to investigate whether a relationship existed between fatigue and activity levels following MTBI, specifically whether individuals who had lower activity levels experienced higher levels of fatigue. The implications of physical activity and fatigue levels were further explored by analysing the association that fatigue or activity levels had on the success, or otherwise, of a return to work.

If the engagement in physical activity is associated with lower self-reported fatigue, and lower fatigue levels are associated with improved vocational outcomes, the clinical relevance of this study becomes clear. It may be that by participating in regular physical activity individuals are able to reduce the amount of fatigue experienced, and consequently participate in a timely return to work. Although further research would be required to identify a directional causation, the results of this study will give clinicians a better understanding of the relationship between physical activity levels and fatigue. Furthermore it will provide clarity to the impact and extent of fatigue, an area that has been described as lacking in effective treatment or understanding (ACC, 2006a).

1.2 Hypotheses

To test the hypotheses, outlined below, a significance level of $\alpha = 0.01$ was utilised. This level of significance was preferred over a level of $\alpha = 0.05$ as it only gives a 1% chance of rejecting the null hypothesis when it is true, as opposed to a 5% chance with a significance level set at 0.05 (Field, 2009). Consequently if the *p* value was less than 0.01, the relevant null hypothesis was rejected and the association was recorded as being statistically significant.

1. Lower physical activity levels will be significantly associated with higher self-reported fatigue levels in individuals following MTBI.
2. Self-reported fatigue levels will be significantly lower in individuals that achieve a return to work outcome in comparison to those that do not.
3. Self-reported physical activity levels will be significantly higher in individuals that achieve a return to work outcome compared to those that do not.

1.3 Null Hypotheses

1. Lower physical activity levels will not be significantly associated with higher self-reported fatigue levels in individuals following MTBI.
2. Self-reported fatigue levels will not be significantly different for those who achieve a successful return to work and those that do not achieve a successful return to work.

3. Self-reported physical activity levels will not be significantly different for those who achieve a successful return to work and those that do not achieve a successful return to work.

The following chapters will outline the literature reviewed in preparation for the research project and the study methodology that was implemented. The results achieved following the hypotheses testing will be described and the clinical implications of these findings discussed. Finally areas for future research will be identified.

2. Literature Review

2.1 MTBI and Persisting Symptoms

2.1.1 Traumatic Brain Injury Definition

Although numerous systems have been developed over the years to classify Traumatic Brain Injury (TBI) (Stein, 2006), in New Zealand the distinction in severity is commonly made based on the patients presenting Glasgow Coma Scale (GCS) (Teasdale & Jennett, 1974) and/or length of Post Traumatic Amnesia (PTA) (Carroll et al., 2004). These are outlined in Table 2.1.

Table 2.1: Criteria for Classifying the Severity of Traumatic Brain Injury

Severity	**Glasgow Coma Scale**	**Duration of Post Traumatic Amnesia**
Mild	13-15	less than 24 hours
Moderate	9-12	1-6 days
Severe	3-8	7 days or more

Note: Where there is a discrepancy between the GCS and PTA scores, the individual is assigned to the more severe of the two categories (ACC, 2006a).

2.1.2 Mild Traumatic Brain Injury Definition

Approximately 90% of all TBI are classified as mild (ACC, 2006a); however taking into consideration previous literature that has identified up to 41 differing definitions for MTBI, identifying true incidence rates remains a challenge (Anderson, Heitger, & Macleod, 2006). In 2004, The World Health Organisation (WHO) Collaborating Centre Task Force (Carroll et al., 2004) recognised the need for a common criterion to define a MTBI to enable analyses of differing research and evaluation of intervention services. Recognising that an in depth discussion on the varying strengths and weaknesses of other guidelines was beyond the scope of the paper presented, they recommended the following operational definition for future research:

> MTBI is an acute brain injury resulting from mechanical energy to the head from external physical forces. Operational criteria for clinical identification include: (i) one or more of the following: confusion or disorientation, loss of consciousness for 30 minutes or less, post-traumatic amnesia for less than 24 hours, and/or transient neurological abnormalities such as focal signs, seizures, and intracranial lesion not requiring surgery; (ii) Glasgow Coma Scale score of 13-15 after 30 minutes post-injury or later upon presentation for healthcare. These manifestations of MTBI must not be due to drugs, alcohol, medications, caused by other injuries or treatment for other injuries (e.g. systemic injuries, facial injuries or intubation), caused by other problems (e.g. psychological trauma, language barrier or coexisting medical conditions) or caused by penetrating craniocerebral injury. (Carroll et al., 2004, p. 115)

The current study adopted this definition of MTBI in line with the WHO recommendations.

2.1.3 Symptomology Post Mild Traumatic Brain Injury

Common symptoms following an MTBI include; fatigue, headache, nausea, vestibular disturbances, subjective cognitive impairment, irritability, visual disturbances, tinnitus, neck pain, sleeping problems, noise and light intolerance, low mood and anxiety (Snell & Surgenor, 2006). The majority of individuals should recover naturally within three months (Carroll, et al., 2004); although the literature has identified that a variable minority may continue to report symptoms for up to 12 months or longer (Wood, 2004).

The presence of persisting symptoms following MTBI has been labelled as Post Concussion Syndrome (PCS) (Ryan & Warden, 2003), or Post Concussion Disorder (PCD) (McCauley et al., 2005). These diagnostic criteria are outlined in Figures 2.1 (p. 8) and 2.2 (p. 9) respectively, as defined by both the Diagnostic and Statistical Manual of

Mental Disorders Fourth Edition (DSM-IV), and the International Classification of Diseases, 10th Revision (ICD-10).

Figure 2.1: ICD-10 Diagnostic Criteria for Post Concussion Syndrome

A. History of head trauma with loss of consciousness precedes symptoms onset by maximum of four weeks
B. Symptoms in three or more of the following symptom categories:
    - Headache, dizziness, malaise, fatigue, noise tolerance
    - Irritability, depression, anxiety, emotional lability
    - Subjective concentration, memory, or intellectual difficulties without neuropsychological
    - Insomnia
    - Reduced alcohol tolerance
    - Preoccupation with above symptoms and fear of brain damage with hypochondrial concern and adoption of sick role

(WHO, 1993)

While accurate diagnosis is important to assist with appropriate management and analysis of health care, symptom based diagnosis of PCS or PCD, as per the DSM-IV and ICD-10 criteria has been cautioned by McCrea (2008). The author reviewed the evidence base for the diagnosis and treatment for MTBI and raised issues surrounding the poor reliability of both the diagnostic criteria and also the non-specificity of PCS symptoms as reasons for limiting the use of PCS or PCD as a diagnosis. McCrea further commented that both the ICD-10 and the DSM-IV have limitations for clinical and research use, as both are fraught with similar limitations in reliability and validity.

Figure 2.2: DSM-IV Research Criteria for Postconcussional Disorder

A. A history of head trauma that has caused significant cerebral concussion. Note: The manifestations of concussion include loss of consciousness, post traumatic amnesia, and, less, commonly, post traumatic onset of seizures. The specific method of defining this criterion needs to be established by further research.
B. Evidence from neuropsychological testing or quantified cognitive assessment of difficulty in attention (concentrating, shifting focus of attention, performing simultaneous cognitive tasks) or memory (learning or recall of information).
C. Three (or more) of the following occur shortly after trauma and last at least three months:
    1. Becoming fatigued easily
    2. Disordered sleep
    3. Headache
    4. Vertigo or dizziness
    5. Irritability or aggression on little or no provocation
    6. Anxiety, depression, or affective instability
    7. Changes in personality (e.g., social or sexual inappropriateness)
    8. Apathy or lack of spontaneity
D. The symptoms in criteria B and C have their onset following head trauma or else represent a substantial worsening of pre-existing symptoms.
E. The disturbance causes significant impairment in social or occupational functioning and represents a significant decline from a previous level of functioning. In school-age children, the impairment may be manifested by a significant worsening in school or academic performance dating from the trauma.
F. The symptoms do not meet criteria for Dementia Due to Head Trauma and are not better accounted for by another mental disorder (e.g., Amnesic Disorder Due to Head Trauma, Personality change due to Head Trauma).

(American Psychiatric Association, 1994)

While consistent types of complaints might support the validity of a post-concussive syndrome or disorder, the limitations outlined by McCrea (2008) surrounding the validity and reliability in both the ICD-10 and DSM-IV meant that neither of these diagnostic criteria were used in this research project. Instead it was decided that the definition of an MTBI as outlined by Carroll et al., (2004), would be adopted and all individuals would be included regardless of whether they met the criteria for PCD or PCS.

With differing clinical opinion over the diagnosis of MTBI and what causes or constitutes persisting symptoms, it is of no surprise that the literature published on the management of this condition is also polarised.

2.2 Current Management of Mild Traumatic Brain Injury

Borg et al. (2004) performed an extensive literature review on non-surgical intervention following MTBI. After screening 38,806 articles, they reviewed 45 and accepted seven. They summarised that “the evidence supports a minimal education strategy that also promotes a return to activity as soon as possible. There was no evidence for routine administration of intensive assessment and intervention to minimise persisting complaints in MTBI” (p. 83). Wood (2004) supported this statement, adding that out of the studies reviewed, the most promising results were those that provided early education on symptoms and set expectations that symptoms are transient and will naturally reduce with time. The author commented further that relatively few people are provided with this service and further work needs to be done to attempt to identify the personality, or other factors, that may assist in predicting those individuals who are more at risk of the development of long term symptoms.

Kozlowski (2008) presented a summary of clinical care, which included pharmacological treatment, cognitive rehabilitation, neurotherapy, patient education, psychological treatment, and rest. He argued the negative side effects of complete rest include; an increase in anxiety, increase in depression and a concurrent deterioration in physical conditioning. The author went on to reiterate that the lack of methodological rigour within the MTBI literature, also described by Borg et al., (2004), limits the scientific evidence for current treatments.

In New Zealand, contracts for MTBI rehabilitation services are held by specialist services to assess and provide appropriate intervention.

The purpose of this service is to:

- Provide early intervention rehabilitation to support clients' recovery and prompt return to everyday life, including work or school.
- Identify clients who are likely to develop long-term consequences, such as post-concussion syndrome (PCS), and provide them with effective interventions and education. (ACC, 2010, p. 2)

Without a clear evidence based pathway to follow, it appears current rehabilitation in the ACC funded MTBI clinics in New Zealand has been split into two stages. Stage one aims to provide education on the symptoms, rehabilitation process, brain injury and how to source other appropriate support. It also aims to complete a risk assessment and plan for further input if required. This can be provided by occupational therapists, physiotherapists, speech and language therapists or a registered nurse. The second stage shifts the focus to clinical assessment and treatment from an interdisciplinary team which must have access to clinical psychology, an appropriate medical specialist, and occupational therapy. In addition, the team should have access to a range of other associated health related disciplines such as optometrists, vocational counsellors and driving assessors (ACC, 2010).

Despite the misgivings previously mentioned by McCrea (2008), regarding the non-specificity of PCS, it is interesting to see this term is included in the current rehabilitation model in New Zealand. Regardless of this limitation, the approach outlined above does appear to achieve the general recommendations made within the literature of early non-intensive and education based rehabilitation. Furthermore, it appears to provide a safe-guard that enables escalation to more intensive support if ongoing issues are identified. As this is a relatively new service, data has not been provided regarding its effectiveness or ability to achieve the outcomes expected, which limits detailed critique.

Overall, the generalised management of MTBI is a poorly described and consequently controversial area, yet one specific area of management receiving attention in the literature, is the use of sub-symptom exercise. In this intervention physical activity levels are carefully prescribed at an intensity level so as not to stimulate MTBI attributable symptoms. Leddy et al. (2007) advocated the use of this specific exercise protocol to assist with a return to sport and to avoid the secondary de-conditioning effects in resting athletes following MTBI. This type of intervention is worth further consideration in a non-athletic population, especially when taking into account the literature that supports participation in general activity following brain injury, and how exercise can positively impact on the psychosocial functioning of individuals who have had a brain injury (Driver & Ede, 2009).

2.3 Physical Activity Following Mild Traumatic Brain Injury

Recently the use of physical activity has focused specifically on its effect on persisting symptoms following MTBI (Kozlowski, 2008; Leddy et al., 2007; Willer & Leddy, 2006). These authors advocated the use of regular sub-symptom exercise as a way to enable individuals to actively manage residual symptoms, objectively measure recovery and safely return to sport in athletes following MTBI. They described a process whereby individuals performed a graded stationary exercycle programme attempting to reach 85% of age-predicted maximum heart rate. Blood pressure and symptoms were monitored regularly and participants were instructed to stop the moment they had an onset of MTBI related symptoms. Following the establishment of a maximal non-symptomatic exercise intensity rate, the researchers suggested regular activity at a heart rate 15% below this baseline level. Participants were then reassessed and new baselines of exercise intensity established. The authors acknowledged that there is no evidence-based research to quantify specific activity type, intensity, or progression rate.

