



**The association between pain and sleep and their effects on health-related  
quality of life, wellbeing and disability in people presenting to healthcare clinics  
in New Zealand**

A research thesis completed in partial fulfilment of the requirements for the degree of  
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**Fraser Roberts**

# Declaration

**Name of candidate:** Fraser Roberts

This thesis entitled: The associations between pain, sleep, health-related quality of life, and disability in people presenting to healthcare clinics in New Zealand is submitted in partial fulfilment for the requirements for the Unitec Master's degree of Osteopathy

**Principal Supervisor: Dr Shamim Shaikh**

**Associate Supervisor: Dr Sylvia Hach**

Candidate's declaration

I confirm that:

- This Thesis represents my own work;
- The contribution of supervisors and others to this work was consistent with the Unitec Regulations and Policies.
- Research for this work has been conducted in accordance with the Unitec Research Ethics Committee Policy and Procedures and has fulfilled any requirements set for this project by the Unitec Research Ethics Committee.

Research Ethics Committee Approval Number: 2017-1075

Candidate Signature: ..... Date: .....

**Student number:** 1432017

**Note to examiner/s:** This thesis is structured in a traditional style with the following sections mentioned in the order they are presented in this document; abstract, introduction, outline of research aim and objectives, literature review, methodology, results, discussion, bibliography and appendix.

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# Contents

<b>Fraser Roberts</b> .....	i
Declaration .....	ii
Acknowledgments .....	iv
Abstract .....	viii
CHAPTER 1 - INTRODUCTION .....	1
CHAPTER 2 – AIMS, AND OBJECTIVES .....	4
Aims .....	4
Objectives .....	4
CHAPTER 3 - LITERATURE REVIEW .....	5
Defining sleep health and influence of sleep on overall health .....	5
Sleep quality .....	7
Sleep Duration .....	9
Role of sleep in pain and mechanistic considerations .....	10
Health-Related Quality of Life and wellbeing in the context of pain .....	13
Physical disability .....	15
Common measures employed in assessing sleep, pain, disability, and HRQOL .....	18
Wellbeing .....	18
Health-related quality of life .....	19
Single item physical activity measure .....	20
Sleep Quality .....	20
Pain and Sleep Questionnaire .....	21
Physical Disability Index .....	21
Conclusion .....	22
CHAPTER 4 – METHODS .....	23
Study Design and Setting .....	23
Questionnaire .....	24
Demographic information .....	24
Clinical information .....	24
Procedures .....	25
Data Analysis .....	25
Data extraction .....	25
Data processing .....	26
Pittsburgh Sleep Quality Index - PSQI .....	27
Pain Sleep Questionnaire - PSQ-3 .....	27
Health-related quality of life – SF-12v1 .....	27
Physical Disability Index .....	28

Wellbeing – WHO-5.....	28
Statistical analysis.....	28
CHAPTER 5 - RESULTS .....	30
Survey response and demographic data of participants .....	30
Interference of pain on sleep as measured by the Pain and Sleep Questionnaire.....	32
Health-Related Quality of Life – SF-12v1 questionnaire .....	33
Physical Disability.....	33
Pain chronicity and pain intensity as assessed by PSQ-3 .....	34
Differences in health status between good and poor sleepers .....	36
Differences in measures of health between levels of pain intensity.....	37
Differences in measures of health between varying pain durations .....	40
CHAPTER 6 – DISCUSSION.....	42
Demographic characteristics of the study population.....	43
Influence of sleep quality on pain outcomes .....	45
The effect of health-related quality of life (HRQOL) on sleep and pain outcomes ...	47
Future research and implications for healthcare modalities.....	50
Limitations .....	52
Conclusion.....	53
References:.....	55
APPENDICES.....	73
Appendix A: Ethics Approval .....	73
Appendix B: Facebook and LinkedIn post.....	74
Appendix C: Poster.....	75
Appendix D: Patient Information Sheet.....	76
Appendix E: Composite questionnaire .....	78
Appendix F: Composite correlation table .....	90