The concept of an exercise based intervention following MTBI is given further support in reviewing the literature which indicates that common persisting symptoms following MTBI such as, fatigue, low mood and anxiety, all benefit from regular exercise (Johnson, 2007). The use of exercise following MTBI has been explored further by Driver and Ede (2009) who commented that physical activity can positively influence mood for individuals following brain injury. Despite only including eight participants who completed an 8 week aquatic activity course in comparison to eight participants who completed a vocational rehabilitation class, the authors reported significant differences and large effect sizes for the improved positive mood states of vigour and friendliness, and reduction in the negative mood states of depression and fatigue. Driver and Ede drew on these findings and reported that individuals who experience these changes are more likely to engage socially, maintain employment and experience increased quality of life; however they did not directly measure these outcomes.

Wetzel and Rorke (2001) provided further support for carefully prescribed non-symptom provoking exercise and reported benefits to individuals following MTBI including; reduced fatigue, reduced frequency and/or intensity of symptoms, reduced stress and depression and improved mood, sleep and motivation. Unfortunately this paper did not undertake a systematic review, rather drew evidential backing to highlight their points from the relevant literature.

As support for physical activity following MTBI is growing, the importance of monitoring this type of intervention has been highlighted by Willer and Leddy (2006) in their review on the management of concussion. They raised a pertinent point that in the athletic population they work with, individuals are conditioned to routinely push themselves for improvement. The authors commented that if exercise is implemented too soon or too vigorously, individuals can have an increased or return of symptoms that may last several days or weeks. This highlights the need for carefully prescribed or supervised exercise.

Glass et al. (2004) explored the effect of physical activity from a different angle. The authors investigated the impact of exercise cessation in a group of healthy middle aged individuals and described the development of fatigue and depressive mood symptoms in the individuals who were required to stop exercising. They concluded by postulating that their results may explain the negative mood changes experienced in response to short-term exercise withdrawal, such as the time following injury or illness. The study was well described and the limitations, such as participants being advised that the study was examining mood changes as a result of exercise withdrawal, were discussed. Although this research was not carried out with a MTBI population, if the act of resting or exercise cessation is implicated in the development of fatigue and low mood in healthy individuals, then careful consideration should be given prior to prescribing rest to an MTBI population who are already reporting fatigue. It could be argued that further rest or reduced levels of activity may only increase fatigue levels and even prolong the individual's disability.

2.4 Fatigue Following Mild Traumatic Brain Injury

Research into other neurological populations, such as stroke and multiple sclerosis, shows that prolonged severe fatigue interferes with daily functioning and is associated with diminished quality of life (Chaudhuri & Behan, 2004). Fatigue has been linked to the pathophysiology of other illnesses such as; a reduction in muscle fibre size in individuals with multiple sclerosis, reduction in respiratory mechanics in individuals with chronic obstructive pulmonary disorder and reduced muscle blood flow in chronic heart failure (Evans & Lambert, 2007); however, its cause and consequently management within MTBI remains unclear. McCrea (2008) described the pathophysiology of MTBI suggesting that a period of metabolic dysfunction occurs initially post injury. This dysfunction has a rapid reversal and normal brain metabolic function should occur within several days in the majority of people with a MTBI. This may explain the acute symptoms of fatigue, however does not give an explanation for those individuals who continue to report fatigue as an ongoing issue. Iverson and Lange (2003) examined this phenomenon investigating the prevalence of post-concussion like symptoms in a sample of healthy individuals. They concluded that the presence of post-concussion like symptoms are not unique to a MTBI population, are commonly found in healthy individuals and are highly correlated with depressive symptoms.

A recent study (Stulemeijer et al., 2006) investigated the severity of fatigue at 6 months post injury in individuals with a MTBI, in comparison to those with a minor orthopaedic injury and no diagnosis of MTBI. The authors chose to use a Checklist Individual Strength (CIS) questionnaire which looks at four aspects of fatigue: severity, concentration difficulties, motivation and activity. The authors reported that severe fatigue was prevalent in 32% of people diagnosed with a MTBI and 12% of those with a minor orthopaedic injury. They commented that both these rates of fatigue were higher than expected in a normal population, but lower than other neurological conditions such as stroke and multiple sclerosis. The study had some limitations including a lack of equivalence in the population demographics and a lack of information provided as to the validity or reliability of the measurement tool. While this study attempted to quantify fatigue, to date there have not been any studies that look specifically at intervention strategies for fatigue following MTBI (King, Crawford, Wenden, Moss, & Wade, 1995).

As previously mentioned, the New Zealand Guideline Group completed a recent review on the diagnosis, management and rehabilitation of TBI and advised that in dealing with fatigue experienced following MTBI, "there is virtually no good quality evidence relating to its extent, impact, and effective treatment" (ACC, 2006a, p. 128). Despite this statement, one common clinical intervention reported for fatigue following MTBI is the use of pacing or energy conservation techniques. The concept of pacing is not unique to MTBI and is frequently used and referred to in other non-specific conditions such as chronic fatigue syndrome (Thomas, Sadlier, & Smith, 2008). Unfortunately without clear evidential guidelines or definition, the concept of pacing is open to conceptual clinical and personal opinion as to: What pacing actually is? How long people should participate in a pacing programme?; and whether this type of intervention is actually effective? It could even be further argued that, as no definitive physiological cause has been linked to the development of fatigue following MTBI, the prescription of a pacing intervention in this population is merely prolonging disability. It may actually be better for individuals to return to their pre-injury activity levels once the acute phase of recovery has passed. This approach may be too extreme and as fatigue continues to be a common symptom reported post MTBI, perhaps a more acceptable approach would be to recognise that it is an issue and manage it with a progressive return to normal activities over a specific time period, as opposed to waiting for it to resolve.

Inherent in the prescription of rest is the removal from social responsibilities such as domestic tasks and vocational roles. While it is accepted that any return to activity should not expose an individual to risk of secondary injury, there is no evidence presented that individuals will have a poorer outcome or more persisting symptoms when appropriately encouraged to return to their social and vocational roles, in a timely manner.

Without further research into the specific management of MTBI related fatigue, the prescription of rest or recommendation of pacing needs to be done with careful clinical reasoning. Patients should be given clear guidelines on the expectation of a progressive increase in activity. This approach is reinforced by the literature outlining the positive effects that physical activity can have on psychological health and overall physical functioning.

2.5 Return to Work

The literature describing return to work rates following MTBI needs to be interpreted with caution due to the difficulty in identifying a true population. It has been estimated that 25% of MTBI patients never seek medical attention, spontaneously recover, and return to their everyday activities (McCrea, 2008). These individuals are at risk of being routinely missed within research, as commonly MTBI studies recruit participants from emergency departments or other medical settings. By not including these individuals, the literature is open to reporting bias with a general skew towards overly negative outcomes. For example, it is more likely that an individual that does not manage to return to work will eventually be reviewed by a health professional and therefore entered into a medical or insurance database. This gives a higher chance of an unsuccessful outcome being included in research, as these databases are also a common recruiting tool for health based research. In comparison, the individual that recovers without intervention and successfully returns to work may not have the same opportunity to be included in the research, due to a lack of contact with the health system. This would therefore tend to give a more negative picture than perhaps is actually true. In the New Zealand context, all individuals who sustain an injury are able to lodge their claim with ACC and consequently have the opportunity to be included in research, such as the current project. However as ACC claims are required to be lodged by a health professional, this leaves New Zealand research open to similar issues as outlined previously.

In the absence of data on return to work rates of individuals following MTBI in New Zealand, data collected in an insured population in America revealed that 88% of people had returned to work at 8 weeks post MTBI (Englander, Hall, Stimpson, & Chaffin, 1992). It was further reported that 16% of these individuals were still experiencing persistent symptoms on their return to work. The clinical issue of whether an individual should return to work while still experiencing symptoms following MTBI remains unanswered. However Chan (2001) reported that many of the commonly reported MTBI symptoms can occur in the general working population, therefore, the presence of these symptoms may not, in themselves, be a reason to delay a return to work. In New Zealand, ACC have provided guidelines on how to assist people with a TBI to return to work, stating that the effect of prolonged time away from work can include an increased risk of depression and anxiety, reduced physical activity and energy loss (ACC, 2006b). These symptoms, common in the MTBI population, may be increased or prolonged by the cessation of physical activity (Glass, et al., 2004). McCrea (2008) summarised an extensive review of the literature of return to work following MTBI and highlighted that the majority of individuals will return to work at some point, albeit with substantial variation. He noted the methodological difficulties across the studies that contribute to this variation including, differences in inclusion criteria, work capacity definitions and work status.

A return to work following MTBI should ensure that any risk of re-injury is carefully managed and this management is specific to the vocational tasks of the individual. For example, a return to building industry work may require a period of alternative duties to avoid risk of exposure to injury. Comparatively, an office worker may initially need reduced hours to limit cognitive load. Individuals should also avoid situations beyond their usual tolerance level of activity as they may find themselves unable to operate for a lengthy period afterwards (ACC, 2006b).

A decision to limit an individual’s return to work, following the acute stage, due to the presence of symptoms, should be carefully weighed up against the consequences likely to be incurred from a lengthy time away from the workplace. A clinical decision based on the presence of persisting symptoms may also give individuals the perception that these symptoms are serious and create a perceived need that they should completely abate before an increase in function is possible. It may also cause further de-conditioning, removal from social participation and other negative consequences as previously outlined.

The need for support to return to work post-TBI is highlighted by Anderson et al. (2006), who observed that many patients, without guidance, are likely to return to work too early. They posited that some individuals may only begin to be aware of cognitive symptoms, such as poor concentration, when they return to work, particularly if their job is intellectually demanding. This can lead to a loss of confidence, self-esteem and potentially the development of chronic symptoms (Ponsford et al., 2000). Therefore, a careful balancing act is required to ensure an appropriate return to work happens in a timely manner with appropriate support.

2.6 Summary

This literature review has raised a number of points common to the area of rehabilitation. These have ranged from methodological issues in previous literature, to problems encountered when attempting to identify a representative population. The literature has further questioned current management strategies of fatigue and highlighted the need for the current research project. The main points are summarised in Table 2.2 (p. 21).

Table 2.2: Summary of Main Points from the Literature Review

Main Point	Authors
There are a number of methodological issues encountered when researching the MTBI population and there is a need to agree on, and use, standardised terms.	(Anderson et al., 2006) (Carroll et al., 2004)
The use of PCS and/or PCD should be used with caution given the non-specificity of the symptoms experienced and the poor reliability of both the DSM-IV and ICD-10 criteria.	(McCrea, 2008)
The current management of MTBI is highly variable and, given the lack of evidence based research to guide intervention, open to clinical and conceptual opinions of best practice.	(Borg et al., 2004) (Kozlowski, 2008) (McCrea, 2008) (Wood, 2004)
Physical activity has been shown to have a positive effect on the psychosocial function of individuals following MTBI.	(Driver and Ede, 2009) (Johnson, 2007) (Kozlowski, 2008) (Leddy et al., 2007) (Wetzel & Rorke, 2001) (Willer & Leddy, 2006)
Removal from physical activity can be detrimental for the general population as well as for individuals following MTBI.	(Glass et al., 2004)
There is little evidence relating to the extent, impact or treatment for fatigue following MTBI.	(ACC, 2006a)
Long periods away from work can increase the risk of depression, anxiety, reduced physical activity and energy loss.	(ACC, 2006b) (Ponsford et al., 2000)
Individual return to work rates are highly variable following MTBI.	(Englander et al., 1992) (McCrea, 2008)

Taking the above summarised points into consideration, the need for a carefully designed and described research paper exploring the association between fatigue, physical activity and return to work becomes apparent. If associations between fatigue, physical activity and return to work are identified, the information will help guide clinicians in the management of persistent fatigue following MTBI. It will bridge the gap between the current research in an athletic population, which advocates the use of carefully prescribed exercise to assist with a return to play, and identify if this type of intervention may have validity in a general population that are struggling with fatigue and having difficulty returning to work.

3. Method

3.1 Introduction

The primary aim of this project was to explore the association between self-reported fatigue and self-reported physical activity levels in individuals following a MTBI. The secondary aim was to explore the associations between self-reported fatigue levels, self-reported activity levels and return to work outcome. In order to explore these issues a survey was undertaken. This chapter describes the study design, the research participants, the questionnaire format, and the statistical analysis used.

3.2 Study Design

An observational study design utilising a postal survey to quantify individuals self-reported levels of fatigue, self-reported physical activity levels, and return to work outcome was implemented.

A New Zealand wide postal survey was the method of choice and is an appropriate method to use when exploring associations between variables of interest in a geographically spread population (Peat, 2001). It was felt that this approach would account for any regional socio-demographic variance or any regional differences in clinical management from the nationwide MTBI clinics. This was an important consideration as the literature review highlighted that without a strong evidence base for delivering intervention, management strategies are likely to have a bias depending on the health professional delivering them. It was therefore likely that the MTBI clinics management approaches would vary nationally dependent on individual staffing and conceptual opinions of management (i.e. a MTBI clinic led by an occupational therapist might differ significantly from a clinic led by a neuropsychologist). A postal survey was also the most efficient design given the personal and financial resources available.

During the design phase of this study, note was taken of methodological issues raised through similar research in an MTBI population. Stulemeijer et al. (2006) utilised a postal questionnaire and reported a response rate of 52%. To achieve this response rate, the authors sent a letter to all potential participants 6 months following injury, and then a further reminder letter 3 weeks later. The response rate achieved by the authors is acceptable considering response rates for surveys in the general population rarely exceed 50% (Nakash, Hutton, Jørsta, Gates, & Lamb, 2006).

To maximise response rates in the current study, the postal survey was designed using an adapted version of the tailored design method as described by Dillman (2000). Towers (2006) reported studies utilising this method have managed to achieve response rates between 58 to 92%. Dillman (2000) advocated a structured approach to survey design which incorporates five points of contact between the researcher and the participants in order to maximise response rates. For the current study the approach was adapted following the fourth point of contact, as only a further six responses were returned. This rate was considered within the relative costs and benefits of a further round of contact and, as the study was already adequately powered with the number of responses achieved, a decision was made to contact the relevant ethical committees to request consideration of omitting the final point of contact. This process was approved and the methodology amended with the final contact method outlined in Table 3.1 (p. 25).

Table 3.1: Adapted Final Postal Survey Method

Point of contact	Posting procedure and content	Weeks after initial contact
1	ACC posted out a pre-notification letter (Appendix A) to the identified target population based on the inclusion criteria. Individuals were advised that they had been identified and to contact ACC via an 0800 number if they wished to opt out of the research. If they did not opt out, ACC provided the contact details to the researcher and they were sent a questionnaire.	Initial Contact by ACC
2	The questionnaire was sent with a token incentive (pen) and a free-post return envelope. This was accompanied by a detailed participant information sheet (Appendix B) explaining the premise of the study, who was involved, participants rights and expectations, and points of contact in case they had any queries.	2 weeks
3	A “thank you” letter (Appendix C) was sent to everyone in the sample, thanking those who had responded and encouraging those who did not respond to do so.	6 weeks
4	A final letter (Appendix D) and replacement questionnaire was sent to all non-respondents to encourage participation.	12 weeks

Note: Only four points of contact

3.3 The Research Participants

Inclusion criteria in this study required individuals to have sustained a MTBI within the last six months, as defined by ACC in their *Provision of Mild Traumatic Brain Injury Assessment and Rehabilitation* services contract and outlined in Figure 3.1 (p. 27; ACC, 2001). Potential participants were identified by the ACC research advisors via an internal system code that is generated following a referral to a MTBI clinic. Participants were also deemed to be currently active in ACC’s system, inferring they were requiring or accessing rehabilitation services. By using the service code that only identified individuals who were having ongoing symptoms, there is a high likelihood that individuals who had ‘recovered’ or had their claim closed, would be excluded. This has the potential to significantly skew the return to work data, as it would be expected that individuals who were working pre-injury would be back at work in their pre-injury capacity (as defined by ACC legislation). Despite this, the methodology used ensured that individuals that were included had a higher chance of having ongoing symptoms, which was the population of interest. As return to work was not the primary variable of interest, this methodology of recruitment was acceptable.

Participants under the age of 18 were excluded from this study in line with ACC’s policy that individuals under the age of 18 will be considered as children or young persons (ACC, 2006a). It is difficult to compare the effects of brain injury in children and young people with adults as the brain is not fully developed until approximately 16 years of age and the social and behavioural demands on children are different to that of adults. No other exclusion criteria were used to maximise the generalisability of the results to the general population.

Following identification, raw data that included the individuals name, gender and contact details was presented to the researchers on an excel spreadsheet. Contact was then initiated as per the process previously outlined in Table 3.1 (p. 25).

Figure 3.1: Criteria for MTBI

Mild TBI occurs when a person has had a traumatically induced disruption of brain function manifested by:

A. At least *two* of the following:
   - A period of loss of consciousness from a few seconds up to 30 minutes, verified by an external observer wherever possible
   - Disturbance of memory for events immediately before and/or after the accident. Memory disturbance should last at least 1 minute but no longer than 24 hours, verified by an external observer wherever possible
   - Focal neurological deficit(s) that may or may not be transient, including evidence of altered mental state such as confusion or disorientation

AND

B. A Glasgow Coma Score (GCS) of 13 or higher usually present at the time of initial medical examination, preferably at 1 hour after the injury.

AND

C. Presenting symptoms are not attributable to pre-existing medical condition or pre-existing psychological disorder, or primarily due to drug or alcohol intoxication. The presence of any of these may still mean an injury has occurred.

AND

D. ONE of the following:
   - Evidence that medical care has been sought within 7 Days of injury (unless it is unavailable, e.g. the person was on a fishing boat, in the mountains, or similar)
   - There is documentation from a Registered Health Professional consistent with external force to the head having occurred, such as
     - Contusion, abrasion, bruising or other injury to the skin or scalp
     - Skull fracture, with radiological evidence
     - Injury to the scalp, skull, meninges or brain including intracranial haematoma
     - Acceleration-deceleration injury
   - In the absence of either of the above, review by a Registered Specialist that indicates, on the balance of probabilities, an external force to the head has occurred

(ACC, 2001, p. 14)

3.4 Sample Size

To achieve the study's objective, a sample size calculation was undertaken using G*Power 3.0.10 (Heinrich Heine Universitat, Duessledorf, Germany, 2008). Power was set at 0.80 and the probability level was set at 0.05. The power level and significance levels were set to minimise the chance of a type I or type II error occurring (Peat, 2001). Hypothesising a moderate effect size of 0.3, which can account for 9% of total variance (Field, 2009) and a correlation of 0.6 or higher, a sample size of 54 individuals was targeted. Effect sizes enable researchers to compare studies that use different scales of measurement or different variables. A moderate effect size was anticipated between physical activity levels and fatigue based on literature supporting the notion that fatigue is commonly observed in individuals who are deprived of usual exercise activities (Berlin, Kop, & Deuster, 2006), and the assumption that individuals post MTBI are routinely advised to limit their activity levels through pacing techniques (ACC, 2006c).

Based on a response rate of 30% to 50% reported in a similar postal survey that looked at fatigue following MTBI (Stulemeijer et al., 2006), 180 individuals would need to be sent the questionnaire pack to ensure a sample of at least 54 individuals. Following the application of the study criteria, ACC research advisors identified the dataset of 226 individuals who met the inclusion criteria. These individuals were all sent a letter by ACC asking if they wanted to be excluded from the study. Following the 14 day opt out period, 10 individuals were excluded (five opted out and five bounced back as undeliverable). The remaining 216 individuals were sent the questionnaire pack (Appendix E).

3.5 Measures

The final questionnaire pack comprised of basic questions on demographic background and information about return to work, combined with the two standardised measures. The first measure was included to quantify fatigue, the Checklist Individual Strength Questionnaire (CIS) and the second measure was used to quantify physical activity levels, The New Zealand Physical Activity Questionnaire – Short Form (NZPAQ-SF). These will now be described in further detail.

3.5.1 Checklist Individual Strength Questionnaire

Self-reported fatigue was measured using the CIS (Beurskens et al., 2000). This 20-item self-report questionnaire captures four dimensions of fatigue, including the subjective experience of fatigue, reduction in motivation, reduction in activity and reduction in concentration. Respondents rate the extent to which each statement is true for them in the past two weeks on a seven-point likert scale ranging from 1 = “Yes, that is true” to 7 = “No, that is not true.”

The CIS has been described as an appropriate instrument for measuring fatigue in a study (Beurskens et al., 2000) that looked directly at the validity of the CIS in a working population. Research participants included individuals with expected differences in fatigue levels from five differing groups of employees. They were employed in a variety of settings, including employment with a high degree of manual and cognitive demands. Validity was evaluated by comparing the results on the CIS with three related measures. The results indicated that the CIS was able to discriminate between fatigued and non-fatigued employees. The authors summarised that the CIS seems to be an appropriate measure for use in the working population.

Although the CIS has not been directly validated in an MTBI population, it has been validated amongst individuals with chronic fatigue syndrome and has been shown to be sensitive to change in fatigue levels over time (Dittner, Wessely, & Brown, 2004). As it has been argued that no gold standard for measuring fatigue exists (Bultmann et al., 2000) and symptoms common in individuals post MTBI are also common in individuals with chronic fatigue (Carroll, et al., 2004) and the general population (Chan, 2001; Chan, 2005; Rees, 2003), it was decided that the CIS would be a useful and acceptable measure.

The CIS has been used in a previous study that focused on fatigue following recovery from MTBI (Stulemeijer et al., 2006). The authors sent participants a questionnaire pack which included the CIS as the outcome measure for fatigue. They reported good to excellent internal consistency using the CIS, with Cronbach's alpha reliability coefficients ranging from .839 to .948. The authors also stated that individuals diagnosed with a MTBI reported significantly more fatigue than the minor-injury controls. The results of that study indicated that the CIS was a reliable scale to use when measuring MTBI related fatigue and therefore appropriate to use in the current research project.

3.5.2 The New Zealand Physical Activity Questionnaire – Short Form

Activity levels were measured using a self-report questionnaire, NZPAQ-SF (McLean & Tobias, 2004). The Physical Activity Joint Monitoring group comprising of Sport and Recreation (SPARC), the Ministry of Health and Statistics New Zealand, developed the NZPAQ-SF as a modified version of the International Physical Activity

Questionnaire-Short. The NZPAQ-SF is designed to assess three dimensions of physical activity; frequency, duration and intensity, and is the preferred tool for physical activity measurement in the New Zealand population (Mackay, Schofield, & Schluter, 2007). It has been used by SPARC and the Ministry of Health in national sample sizes including the 2002/03 and 2006/07 New Zealand Health Surveys (Ministry of Health, 2004; 2008).

In completing the NZPAQ-SF individuals were requested to retrospectively record the amount of physical activity undertaken in the last seven days. This included total time spent brisk walking and/or time spent performing moderate and vigorous activities. Specific activities for each category were provided for reference (see Appendix E). Total time spent completing moderate physical activity was calculated as; brisk walking, plus moderate activity, plus (vigorous activity times two); that is, one minute of vigorous activity was equated with two minutes of moderate intensity activity in line with recommendations made by McLean and Tobias (2004). A higher time recorded by the individuals represents more time spent performing equivalent moderate physical activity.

The NZPAQ-SF was initially designed to be administered by an interviewer, however due to the geographical spread of participants and the postal method employed in this study, this approach was not feasible. Mackay et al. (2007) presented supportive evidence for the use of a self-administered version of this tool. They performed an inter-method validity analysis between a self-administered and telephone version of the NZPAQ-SF and reported excellent agreement between the two versions. Further support for the use of a postal questionnaire to measure physical activity levels is offered by Kohl, Blair, Paffenbarger, Macera, and Kronenfeld (1988), who advised that exercise behaviour can accurately be measured in large populations using simple questions in a mail survey. Sallis et al. (1996) also reviewed physical activity levels comparing a personal interview with a self completed form. They reported a Pearsons correlation of 0.76 between the two methods ($p<0.001$). These studies provide support that self-administered questionnaires are cost effective and comparable to interviewer led data when assessing physical activity levels. While self-report methods have an inherent problem of overestimating physical activity levels, a recent validation study has demonstrated that the NZPAQ-SF is comparable to international survey instruments and, importantly, is culturally appropriate to the New Zealand context (McLean & Tobias, 2004).

Despite not being specifically validated in the MTBI population, due to the non-specificity of symptoms outlined previously, and the high base rate of MTBI symptoms present in the normal population, it was felt that the validated NZPAQ-SF was acceptable for measuring population level physical activity levels in the target population.

3.5.3 Functional Outcome – Return to Work.

Return to work was included as a functional outcome and was measured by asking participants to identify their pre-injury occupational status along with their current post-injury occupational status. If they had returned to their pre-injury occupation further questions explored the length of time this took and how the return to work process was implemented.