## List of Tables

<b>Table 1.</b> Sleep quality of respondents as measured by the Global Score of the PSQI... 32	32
<b>Table 2.</b> Interference of pain on sleep as measured by PSQ-3 .....	32
<b>Table 3.</b> Health-Related Quality of Life scores in males and females as measured by the SF-12v1.....	33
<b>Table 4.</b> Physical disability in males and females as measured by the Physical Disability Index. ....	34
<b>Table 5.</b> Pain and Sleep Questionnaire score versus pain intensity.....	34
<b>Table 6.</b> Analysis of the impact of pain duration on sleep, as measured by mean PSQ-3 scores .....	35
<b>Table 7.</b> Differences in health-related measures between participants reporting good sleep quality and those reporting poor sleep quality .....	37
<b>Table 8.</b> Differences in health-related measures between participants reporting different levels of pain intensity.....	40
<b>Table 9.</b> Differences in health-related measures between participants reporting different pain durations.....	40

## List of Figures

<b>Figure 1.</b> Histogram representing sleep duration (in hours) as measured by the PSQI of the total sample of the present study. Frequency is equal to the number of people reporting a given duration of sleep.....	23
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## Abstract

### **INTRODUCTION:**

There is abundant evidence that sleep and pain are related. Sleep and pain also influence health-related quality of life (HRQOL), wellbeing, and physical disability. This study seeks to build upon existing New Zealand literature investigating pain, sleep, and HRQOL of individuals presenting to an osteopathic teaching clinic.

### **AIM:**

To investigate the associations between sleep and pain and their effects on, health-related quality of life, wellbeing, and physical disability in New Zealand adults.

### **METHOD:**

A composite online questionnaire was administered using SurveyMonkey and advertised online and at community centers/libraries. Data was collected from adults with pain and/or sleep complaints in New Zealand. Quality of life was assessed using the 12-item Short Form Survey (SF-12v1); general well-being was assessed using the World Health Organisation WHO-5 index questionnaire; sleep quality and interference of pain on sleep were assessed using the Pittsburgh Sleep Quality Index (PSQI) and the Pain and Sleep questionnaire (PSQ-3) respectively; and physical disability was assessed using the Physical Disability Index (PDI).

### **RESULTS:**

A total of 136 participants (age  $M = 40.53$  years,  $SD = 14.42$ ) were included. Almost all of the participants (94.4%) reported 'poor' sleep quality, as measured by the PSQI. Mean sleep duration was less than six hours. The majority (84.6%) of respondents had been affected by moderate pain for more than three months. Mild to moderate disability in physical and mental aspects of health were also reported. There was a significant difference between PSQ-3 scores for respondents affected by no or mild pain and those affected by severe pain and between respondents affected by pain in the timeframe of six weeks to three months and those affected by chronic pain. Poor sleep quality, higher pain intensity, and longer pain duration were associated with significant decreases in HRQOL and wellbeing status- primarily the physical component. Poor sleep quality was also significantly associated with moderate disability and the mental health component of respondents' HRQOL.

**CONCLUSIONS:**

The results were consistent with local and wider existing research. Close associations between sleep quality, pain intensity and duration, HRQOL, and wellbeing highlight the importance of future research for multifaceted therapeutic management of pain. Supplementing traditional methods of treatment with sleep interventions and support for daily mental and physical function, where appropriate, may be indicated in future ‘best practice’ pain or sleep management. Further research involving larger populations and longitudinal methodology needs to be undertaken to understand causal relationships between sleep, pain, and HRQOL in a New Zealand population.

**KEYWORDS:** sleep quality, health-related quality of life, pain, disability, physical function, sleep

## CHAPTER 1 - INTRODUCTION

Pain is a signal of potential or actual bodily harm that has both physical and emotional manifestations. Sleep is a physiologically complex process of optimisation of function of various physiological systems, restoration, and maintenance of homeostatic systems. It is regulated by a circadian rhythm and also influences or contributes to overall homeostasis of metabolic, immune, nervous and musculoskeletal systems. Dysfunctions in pain and sleep systems, particularly those of a chronic nature, may have wide and adverse range of effects on health. Sleep problems are reported in 67-88% of those experiencing chronic pain (Morin, LeBlanc, Daley, Gregoire, & Mérette, 2006; Smith & Haythornthwaite, 2004) and at least 50% of those diagnosed with insomnia, the most common sleep disorder, report suffering from chronic pain (D. Taylor et al., 2007). Pain and sleep also contribute to decreases in daily function and physical disability, worsening as pain severity or sleep dysfunction increases (Mccracken & Iverson, 2002; Soldato et al., 2007).