Although return to work has been shown to be a good measure of social participation, measuring it is a complicated issue. To accurately measure return to work, a range of issues need to be considered (Gu´erina, Kennepohla, L´eveill´e, Dominiquea, & McKerrala, 2006). The current research project was focused on identifying the impact of fatigue and physical activity levels on a return to work outcome, however it is recognised that a return to work outcome can also be the beginning of functional recovery which is not achieved until vocational stability is sustained (Young et al., 2005a). To clarify, while an individual may achieve a return to work outcome, consideration needs to be given as to the long term implications before it can be labelled as a 'success'. When measuring return to work varying stakeholders interests also need to be considered as, although all stakeholders can share a common goal, they can have varying definitions and competing goals. Young et al. (2005b) raised the point that, for some persons, being out of work or in alternative work may be an acceptable outcome, although this may not constitute a successful goal for an insurer. Within the current study, the group of individuals who were still in the process of returning to work are difficult to categorise, as individualised return to work programmes can include variables, such as altered hours, duties, responsibilities or productivity.

Despite the obvious complexity encountered when measuring a return to work, it was decided that this was an important measure to include as this data has not previously been made available in this population in a New Zealand context, and previous research has indicated that the impact of MTBI related fatigue is not clear. Accepting this limitation, and understanding that any results would be limited in their generalisability due to the approach taken, it was decided that when analysing the return to work outcome individuals should be categorised using a dichotomous variable of a successful return to work or not. If individuals were either not at work or in the process of returning to work, they were coded as not having achieved a successful return to work outcome. Those individuals who indicated a return to pre-injury vocational role were coded as a successful return to work outcome. The significant limitation in this approach is that individuals who had almost achieved a return to work outcome, as defined above, would still be treated as not having achieved a return to work outcome, even if they were 99% through the process. While this approach places limits on the depth of possible data analysis, by providing a clear definition of return to work outcome it enables future researchers to explore this area more specifically should associations be identified between the variables of interest. Table 3.2 summarises the outcome measures used in this study.

Table 3.2: Summary of the Outcome Measures Used

Outcome measures	**CIS**	**NZPAQ-SF**	**Return to work**
Dimensions measured	Measures four dimensions of fatigue; subjective experience, motivation, activity and concentration.	Measures the three dimensions of physical activity; frequency, duration and intensity.	Measure of return to pre-injury role was categorised as successful, all other outcomes were categorised as unsuccessful.
Units	Seven point Likert scale Scores can range from 20 to 140.	Total hours equivalent to moderate activity over the last seven days. Scores start at zero hours and have no maximum value.	Dichotomous variable – Yes or No.
Comments	A CIS total fatigue score of greater than 40 has been previously used to identify severe fatigue (Stulemeijer et al., 2006).	In calculating the total physical expenditure one minute of vigorous physical activity equals two minutes of moderate physical activity (McLean & Tobias, 2004).	Acknowledgement that return to work is a dynamic process as opposed to an outcome. In depth analysis of return to work is outside the scope of this project (Young et al., 2005b).

3.6 Questionnaire Format

During the development of the questionnaire it became apparent of the need for balance between gathering appropriate data and ensuring the length of the questionnaire was not a barrier to completion, especially given fatigue was one of the variables being measured. To achieve this, consultation with both an occupational therapist and physiotherapist, with a combined experience of over 50 years of rehabilitation with individuals following MTBI, was completed and formatting changes identified. Following this consultation, a draft was provided to three individuals who had been diagnosed with a recent (less than six weeks) MTBI. It was expected that these individuals would have more acute fatigue levels than the target population and if they were able to complete it, then the target population should also find the questionnaire acceptable. The pilot group completed the questionnaire within 10 minutes, which was acceptable to them. One individual had some difficulty following instructions due to formatting issues. Consequently further minor changes were made, including increasing the white space between questions to aid readability and clarifying the demographic questions.

No changes were made to the format of the standardised questionnaires. The final questionnaire pack can be found in Appendix E.

3.7 Data Management

A password protected database, containing the details of potentially eligible participants identified by ACC, was sent to the principal researcher via signed courier delivery. Prior to the initial posting, all participants were allocated a unique identification code to identify their specific questionnaire. This made it possible to distinguish responders from non-responders at each stage of the posting schedule and ensured only non-responders were sent any follow-up correspondence. Raw data was stored in a locked filing cabinet.

Once the questionnaire was returned the raw data was entered into an SPSS software package (SPSS 17.0 for Windows) by the principal researcher. Screening to check the accuracy of data entry included a random check of 20% of the results, comparing the values entered into SPSS against the raw data. Missing values were given a specific code and excluded from analysis on a pair-wise basis due to the size of the sample.

On completion of the analysis phase of the study, the database of potentially eligible participants from ACC was destroyed.

3.8 Statistical Analysis

Following the recommendations, made by McLean and Tobias (2004), individuals' physical activity levels were quantified into total time equivalent to moderate activity over the last seven days. Vigorous activity was given an equivalence of two minutes of moderate activity as the authors advised this achieved the best correlation with the New Zealand Physical Activity Questionnaire– Long Form (NZPAQ-LF). Total exercise time was calculated and entered into the SPSS database. Following this adjustment individuals were categorised into one of three groups;

- Relatively inactive (less than 2.5 hours)
- Relatively active (between 2.5 and 4.9 hours)
- Highly active (more than 5 hours)

This was completed to allow for comparison to previously reported data in the general population by the above-mentioned authors who also used these breakpoints.

CIS data was entered and scored as per the instructions outlined in the paper by Beurskens et al. (2000). Subscale and total scores were calculated in preparation for further analysis.

Data analysis involved three phases: 1) descriptive analysis of group characteristics was performed; 2) statistical analysis focused on the primary study objective, to evaluate if total fatigue scores were associated with lower physical activity levels; and 3) further analysis to consider any association between fatigue levels, activity levels and a return to work outcome.

Descriptive analysis of the data meeting the assumptions of parametric data provided information on the mean, standard deviation, minimum and maximum values. Both CIS and NZPAQ-SF produce ordinal level data and therefore non-parametric analysis was completed. This provided information on the median and inter-quartile ranges for these variables (Field, 2009). Further analysis of basic return to work data is also presented.

4 Results

4.1 Introduction

This chapter presents the results of the observational postal survey. As noted in Chapter 1, the specific hypotheses in this study were that:

1. Lower physical activity levels will be significantly associated with higher self-reported fatigue levels in individuals following MTBI.
2. Self-reported fatigue levels will be significantly lower in individuals that achieve a return to work outcome in comparison to those that do not.
3. Self-reported physical activity levels will be significantly higher in individuals that achieve a return to work outcome compared to those that do not.

An initial overview of recruitment and response rates will be followed by information on data screening. Following this, a description of the sample characteristics will be provided and finally results of the statistical analysis for the primary and secondary objectives will be presented.

4.2 Recruitment and Response Rates

Based on the inclusion and exclusion criteria, ACC provided details of 216 potential participants. These individuals were consequently sent the study questionnaire, as per the approach outlined previously in Table 3.1 (p. 25) in the methods section. At the completion of the recruitment phase 50% (n = 108) of the questionnaires were returned with:

- 43% (n = 93) completed
- 3% (n = 7) noting incorrect addresses and returned as undeliverable
- 3% (n = 6) declined to participate
- 1% (n = 2) did not have a MTBI

A final response rate of 47% was achieved given that 3% of the population were unable to be contacted. The remaining 50% of the sample population did not respond by the fourth contact point.

Analysis of the characteristics of responders compared to non-responders was limited to gender comparison due to the limited information provided in the initial database. Further analysis could not be completed due to confidentiality issues and ethical considerations.

4.3 Data Screening

In addition to the data entry checks described previously, data were also visually checked using SPSS frequency tables to identify any outliers or accidental inputs. No inconsistencies were identified.

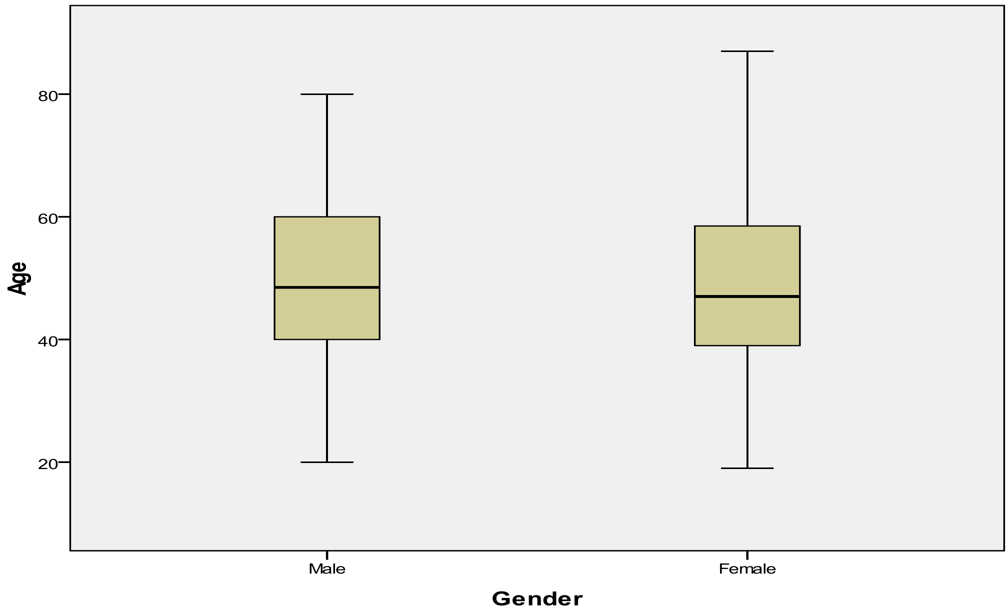
4.4 Sample Characteristics

4.4.1 Age and Gender

The age data met parametrical assumptions following testing for normality. Testing included visual analysis of the P-P plot and histogram, and statistical analysis using the Kolmogorov-Smirnov test, $D(93) = 0.06$ $p = .20$. This non-significant result indicated that the age values are not significantly different from a normal distribution (Field, 2009).

Of the target population, basic demographic data indicated that 45% of participants were female and of the responders, 59% were female. Analysis of the mean age of the responders provided a value of 48.9 years (SD = 15.4, range 19-87). In the female population of the responders (n = 55) the mean age was 48.5 (SD = 15.3, range 19-87), and in the male population (n = 38) the mean age was 49.6 (SD = 15.7, range 20-80). This is presented in the boxplot (figure 4.1) below.

Figure 4.1: Age and Gender of Responders



Previously published literature allows basic comparison of the data collected and is summarised in Table 4.1 (p. 41). Snell and Surgenor (2006) analysed referrals to a MTBI clinic based in Christchurch, New Zealand over a two year period (N=357). The authors reported a mean age of 33.8 (SD = 13.8) with a range of 16-72. 57% of all individuals assessed were male. For comparative purposes this data is presented alongside the data recorded in the current research project in Table 4.1.

Table 4.1 Comparison of the Current Study Population with a Sample from the Burwood Concussion Clinic

	Responders from the current study population	**Sample from two years data at Burwood concussion clinic** (Snell & Surgenor, 2006)
Mean age (SD)	48.9 (15.4)	33.8 (13.8)
Percentage of males in sample population	41%	57%
Percentage of females in the sample population	59%	43%

SD = Standard Deviation

4.4.2 Time Since Injury

The final population surveyed had a mean time since injury of 6.7 months (SD = 1.5, range 4-9 months). Although the inclusion criteria specified that participants would have had their MTBI within the last six months, the time that elapsed between sample identification and posting of the questionnaires to the participants, meant that the final population had a higher maximum value than the specified inclusion criteria. The minimum value of four months also reflects the time period between sample identification and posting and the length of time taken for an individual to be assessed and referred to a concussion clinic, which then enabled identification. It is not anticipated that these factors had a significant impact on the results or analysis, as the population of interest were individuals who reported persisting symptoms.

4.4.3 CIS Scores

Table 4.2 presents a summary of the CIS scores. The total CIS score represents the sum of the four subscale scores.

Table 4.2: Summary of the Subscale CIS Scores and Total CIS Scores

	Median (Range)	**25th Percentile**	**75th Percentile**
Subjective subscale	35.0 (8-48)	24.0	42.0
Concentration subscale	21.0 (5-30)	12.8	28.0
Motivation subscale	14.0 (4-24)	9.0	17.0
Physical Activity subscale	9.0 (3-18)	5.0	13.0
Total CIS score	80.0 (25-90)	52.5	98.0

Further analysis of the data identified 30.7% of the individuals had severe fatigue, based on a subjective subscale score on the CIS of $\geq$ 40. This compares with 31.8% previously reported in a MTBI population (Stulemeijer et al., 2006).

4.4.4 Physical Activity Scores

Analysis of physical activity scores revealed that of the total population who returned the questionnaires, 26.7% reported relatively inactive levels of physical activity (less than 2.5 hours of physical activity per week), 13.3% reported relatively active levels of physical activity (between 2.5 and 4.9 hours of physical activity per week), and 60.0% reported being highly active (more than 5 hours of physical activity per week).

The data collected from the sample population is compared with previously published data from a validation study on the use of the NZPAQ-LF and NZPAQ-SF, (McLean & Tobias, 2004).

Table 4.3 Comparison of Activity Levels in the Study Respondents to Previously Published Literature

Activity category (total time equivalent to moderate activity over last seven days)	**NZPAQ-SF % in activity group in the current study**	**NZPAQ-SF % in activity group in previously published literature** (McLean and Tobias, 2004)
Relatively inactive (<2.5 hrs) 21.7	26.7%	21.7%
Relatively active (2.5 – 4.9 hrs)	13.3%	21.7%
Highly active (5 or more hrs)	60.0%	56.7%

4.4.5 Return to Work

Analysis of the return to work data identified that 35.5% of individuals had not managed to return to their pre-injury level of employment. The remaining 64.5% reported they had managed a return to pre-injury employment. For those individuals who managed to return to their pre-injury vocational roles, further data analysis indicated that on average it took individuals 16.9 weeks (SD = 9.4) to achieve this outcome. This included individuals who returned without a graduated increase in duties and those who participated in a graduated return to full pre-injury employment. The data indicated a large range of time required from a minimum of three weeks up to a maximum of 40 weeks.

Care needs to be taken when reviewing these results as participants were not asked to record if failure to return to work was due to injury, simply if they had returned to their pre-injury employment and full-time equivalent roles. Therefore, as well as those individuals who had not achieved a return to their pre-injury employment role due to their injury, the analyses may also include individuals who had chosen to leave or had been asked to leave their employment due to non-injury related issues (such as employment matters). Further discussion regarding the limitations in the analysis of return to work data is provided in the following chapter.

4.5 Hypotheses Testing

4.5.1 Fatigue and Activity Levels

To test the hypothesis that lower physical activity levels (measured by the NZPAQ-SF) would be significantly associated with higher self-reported fatigue levels (measured by CIS), a Spearmans correlation co-efficient was calculated. This two tailed test is a measure of correlation for non-parametrical data (Field, 2009). This is appropriate as the data did not meet parametrical assumptions.

Following statistical analysis a significant negative association was identified between scores on the NZPAQ-SF and scores on the CIS, $r_s = -.38$, $p < .01$. This result supports the primary hypothesis that lower physical activity levels are associated with higher levels of self-reported fatigue following MTBI.

4.5.2 Fatigue and Return to Work

To test the secondary hypothesis, that individuals who reported lower fatigue levels would have a significantly higher chance of completing a successful return to work, a logistic regression was performed using a forced entry method. This is an appropriate method to use for theory testing using non-parametrical data with a dichotomous categorical outcome variable (Field, 2009). The total CIS score was used as the predictor variable and a yes/no response to the return to work question was used as the outcome variable. Table 4.4 (p. 45) presents data revealing that the total

CIS score of an individual makes a significant contribution towards a return to work outcome.

Table 4.4: Association between Fatigue (CIS score) and Return to Work

		95% CI for Odds Ratio		
	B (SE)	**Lower**	**Odds Ratio**	**Upper**
Variables included in the model				
Constant	-2.76 (0.96)			
CIS total score	0.03* (0.01)	1.00	1.03	1.05

R^2= .11 (Cox and Snell), .15 (Nagelkerke). Model $x^2(1)$ =7.77, * p<0.01

The odds ratio of 1.03 indicates that as the predictor variable (total CIS score) increases, the odds of having an unsuccessful return to work increase. Both limits of the confidence interval are above one, meaning the result is statistically significant in this population.

Following the analysis between fatigue and return to work a further logistic regression (forced entry method) was completed using the same categorical outcome variable (yes/no return to work); but analysing the effect of the individual CIS subscale scores as potential predictor variables. This additional analysis was performed to identify if any, or all, of the four individual dimensions of fatigue had a significant impact on the categorical outcome. This would have clinical interest, as intervention strategies for the four dimensions, as measured by the CIS, may require different approaches.

Table 4.5 (p. 46) presents data indicating that out of the four variables included in the model, only the physical subscale score made a significant contribution to the return to work outcome.

Table 4.5: Relationship between CIS Subscale Scores and Return to Work

		95% CI for Odds Ratio		
	B (SE)	**Lower**	**Odds Ratio**	**Upper**
Variables included in the model				
Constant	-3.44 (1.13)			
Subjective subscale	0.61 (0.05)	0.97	1.06	1.17
Concentration subscale	0.31 (0.05)	0.95	1.03	1.13
Motivation subscale	-0.15 (0.09)	0.72	0.86	1.03
Physical activity subscale	.23* (0.08)	1.08	1.27	1.48

R2= .25 (Cox and Snell), .34 (Nagelkerke). Model x2(1) =18.63, * p<0.01

The odds ratio of 1.27 and confidence interval indicate that as the predictor variable (total physical subscale score) increases, the odds of having an unsuccessful return to work increase in a statistically significant way. This is interpreted by analysing the mechanism of scoring of the outcome measure. A higher score on the physical subscale of the CIS indicates lower self-perceived physical ability; therefore individuals who perceive more physical limitation, have a higher chance of having an unsuccessful return to work outcome.

4.5.3 Activity Levels and Return to Work.

To test the hypothesis that individuals who report higher activity levels will have a higher chance of a successful return to work, a logistic regression was performed using a forced entry method. This is an appropriate test to perform due to the non-parametrical data and a dichotomous categorical outcome variable (Field, 2009). The outcome variable was return to work (yes/no) and the predictor variable was the total time spent exercising (minutes). Table 4.6 (p. 47) indicates that self-reported physical activity did not add significantly to the model of return to work.

Table 4.6: Associations between Physical Activity Levels (NZPAQ-SF) and Return to Work

		95% CI for Odds Ratio		
	B (SE)	**Lower**	**Odds Ratio**	**Upper**
Included				
Constant	-0.15 (0.31)			
Total time spent exercising	-0.04 (0.02)	0.92	0.96	1.01

R2 = .07 (Cox and Snell), .10 (Nagelkerke). Model x2(1) = 5.49

The results from the analysis between the subscales of the CIS and return to work outcome (Table 4.4, p. 45) indicated that self-perceived physical activity, as measured by the physical subscale on the CIS, contributed significantly to return to work outcome. However, as outlined above (Table 4.6), self-reported physical activity levels using the NZPAQ-SF did not. While it is accepted that these are two different tools, measuring different aspects of physical activity, further investigation appeared warranted. This was considered important as it could be argued that the physical subscale of the CIS looks more at an individual's perceived limitations of physical activity secondary to fatigue, while the NZPAQ-SF is validated to directly measure actual physical activity levels.

To determine if a relationship existed between scores on the physical subscale score on the CIS and total time spent exercising recorded on the NZPAQ-SF, a Spearman's correlation was completed, the data being non-parametric in nature. This analysis indicated a significant negative relationship between perceived physical activity and self-report of actual physical activity levels r_s = -.47, p < .01. Given that lower scores on the physical activity subscale indicate higher self-perceived physical activity, this means lower self-perceived physical activity levels were associated with lower self-reported actual physical activity levels.

4.5.4 Severe Fatigue and Physical Activity Levels

To analyse if there was a statistical difference of activity levels in those individuals who reported severe fatigue, indicated by a CIS subjective sub-scale score of $\geq$ 40 (Stulemeijer et al., 2006) or non severe fatigue, an exact Mann-Whitney test was used. This test is able to compare two independent means of non-parametrical data (Field, 2009). Analysis indicated that activity levels in individuals who reported severe fatigue ($M = 30.65$) were significantly lower than individuals who reported non severe fatigue ($M = 49.38$), $U = 449.5$, $z = -3.23$, $p < 0.001$, $r = -0.35$ (large effect size).

4.6 Summary

This chapter has presented the results of the observational postal survey. Testing of the primary hypothesis identified significant associations between self-reported fatigue and physical activity levels and therefore the null hypothesis can be rejected. Thus, this result provided support for the primary hypothesis that fatigue would be significantly associated with lower levels of physical activity in these individuals following MTBI.

Testing of the secondary hypotheses identified that scores on the CIS were significantly associated with a return to work outcome. This result supported one of the secondary hypotheses indicating that individuals with higher self-reported fatigue (CIS) had a higher chance of not achieving a successful return work. Further analysis of the subscales of the CIS identified that, while a self-perceived lack of physical ability was associated with a lower chance of a return to work, scores on the motivation, concentration and subjective subscales of the CIS did not.

Testing of the third hypothesis identified that physical activity scores recorded using the NZPAQ-SF were associated with a return to work outcome, however this result was not significant. There is, therefore, no evidence to reject the null hypothesis and there is no support for the hypothesis that self-reported physical activity levels would be significantly higher in individuals who achieve a return to work outcome compared to those that do not.

Further data analysis identified a significant association between physical activity scores on the NZPAQ-SF and scores on the physical subscale of the CIS. This indicated that individuals who completed comparatively less exercise also perceived they had less physical ability secondary to fatigue. Although results will be discussed in full in the next chapter, it is noteworthy that this needs to be considered in the context of the surprising result that identified 60.0% of the population as completing levels of physical activity. This result would categorise them as being highly active (McLean & Tobias, 2004), when population data suggests a lower proportion of 56.7% being highly active. Final analysis indicated that individuals who reported severe fatigue (30.7% of the participants) were significantly more likely to report lower physical activity levels than individuals who reported non-severe fatigue.

5. Discussion

5.1 Introduction

The primary purpose of this project was to identify if there was an association between self-reported fatigue and self-reported physical activity levels in individuals following a MTBI. A secondary aim was to analyse if there was any association between self-reported fatigue levels, self-reported activity levels and achieving a return to work.

The study findings support the primary hypothesis, indicating a significant association between self-reported fatigue and self-reported physical activity levels. To clarify, individuals with high self-reported fatigue were more likely to have reduced self-reported activity levels following MTBI. Further analysis identified an association between higher self-reported fatigue and a lower chance of having successfully returned to work; however there was no significant association found between self-reported activity levels and return to work.

This chapter will provide context for interpreting the results and compare these results to other previously published literature. It will also discuss the potential limits of the study design and methodology, along with the potential effects these may have on the study findings. Finally, consideration will be given as to how the results of this study can assist in enhancing MTBI rehabilitation and what future research could be done to improve this area of practice.

5.2 Associations between Variables of Interest

The study aim was to investigate the relationships between the variables of interest, more specifically to identify if there was a relationship between physical activity levels, self-reported fatigue levels and return to work following MTBI.

5.2.1 Physical Activity Levels and Self-Reported Fatigue levels

Although a significantly negative association was identified between the two variables, as this was only an analysis of association causality is unable to be inferred, it is unclear whether it is high fatigue levels that cause low activity levels or low activity levels that cause higher fatigue. However, taking into account previous research that reports regular physical activity can assist in reducing persisting symptoms (including fatigue) post MTBI (Leddy et al., 2007; Wetzel & Rorke, 2001), one could cautiously assume that it is more likely that the association identified in the current study reflects that participation in physical activity can influence self-reported fatigue levels. This statement is supported by other research that reports the benefits of participation in regular physical activity (Driver & Ede, 2009), and still further literature that describes the effects of exercise cessation on the development of pain, fatigue and mood symptoms in a subset of healthy, fit individuals (Glass et al., 2004).

If one accepts the argument that increasing physical activity levels were an appropriate form of intervention for fatigue management, further consideration of how this could be best achieved and what intensity it should be completed at is required. Previous research has advocated a non-symptom provoking stepwise approach when prescribing exercise intensity, building to 85% of the individual's maximum heart rate (Willer & Leddy, 2006); therefore it is interesting to consider that in the current study individuals who were just generally more active had lower fatigue levels. This suggests that even the promotion of normal activity may be enough to start to influence fatigue levels post MTBI. This is an important consideration given that this type of non-specific intervention would be able to be delivered by a multitude of health professionals, as opposed to the very specific protocol described by Willer and Leddy (2006). This finding also challenges some of the current assumptions around managing persisting symptoms following MTBI that individuals should be advised to rest until asymptomatic (Kozlowski, 2008), and raises the question: Should individuals, following the acute recovery phase, be given the recommendation to return to normal activity, including work, and advised that if they experience fatigue it is just a natural part of the recovery process? Wood (2004) reported that intervention should focus on providing early education and set expectations that symptoms are transient and will naturally reduce with time. Perhaps it is now time to consider that in setting expectations clinicians should, at the very least, be encouraging normal activity. This could be developed by promoting a specific exercise based intervention to directly increase individual physical activity levels.

5.2.2 Severe Fatigue and Physical Activity Levels

There was a moderate, significant difference between individuals who reported severe fatigue (CIS subjective score $\geq$ 40) and those that reported non-severe fatigue (CIS subjective score <40) in their self-report of physical activity. The severe fatigue group completed, on average, 10 hours of physical activity per week, compared to the non-severe fatigue group who completed 17 hours of activity per week. Overall, both groups' averages sat within the highly active definition used in previous studies

(McLean & Tobias, 2004); indicating either an overall high level of physical activity in the study population or a lack of specificity of the NZPAQ-SF. However as the NZPAQ-SF has been described as being able to accurately measure population activity levels (McLean & Tobias, 2004), perhaps this was indeed reflective of physical activity rates in this population.

It is interesting to consider that even those who subjectively reported severe fatigue still reported they were able to complete a level of physical activity that would put them in the highly active category. One conclusion that can be derived from this is that a perception of high levels of fatigue was not a barrier to participation in normal activity levels. This statement is drawn from the results that showed actual physical activity levels being comparable to a general population, and the statistical significance identified between physical activity levels and fatigue in the current study. Given the literature previously reviewed advocating the benefits of physical activity (Driver & Ede, 2009; Johnson, 2007; Wetzel & Rorke, 2001), and the finding in the current study that fatigue was not a barrier to reporting comparative amounts of exercise to a general population, clinicians are encouraged to carefully consider the recommendation of rest in the face of persistent fatigue. It is possible that by advocating extended rest, clinicians may be adding to an individual's perceived levels of disability. The effect of the impact of perception of disability is discussed later in this chapter.

5.2.3 Self-Reported Fatigue Levels and Return to Work

Return to work was included as a functional outcome and measured by asking participants to identify their pre-injury occupation, and compare this to their current occupation. If they had returned to their pre-injury occupation, further questions explored the length of time this took to achieve.

Logistic regression analysis indicated the total CIS score to significantly contribute to the chance of an individual having made a successful return to work. A negative relationship was found indicating that the more fatigue individuals report, there is a lower chance that they would have made a return to their pre-injury employment. This finding aligned with previously published literature by Ouellet and Morin (2006) who reported that an inability to return to work was a predictive factor (B = 0.765, $p < .05$, OR 2.2) for significant fatigue. They clarified this finding, highlighting that the inverse relationship may also apply, whereby the fact that individuals who are not at work, or unable to work, might experience more fatigue secondary to inactivity, lack of routine and frequent napping.

The CIS is a multidimensional checklist designed to measure several aspects of fatigue. It has good overall internal consistency with a Cronbachs α of 0.90 and for the scales the α ranged from 0.83 to 0.92 (Beurskens et al., 2000). This enables further discussion following logistic regression analysis of the individual subscales. Further analysis of the subscales of the CIS indicated that only the physical activity subscale significantly contributed to the final return to work model (B = 0.23, $p < 0.01$) meaning that higher levels of self-perceived physical limitation (CIS physical subscale) were associated with poorer return to work outcomes. The results of the analysis of the subscales of the CIS also indicated that the subjective experience of fatigue, issues with concentration and motivation, do not significantly predict a return to work outcome. This is an important point to consider, as clinically decisions on when or how an individual should return to work, are often based on the subjective report of fatigue. As the aforementioned variables were not significantly associated with a return to work in the current population, it would seem that this process may need to be challenged. In this population it may actually be more useful to measure perception of physical limitation, rather than fatigue, when assessing return to work barriers.

5.2.4 Self-Reported Physical Activity Levels and Return to Work

Scores on the NZPAQ-SF did not significantly discriminate those who had a successful return to work outcome from those that did not. The odds ratio of 0.96 does suggest that lower self-reported activity levels could be linked to unsuccessful outcome regarding a return to work. However with the upper odds ratio crossing one, this finding does not meet statistical significance and as such there is a risk that if the hypothesis was accepted, it could be due to a type I error. Further analysis in a larger sample group may give a more definitive result. Furthermore, a more direct method of measuring physical activity levels could be considered due to the limitations previously mentioned when gathering information on physical activity via a self-report method.

An interesting point to consider is that while the NZPAQ-SF did not contribute to a return to work model, the physical activity subscale of the CIS did. The questions in the CIS physical subscale are directed more at the general nature of activity, asking individuals to agree or disagree with statements such as: ‘I do quite a lot within a day’, ‘I have a low output’ and ‘I don’t do much within a day’. These types of statements look more at the effect that fatigue has on physical function, as opposed to the NZPAQ-SF that looks to directly measure activity levels by asking exactly how much physical activity individuals are completing. Therefore, taking this into consideration it could be assumed that, although individuals following MTBI are comparable to the general population in actual physical activity levels, they perceive that they are unable to do as much. It is this perception of disability or inactivity, that influences a return to work outcome.

The impact of an individual's perception of his or her MTBI is developed in a short report completed by Whittaker, Kemp, and House (2007), who suggested that an individual's illness perception following his or her MTBI may play a role in predicting chronic symptoms. In fact the authors indicated that individuals who believe that the MTBI will have serious and negative consequences, are at an increased risk of experiencing post-concussional symptoms. The finding that actual physical activity levels are not associated with a return to work outcome, while a perception of physical limitation secondary to fatigue was, supports this hypothesis. To confidently infer that it is a perception of inactivity as opposed to actual activity levels that has a greater impact on return to work, a comparison between a non-MTBI injured population and a population post MTBI should be completed that directly looks at actual physical activity levels, fatigue, injury perceptions and return to work.

The current research was not directly measuring a perception of disability. Therefore, the main conclusion that can be drawn regarding overall physical activity in the current study population being comparable to a general population, is perhaps it is only the perception of physical limitation, rather than actual physical limitation that influences return to work outcomes post MTBI.

5.3 Limitations and Considerations

Following the literature review and data analysis a number of methodological issues were identified. The following section outlines the considerations made when designing the study and the limitations of the data presented.

5.3.1 Study Samples

The study sample reflected a population of individuals following a MTBI who reside in New Zealand. It is well documented that one of the difficulties involved in the research of individuals following MTBI is gaining a truly representative population (ACC, 2006a). A number of individuals who sustain a MTBI will not present to a health professional as the natural recovery process is achieved. A further consideration is that if there are other associated injuries, such as broken limbs or visible cuts, these may take precedent in the overall acute management, with the chance that any MTBI may be completely overlooked or left undiagnosed. Further issues arise in that, once identified, the diagnosis of an MTBI can be fraught with inconsistencies. It has been reported that internationally there are approximately 41 different guidelines for its grading (Anderson et al., 2006), therefore to gain accurate incidence rates individuals with a MTBI need to present to a relevant health professional and be accurately diagnosed, against standardised criteria before being included in research data. In a New Zealand specific context, individuals with a MTBI may have an opportunity to be included in health statistics following lodgement of an injury claim with ACC; however accurate analysis requires the assessing clinicians to use the correct codes. This system is not without its faults and errors can occur, for example a MTBI may not be coded as such or a non MTBI may be coded as one when no such injury occurred (ACC, 2006a).

Despite the limitations of the recruitment process, as outlined above and previously acknowledged in the methods chapter, identification of potential participants via referral to one of the ACC funded MTBI clinics was determined to be the most appropriate method. It is acknowledged that not all individuals who sustain an MTBI will be referred to these clinics, yet this methodology was utilised for a number of points:

- ACC have set diagnostic criteria to be evaluated against when being assessed by these clinics. This assisted in ensuring the correct population base was sampled and standardised inclusion criteria could be used.
- Due to time and financial constraints personally assessing individuals at the nationwide individual clinics was not feasible.
- It ensured a large geographic spread of the sample population with a good socio-demographic spread.
- It enabled a large enough sample size to be achieved to adequately power the study.
- Consideration was given to the point that individuals who attended the MTBI clinics are probably more likely to have a complex presentation or ongoing symptomology, hence seeking further treatment. As the study was not looking specifically at incidence rates it was decided that the method employed was acceptable and appropriate, especially given the focus of the current research on the impact of persisting fatigue.

The response rate achieved in this research of 47% is similar to a previous study in a MTBI population conducted in the Netherlands, where the authors reported 52% of the population surveyed returned their questionnaires (Stulemeijer et al., 2006). It was hoped that by utilising an adaptation of the approach advocated by Dillman (2000), that a higher response rate would have been achieved. As this was not the case, it would have been useful to review the socio-demographic differences of the responders and non-responders. Unfortunately, due to a lack of population data provided this could not be achieved. A review of the information on the analysis of referrals from the Burwood Hospital Concussion Clinic, published by Snell and Surgenor (2006), enabled basic comparisons of the responders to the target population of a similar sample (Table 4.1, p. 41). The descriptive data reviewed infers that the population that responded to the current study tended towards older age and a higher frequency of females compared to all individuals who were assessed at a single MTBI clinic over a two year period. This may have implications on the current study, given that on average females have higher morbidity and worse outcomes following MTBI and are more likely to develop persisting symptoms (ACC, 2006a; Ryan & Warden, 2003). These factors limit the external generalisability of the results and should be taken into consideration when applying the outcome of this study.

Without knowing exactly why individuals did not respond to the questionnaire a number of assumptions could be made regarding the non-responders.

- Although the recruitment strategy implemented increased the chance of excluding individuals who no longer reported symptoms, it was possible that some individuals that had recovered fully may have been included in the research. It is possible that individuals that were initially identified as having symptoms may have recovered during the period between sample identification and posting. These individuals may have found the questionnaire regarding return to work and fatigue irrelevant and therefore may not have been motivated to respond.
- Individuals who had significant symptoms and extended periods away from work may have a strained relationship with ACC due to the period of incapacity. These individuals may have specific concerns regarding what the information would be used for.

- Individuals who were referred to an MTBI clinic but did not have a MTBI may not respond.

As these assumptions were unable to be tested, the points raised above are speculative but worth considering when extrapolating the results to the MTBI population. In particular, individuals who had recovered during the period of time between sample identification and receiving the questionnaire may not have been motivated to respond, given that they would no longer have current MTBI symptoms. If this were the case, the current results would be skewed towards reporting higher levels of disability than may actually be present in the total population following MTBI, but may be reflective of the issues in individuals who report persisting symptoms.

5.3.2 Postal Questionnaire

The final questionnaire comprised of basic demographic data and information about return to work combined with two standardised measures; one to quantify fatigue, the CIS, and one to quantify physical activity levels, the NZPAQ-SF. The development of the questionnaire pack is described in the methods section and will not be reiterated in this chapter, however it is noted that in the analysis of the results the limitations of attempting to quantify fatigue (Bultmann et al., 2000) and the trend to over report physical activity using a self-reporting method were considered (McLean & Tobias, 2004).

5.3.3 Fatigue

Research published by Stulemeijer et al. (2006) enabled a basic comparison of the fatigue levels reported in the current study to a MTBI population six months post-injury in the Netherlands. The authors incorporated the CIS into a postal questionnaire in an attempt to determine the severity of fatigue in an MTBI population in comparison to a minor injury control group. While the authors did not report all the individual subscale scores, or the total CIS scores, they did report that 31.8% of the population reported a score of 40 or more on the subjective subscale, indicating severe fatigue. This compares favourably to the current study sample where 30.7% of the population reported severe fatigue levels, indicating that for individuals with persisting symptoms following MTBI, fatigue continues be an ongoing issue.

5.3.4 Physical Activity Levels

General population data provided by a validation study on the use of the NZPAQ-LF and NZPAQ-SF (McLean & Tobias, 2004) provides an opportunity to compare physical activity levels in a normal population to the study population (Table 4.3, p.43). On face value the data appears comparable, which is surprising, as it was expected that the individuals sampled in the current study would have a reduced physical activity level secondary to their injury, and that a number would still be experiencing ongoing debilitating symptoms (Stulemeijer et al., 2006).

This result could be explained by a number of considerations. The study population had an average time since injury of 6.7 months (SD 1.5, range 4-9 months). The time passed since initial injury may mean that the population sampled are more reflective of the general population. This is plausible given the comments made by

Caroll et al. (2004) that the best evidence consistently suggests there are no MTBI attributable deficits beyond one to three months post-injury in the majority of cases. An alternative explanation is the consideration that physical activity levels in the current study were measured via postal questionnaire and the comparative study used a face to face interview. Participants may, therefore, be more likely to over-report physical activity levels in the current study compared to the data reported by McLean and Tobias (2004) which used a face to face method. Both of these points are worthy of consideration. In addition, as the NZPAQ-SF is comparable to international survey instruments, the results may in fact accurately reflect actual physical activity levels in the current population. This may indicate that the occurrence of a MTBI does not impact on physical activity levels four to nine months post injury. To accurately measure this future research would need to employ more direct methods of activity measurement such as accelerometry (Boon, Hamlin, Steel, & Ross, 2008).

5.3.5 Return to Work

Return to work data was included to gain a better understanding of the functional impact of fatigue and activity following MTBI. As previously discussed, in the methods section, consideration was given to the complexities of measuring a return to work, including the variable ways that individuals return to vocational independence and what constitutes a successful return to work (Young, 2005b). In order to limit the effect of these issues and gain some meaningful data in a New Zealand population, the current research project clearly defined a successful return to work outcome as returning to full pre-injury employment. This enabled critique of the current methodology and comparison for future researchers.

If the primary aim of the research was to gain further insight as to how individuals return to work, or the barriers involved in returning to work, then the vocational questions should have been designed differently. In light of the lack of data currently published on return to work for this population, more meaningful and specific data regarding the return to work experience would have been useful. However, this would have affected the length and usability of the questionnaire. This gap in the literature would need a dedicated study with more specific methodology focussed on return to work variables, and as such was beyond the scope of the current research.

Despite the limitations discussed, the study revealed that 35.5% of individuals reported they had not returned to their pre-injury employment at the time of answering the questionnaire. Although this appears high, it needs to be noted that this figure may include individuals who are at work and participating in a return to work process, but not yet achieved a full return to pre-injury roles. These results are comparable with previous literature (Rimel, Giordani, Barth, Boll, & Jane, 1981) which reported 34% of individuals had occupational disability at three months post MTBI, but in contrast to Englander et al. (1992) who described an 88% return to work rate just 8 weeks post-injury in an insured MTBI population in the United States of America. It is difficult to make direct comparisons of these samples due to the differences in defining a return to work, the issues involved in comparing different geographical populations and the different health care and insurance systems that are involved. It is however interesting to note the comparison with the data presented by Rimel et al. (1981).

The analysis of the return to work data identified that the mean time to return to pre-injury work following a MTBI was 16.4 weeks (SD = 9.4). This data is presented for future research reference only as the current study was not designed to provide in-depth analysis of return to work rates. It needs to be highlighted that the current study only measured return to pre-injury role, and did not account for possible issues such as change in roles, changes in productivity or the many other variables that can encompass a return to work following injury (Young et al., 2005b).

With the limitations surrounding the measurement of return to work in mind, the large degree of variance in the data gathered will be of no surprise. The minimum time taken for individuals to return to their pre-injury role was just three weeks, with a maximum of up to 40 weeks. The data gathered reflects the large variance reported in previous literature on recovery rates following MTBI (McCrea, 2008). One point to note is that one might expect that the minimum period to return to work would have been less than three weeks, as it would be expected that in a completely representative sample from an MTBI population some individuals may only have had a day or two away from work, if any at all. The fact that the minimum value was three weeks is probably reflective of the population surveyed of individuals with persisting symptoms and highlights that the data gathered should only be generalised to this population, as opposed to being reflective of all individuals post MTBI.

Despite the difficulties encountered when attempting to measure a return to work, it should continue to be an area of focus as it has been previously stated that time away from work can lead to reduced physical activity and energy loss (ACC, 2006b), both of which are common in the MTBI population.

5.4 Future Research

As this was an exploratory study, causation cannot be deduced from the findings. The identified associations between fatigue, physical activity levels and return to work could be in either direction or a combination of both directions. For example, high levels of fatigue may restrict participation in physical activity; conversely low levels of physical activity could cause an increase in fatigue levels. Similarly the experience of fatigue may restrict an individual's ability to return to work, as has been previously suggested by Ouellet and Morin (2006), or a lack of routine and structure provided by work, may influence the experience of fatigue. This section will explore these concepts further and offer suggestions regarding future research.

5.4.1 Physical Activity and Return to Work

Kozlowski (2008) presented detailed results of the use of a progressive aerobic exercise programme for the treatment of persisting symptoms following MTBI in an athletic population. He advocated the use of a sub-symptom, low intensity and low duration exercise programme to reduce PCS symptoms. This specific area of research, encouraging the use of appropriate exercise following MTBI, needs further consideration in a general population. Future research should attempt to measure if participation in this type of programme has an impact on a functional outcome, such as return to work. By implementing longitudinal or interventional methodology researchers would also be able to gain a better understanding as to how, and when, a return to work is achieved following MTBI.

If future research is able to identify a directional association between fatigue, physical activity and return to work, and it became evident that participation in physical activity was able to reduce self-reported levels of fatigue, it may encourage health professionals to consider the use of a progressive return to normal activity in the face of ongoing symptoms. It would certainly be a leap in the right direction towards dealing with the statement made by the New Zealand Guideline Group (2006) that in dealing with fatigue following MTBI, "there is virtually no good quality evidence relating to its extent, impact and effective treatment" (p. 110).

5.4.2 Perception of Disability

The current study has highlighted the need to include a measure of individual perception of disability when looking at outcomes following MTBI. This was evident particularly as perceptions of physical activity were linked to return to work but actual physical activity levels were not. To investigate this interesting development further, future research should include measures that identify injury beliefs and how they might influence functional outcomes such as a return to work.

5.4.3 Other Considerations

In the process of completing this research project other areas of research were identified given the gaps in the literature reviewed. Some of these issues have been raised previously (ACC, 2006a) and include:

- The ongoing need to accurately identify the incidence of MTBI in New Zealand and use standardised definitions that are correctly applied.
- Identification of appropriate tools and measures to quantify issues and outcomes for individuals following MTBI, such as injury beliefs.

- The need to complete longitudinal follow-up to identify the effectiveness of intervention and the ongoing burden of MTBI.
- The need to complete interventional studies that accurately describe interventions which have evidential basis, and review the effectiveness of intervention on a functional outcome, rather than on symptom reduction.

5.5 Clinical Implications

The findings from the study revealed a significant association between high levels of fatigue and low levels of physical activity. Hence, clinicians may wish to consider shifting their treatment focus, from recommending rest, to facilitating appropriate physical activity levels for persistent fatigue post MTBI. The findings from this study may also impact on recommendations regarding the timing of return to work post MTBI as maintaining general activity levels and participating in social responsibilities may result in a better functional outcome. The caveat to these findings is that it is accepted that early acute symptoms should continue to be managed with appropriate rest (McCrea, 2008), suggesting that there is a need to balance an increase in physical activity and return to work, while allowing a sufficient period of time to recover from the acute symptoms.

The current research findings indicated that individual perceptions of activity limitation and disability were associated with return to work. As such, consideration of people's perceptions about their disability may require further consideration for inclusion in the assessment process. Furthermore if perceptions of injury are identified as a potential barrier, specific strategies aimed at altering these perceptions may warrant inclusion in the overall clinical management of persisting symptoms following MTBI.

5.6 Conclusion

This research has added to the literature investigating a difficult area of rehabilitation, one that is fraught with academic differences of opinion, varied diagnostic criteria and poorly described interventional studies. It has discussed the impact of fatigue on the functional outcome of return to work and shown that there is an association between fatigue, physical activity levels and return to work. Furthermore the current research has also raised questions towards the impact of perception of disability on functional outcome following MTBI. Given the association identified between fatigue and physical activity, further longitudinal or interventional research should now aim to analyse whether the use of specific physical activity should be considered as an effective treatment for persisting fatigue post MTBI. The proposed research should be completed in a community sample of people who have experienced a MTBI and include analysis of the impact this type of intervention may have on a functional outcome. Further research should also aim to gather better representative data on issues surrounding return to work following MTBI.

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Appendices

Appendix A:*Template of letter sent to participants from ACC*

<<date>>
<<name>>
<<address 1>>
<<address 2>>
<<address 3>>

Dear <<first name>><<last name>>

Research study –
"Exploring the relationships between Physical Activity levels, Fatigue and Return to Work following Mild Traumatic Brain Injury or Concussion"

A research study by the AUT University

ACC is supporting researchers at the AUT University to explore Fatigue and Physical Activity Following Concussion or Mild Brain Injury. You are been asked to consider participating in this study following your assessment at the local Concussion Clinic.

Why are we doing this study?
Fatigue is one of the most frequently reported symptoms following Concussion or Mild Brain Injury and it can impact on people's ability to resume work, study or engage in social activities. We are interested in your experience of recovery following Concussion or Mild Brain Injury and how this injury may have impacted on your lifestyle.

If you take part in this study, you will be sent a questionnaire to complete with a return addressed postage paid envelope. This will take 10-20 minutes to complete.
Your participation is completely voluntary. Whether or not you decide to take part has no affect on the status of your claim, or your relationship with ACC. If you do decide to take part, all information you give will be kept confidential by the university researchers and will not be shared with ACC. ACC will only receive a summary report which will not identify any individuals.
In order to ensure people that might benefit from this project are given an opportunity to take part, ACC intends to give the researchers your name, address and telephone number on *[insert new date range each mailout]* so that a university researcher can arrange for the questionnaire to be posted to you.
If you do not want a researcher to contact you, please ring 0800 555 050 within the next 14 days and leave your name and address on the answer-phone and the researchers will not contact you.
The AUT University has prepared the enclosed Participant Information Sheet to explain the study in more detail. If you have any other questions please phone Mark Shirley (the study manager) or Professor Kath McPherson the principal study supervisor (contact details are on the information sheet)
Thank you for taking the time to read this letter. It is only with the assistance of people like you that ACC can improve our services and the outcomes for our claimants.
Yours sincerely

ACC project coordinator

Appendix B:*First contact letter to participants*

PARTICIPANT INFORMATION SHEET

An Invitation
My name is Mark Shirley and I am a Master of Health Science student at AUT University. I am interested to find out more about recovery following Concussion or Mild Brain Injury.

Fatigue and Physical Activity Following Concussion or Mild Brain Injury
You are invited to take part in a survey, which is being carried out by researchers from the AUT University.

Why are we doing this study?
Fatigue is one of the most frequently reported symptoms following Concussion or Mild Brain Injury and it can impact on people's ability to resume work, study or engage in social activities. We are interested in your experience of recovery following Concussion or Mild Brain Injury and how this injury may have impacted on your lifestyle.

Who is being surveyed?
You are been asked to consider participating in this study following your assessment at the local Concussion Clinic.

Do I have to take part in this survey?
Your participation is entirely voluntary and will not affect any future care or treatment.

What is involved?
Should you wish to participate in this study, we ask you to complete a questionnaire exploring the impact that your injury may have had on your lifestyle. The questionnaire will take a total of 10-20 minutes to complete. You do not have to answer all the questions. After you have completed the questionnaire please return it to us in the postage paid envelope provided.
If you forget to post the questionnaire back we will send you a reminder and a new copy of the questionnaire. If you decide not to participate and would not like this reminder sent please contact ACC on 0800 555 050 or one of the researchers below.

What about my privacy?
The information you provide will be kept completely confidential. No material that could personally identify you will be used in any reports from this study. The questionnaires will be locked away in a secure place.
You will be given a unique identification number by a research assistant that will be kept confidential from the research team. This is only to ensure that you are not sent a reminder questionnaire after sending your first one back.

The results will be securely stored on computer that can only be accessed by a code number by the research team, and will not have your name, address or any other information that could identify you.

What are the benefits and risks of the study?
You will not benefit directly from partaking in this study. The results will assist health providers in understanding the effects of Concussion or Mild Brain Injury on people's lives.
No risks have been identified for individuals who take part in this study.

What will happen to the survey results?
When we have collected information on 60 participants we will analyse the results to identify any trends that emerge. The information will be written up as part of a Masters Thesis. There may be a delay between data collection and publication of results. Additional reports will be written and submitted to local and international organisations to be presented at conferences and published in scientific journals. If you would like a summary of the results please contact one of the researchers at the contact details found below.

Statement of Approval
This study has received ethical approval from the Multi-region Ethics Committee, which reviews national and multi regional studies, ethics reference number MEC/09/82/EXP.

If you have any queries or concerns regarding your rights as a participant in this study, you may wish to contact an independent health and disability advocate:
Free phone: 0800 555 050
Free fax: 0800 2 SUPPORT (0800 2787 7678)
Email: advocacy@hdc.org.nz

If you have any questions about the survey, please contact any of the study researchers
Mark Shirley 021 485989 – bfs9944@aut.ac.nz
Professor Kath McPherson – Auckland University of Technology (09 921 9999 Ext: 7110)
Alice Theadom – Auckland University of Technology (Phone number, 09 921 9999 Ext: (7805)

Appendix C:*Second contact letter to participants*

Thank you for helping

Recently we sent you a questionnaire asking you about your experiences following your Concussion or Mild Brain Injury.
Your details were passed on to us via ACC following your assessment at your local Concussion Clinic.

We would like to thank you if you have managed to return this to us.
If you have forgotten to do this it would be greatly appreciated if you could fill the questionnaire in and return it in the postage paid envelope we provided.

If you have returned your questionnaire we would like to say thank you again and we will not be in further contact.

If you have misplaced your questionnaire, don't worry, we will send you another one soon.

If you would rather we did not send a replacement one out, please contact ACC on 0800 555 050 or contact one of the researchers below.

Your participation is entirely voluntary and will not affect any future care or treatment.

Statement of Approval
This study has received ethical approval from the Multi-region Ethics Committee, which reviews national and multi regional studies, ethics reference number MEC/09/82/EXP .

If you have any queries or concerns regarding your rights as a participant in this study, you may wish to contact an independent health and disability advocate:
Free phone: 0800 555 050
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Email: advocacy@hdc.org.nz

If you have any questions about the survey, please contact any of the study researchers
Mark Shirley 021 485989 – bfs9944@aut.ac.nz
Professor Kath McPherson – Auckland University of Technology (09 921 9999 Ext: 7110)
Alice Theadom – Auckland University of Technology (Phone number, 09 921 9999 Ext: 7805)

Appendix D:*Third and final contact letter to participants*

PARTICIPANT INFORMATION SHEET

An Invitation
My name is Mark Shirley and I am a Master of Health Science student at AUT University. I am interested to find out more about recovery following Concussion or Mild Brain Injury.
Recently we sent you a questionnaire to fill out. Unfortunately we have not received your questionnaire. Just in case this has been misplaced, I have enclosed another copy for you and a return postage paid envelope. Thank you for taking the time to complete this.

Fatigue and Physical Activity Following Concussion or Mild Brain Injury
You are invited to take part in a survey, which is being carried out by researchers from the AUT University.

Why are we doing this study?
Fatigue is one of the most frequently reported symptoms following Concussion or Mild Brain Injury and it can impact on people's ability to resume work, study or engage in social activities. We are interested in your experience of recovery following Concussion or Mild Brain Injury and how this injury may have impacted on your lifestyle.

Who is being surveyed?
You are been asked to consider participating in this study following your assessment at the local Concussion Clinic.
Do I have to take part in this survey?
Your participation is entirely voluntary and will not affect any future care or treatment.

What is involved?
Should you wish to participate in this study, we ask you to complete the enclosed questionnaire exploring the impact that your injury may have had on your lifestyle. The questionnaire will take a total of 10-20 minutes to complete. You do not have to answer all the questions. After you have completed the questionnaire please return it to us in the postage paid envelope enclosed.
If you forget to post the questionnaire back we will send you a reminder and a new copy of the questionnaire. If you decide not to participate and would not like this reminder sent please contact ACC on 0800 555 050 or contact one of the researchers below or one of the researchers below.

What about my privacy?
The information you provide will be kept completely confidential. No material that could personally identify you will be used in any reports from this study. The questionnaires will be locked away in a secure place.
You will be given a unique identification number by a research assistant that will be kept confidential from the research team. This is only to ensure that you are not sent a reminder questionnaire after sending your first one back.
The results will be securely stored on computer that can only be accessed by a code number by the research team, and will not have your name, address or any other information that could identify you.

What are the benefits and risks of the study?
You will not benefit directly from partaking in this study. The results will assist health providers in understanding the effects of Concussion or Mild Brain Injury on people's lives.
No risks have been identified for individuals who take part in this study.

What will happen to the survey results?
When we have collected information on 60 participants we will analyse the results to identify any trends that emerge. The information will be written up as part of a Masters Thesis. There may be a delay between data collection and publication of results. Additional reports will be written and submitted to local and international organisations to be presented at conferences and published in scientific journals. If you would like a summary of the results please contact one of the researchers at the contact details found below.

Statement of Approval
This study has received ethical approval from the Multi-region Ethics Committee, which reviews national and multi regional studies, ethics reference number MEC/09/82/EXP.

If you have any queries or concerns regarding your rights as a participant in this study, you may wish to contact an independent health and disability advocate:
Free phone: 0800 555 050
Free fax: 0800 2 SUPPORT (0800 2787 7678)
Email: advocacy@hdc.org.nz

If you have any questions about the survey, please contact any of the study researchers
Mark Shirley 021 485989 – bfs9944@aut.ac.nz
Alice Theadom – Auckland University of Technology (09 921 9999 Ext:7805)
Professor Kath McPherson – Auckland University of Technology (09 921 9999 Ext: 7110)

Appendix E:*Copy of questionnaire sent to participant*

Thank you for taking the time to complete these questionnaires.

Instructions

Your participation will assist health professionals in delivering rehabilitation programmes for individuals following a Concussion or Mild Brain Injury. This questionnaire should only take 10-20 minutes to complete. Please read the instructions carefully and return in the postage paid

Part A – General Information

1) What is your age (in years)? ________________

2) What is your gender? (please tick relevant box)

☐ Male

☐ Female

3) What is your ethnicity? (please tick relevant box(es), you may select more than one)

☐ New Zealand European

☐ Maori

☐ Samoan

☐ Cook Island Maori

☐ Tongan

☐ Niuean

☐ Chinese

☐ Indian

☐ Other-Please list:_________________________

4) What was the date of your Concussion or Mild Brain injury (day/month/year)? ___________

5) Where did your injury occur? (please tick relevant box(es), you may select more than one)

☐ Place of study

☐ Work

☐ Sport

☐ Other – please specify ____

6) How did your injury occur? (please tick relevant box(es), you may select more than one)

☐ Motor Vehicle Accident

☐ Sport

☐ Assault

☐ Other – please specify ____

7) Have you had a previous concussion or brain injury? Y / N (Circle)

If yes – how many previous concussions or brain injuries have you had? __________(number)

8) Have you ever been diagnosed with depression or other mood disorder? Y / N (Circle)

9) What was your employment status at the time of your Concussion or Brain Injury? (please tick relevant box(es), you may select more than one)

☐ Working full time

☐ Working part time

☐ Not employed

☐ Student

☐ Other – please specify ____

10) What is your **current** employment status? (please tick relevant box(es), you may select more than one)

☐ Working full time

☐ Working part time

☐ Not employed

☐ Student

☐ Other – please specify ____

Instructions

The next question is asking about your return to work or study following your Concussion or Brain Injury.

Please answer

- **Question 12** if you **have** returned to your **full** pre-injury work or study commitments or
- **Question 13** if you **have not** managed to return to your **full** pre-injury work or study

12) When you returned to your work or study, did you (please select only one box)

☐ return gradually, slowly building up hours

i) Please write the number of weeks you needed off before you returned in **any capacity** (i.e. started part time or reduced hours) _______________weeks;

ii) Please write the additional number of weeks required before you returned to your **full** pre-injury work or study______________weeks. (ie amount of weeks at reduced hours)

☐ return to full time hours straight away

i) Please write the number of weeks you needed off before you returned to your **full** pre-injury work or study_________________weeks.

13) If you **have not** managed to return to your **full** pre-injury work or study please tick the box that best describes your situation (please select only one box)

☐ I believe I will be able to return to my pre-injury work or study but this will take more time

i) Please write how long you think it will take to return to your pre-injury work or study levels______________weeks

☐ I do not believe I will be able to return to my pre-injury work or study

Part B

Instructions

On this page you will find 20 statements. With these statements we wish to get an impression of how you have felt during ***the past two weeks***. For example:

I feel relaxed

If you feel that this statement is completely true, place a cross in the left box; like this:

I feel relaxed

Yes, that is true	x							No, that is not true

If you feel that this statement is not true at all, place a cross in the right box; like this:

I feel relaxed

Yes, that is true							x	No, that is not true

If you feel that this statement is not "yes, that is true", but also not "no, that is not true", place a cross in the box that is most in accordance with how you have felt.
For example, if you feel relaxed but not very relaxed, place a cross in one of the boxes close to "yes, that is true": like this:

I feel relaxed

Yes, that is true			x					No, that is not true

Please do not skip any statement and place only one cross for each statement.

1.	I feel tired	Yes, that is true								No, that is not true
2.	I feel very active	Yes, that is true								No, that is not true
3.	Thinking requires effort	Yes, that is true								No, that is not true
4.	Physically I feel exhausted	Yes, that is true								No, that is not true
5.	I feel like doing all kinds of nice things	Yes, that is true								No, that is not true
6.	I feel fit	Yes, that is true								No, that is not true
7.	I do quite a lot within a day	Yes, that is true								No, that is not true
8.	When I am doing something, I can concentrate quite well	Yes, that is true								No, that is not true
9.	I feel weak	Yes, that is true								No, that is not true
10.	I don't do much during the day	Yes, that is true								No, that is not true
11.	I can concentrate well	Yes, that is true								No, that is not true
12.	I feel rested	Yes, that is true								No, that is not true
13.	I have trouble concentrating	Yes, that is true								No, that is not true
14.	Physically I feel I am in a bad condition	Yes, that is true								No, that is not true
15.	I am full of plans	Yes, that is true								No, that is not true
16.	I get tired very quickly	Yes, that is true								No, that is not true
17.	I have a low output	Yes, that is true								No, that is not true
18.	I feel no desire to do anything	Yes, that is true								No, that is not true
19.	My thoughts easily wander	Yes, that is true								No, that is not true
20.	Physically I feel in a good shape	Yes, that is true								No, that is not true

Part C

Instructions

This questionnaire is about the time you spent being physically active in the last 7 days. Do not include activity undertaken today.
'Active' means doing anything using your muscles.
Think about activities at work, school or home, getting from place to place, and any activities you did for exercise, sport, recreation or leisure.

Walking
1. During the last 7 days, on how many days did you *walk at a brisk pace?* A brisk pace is a pace at which you are breathing harder than normal. This includes walking at work or school, while getting from place to place, at home and at any activities that you did solely for recreation, sport, exercise or leisure.
Think *only* about brisk walking done for at least 10 minutes at a time.

☐ ________ days per week (GO TO 2)

☐ None (GO TO 3)

2. How much time did you typically spend walking at a brisk pace on each of those days?

☐ ________ hours ________ minutes

Moderate physical activity
3. During the last 7 days, on how many days did you do moderate physical activities? 'Moderate' activities make you breathe harder than normal, but only a little – like carrying light loads, bicycling at a regular pace, or other activities like the **examples on the last page**. Do not include walking of any kind.
Think *only* about those physical activities done for at least 10 minutes at a time.

☐________ days per week (GO TO 4)

☐ None (GO TO 5)

4. How much time did you typically spend on each of those days doing moderate physical activities?

☐ ________ hours ________ minutes

Vigorous physical activity
5. During the last 7 days, on how many days did you do vigorous physical activities? 'Vigorous' activities make you breathe a lot harder than normal ('huff and puff') – like heavy lifting, digging, aerobics, fast bicycling, or other activities like the **examples on the last page.**
Think only about those physical activities done for at least 10 minutes at a time.

☐ ________ days per week (GO TO 6)

☐ None (GO TO 7)

6. How much time did you typically spend on each of those days doing vigorous physical activities?
☐ ________ hours ________ minutes

Frequency of Activity

7. Thinking about all your activities over the last 7 days (including brisk walking), on how many days did you engage in:

- At least 30 minutes of moderate activity (including brisk walking) that made you breathe a little harder than normal, OR
- At least 15 minutes of vigorous activity that made you breathe a lot harder than normal ('huff and puff')?

☐ ________ days per week

☐ None

Stage of Change

8. Please describe your regular physical activity. Regular physical activity means at least 15 minutes of vigorous activity (makes you 'huff and puff') or 30 minutes of moderate activity (makes you breathe slightly harder than normal) each day for 5 or more days each week. Include brisk walking.

☐ I am not regularly physically active because I have been told to limit my activity due to my mild brain injury or concussion

☐ I am not regularly physically active. I would like to do more, however I am concerned about the effects this may have on my mild brain injury or concussion

☐ I am regularly physically active

<u>Moderate</u> Physical Activity - Examples

Carrying light loads	Electrical work	Farming
Heavy gardening(digging, weeding, raking, planting, pruning, clearing section)	Cycling (recreational – less than 15 km/hr – not mountain biking)	Bowls(indoor, outdoor/lawn)
Ballroom dancing	Heavy cleaning (sweeping, cleaning windows, moving furniture)	House renovation
Cricket (outdoors – batting and bowling)	Machine tooling (operating lathe, punch press, drilling, welding)	Golf
Deer hunting	Lawn mowing (manual mower)	Plastering
Plumbing	Horse riding/equestrian	Kapa haka practice
Kayaking – slow	Waiata-a-ringa	Surfing/body boarding
Skate boarding	Yachting/sailing/dingy sailing	Badminton (social)
Exercising at home (not gym)	Doubles tennis	

<u>Vigorous</u> Physical Activity - Examples

Carrying heavy loads	Forestry	Heavy construction
Digging ditches	Chopping or sawing wood	Skiing
Taiaha	Haka	Mountain biking
Soccer Cricket – indoors (batting and bowling)	Rowing Cycling – competitive	Rugby League
Netball	Rugby Union	Hockey
Judo, karate, other martial arts	Race walking	Running/jogging/cross country
Table tennis (competitive)	Singles tennis	Touch rugby
Tramping Swimming – competitive	Triathlon	Volleyball
Boxing	Aerobics	Kayaking – fast
Athletics (track and field)	Aquarobics	Badminton (competitive)
Basketball	Cycling – recreational (not mountain biking) – more than15 km/hr	Rock climbing
Exercise classes / going to the gym (other than for aerobics) / weight training	Softball (running and pitching only)	Squash
Surf life saving	Waterpolo	