Further, pain and sleep are closely associated with mental health. Existing literature indicates that up to 75% of people suffering from chronic pain display symptoms of anxiety and depression, and a similar number of people experiencing depression report symptoms of insomnia (Dahan, van Velzen, & Niesters, 2014; Nutt, Wilson, & Paterson, 2008). These close links between sleep, pain, and mental health mean that dysfunction to any one of them is likely to impact on an individual's quality of life, either directly or via the connection with another area. Quality of life is a concept that has been researched in several countries to date and can be used to understand how an individual measures the 'goodness' of multiple aspects of their life. These aspects may include their work environment, their perceived health, their personal relationships, or their sense of life fulfilment, among others (Theofilou, 2013). Nested within quality of life is health-related quality of life (HRQOL). HRQOL is a multidimensional indicator of an individual's perceived health that incorporates physical, emotional, social, behavioural, and mental parts of wellbeing and health into one construct. It assesses how much a disease or chronic state and its symptoms impacts daily life and functioning within the context of the culture and environment the individual is living in (Schlarmann, Metzger-Blau, & Schnepf, 2008).

Associations between sleep, pain, and HRQOL have been gaining increasing attention in the literature over the last 10 years (Finan, Goodin, & Smith, 2013). Within New Zealand, academic interest in this area is also increasing. This may in part be due to the increasing

prevalence of pain in New Zealanders, particularly chronic pain. Data from the 2016/2017 New Zealand Health Survey indicated that 20.2% of New Zealanders reported experiencing persistent pain (pain lasting for six months or more), up from 17.0% in 2007 (Ministry of Health, 2018). There are currently at least three studies or reports in the last seven years that investigate pain, sleep, and the quality of life of individuals in New Zealand (Arthritis New Zealand & Pfizer, 2012; Dillon, 2017; Gibson et al., 2016), with more articles in New Zealand populations investigating two out of the three aspects of health, primarily within the last eight years (Burri, Rice, Kluger, & Kluger, 2018; Dominick, Blyth, & Nicholas, 2011; Gibson, Campbell, Mather, & Neill, 2018; W. Taylor, 2005; University of Otago, 2007). In particular, the master's thesis completed by Dillon (2017) was particularly comprehensive in obtaining information on and analysing associations between pain, sleep, and health-related quality of life in a population of patients presenting to an osteopathic teaching clinic (Unitec Osteopath Clinic) in Auckland, New Zealand. One area that has been neglected in existing research within New Zealand populations study is the presence of specific measures for pain intensity and physical function. These are important measures to take into account when investigating pain, sleep, and HRQOL, as both pain intensity and physical function are implicated in the clinical picture of a patient that may suffer from pain, sleep disorders, or any issue impacting on their quality of life. An area of future focus that has little research backing in current literature worldwide is the management of sleep or pain disorders through multifaceted management plans involving treating pain and sleep simultaneously to improve therapeutic, functional, and wellbeing-related outcomes. Understanding the relationship between sleep, pain, and HRQOL from both an association perspective and a causal perspective may help influence and guide 'best practice' for the treatment of chronic pain in this manner.

The aim of this study was therefore to examine the association between pain, sleep quality, HRQOL, and disability in individuals presenting to healthcare clinics around New Zealand, extending on existing literature in a New Zealand context. By comparing and contrasting results between the present and prior work, a clearer picture of the New Zealand population and their relevant health outcomes was aimed to be obtained. Factors such as age, gender, employment status, physical activity levels, pain intensity, and pain duration, and physical disability level which may affect painful presentations, sleep, and HRQOL, were also investigated to allow for a more comprehensive characterisation of the relationships between pain and sleep and their effects on disability, wellbeing and health related quality of life.

This thesis is organised into six primary chapters. The current chapter has introduced the current study and topic under investigation, provided background of and the rationale for the project, and introduced the methodology. Chapter two is an overview of the research question, aims, and objectives. Chapter three is a review of pertinent literature surrounding pain, sleep, health-related quality of life (HRQOL), wellbeing, and physical disability. Also included is a review of the measures used in the current study. Chapter four will describe the methodology of the study in greater depth. Chapter five will outline and detail the results obtained from this study. Finally, chapter six will discuss and evaluate the findings in greater detail and outline the implications for current and future healthcare practice in this area.

## CHAPTER 2 – AIMS, AND OBJECTIVES

### Aims

The aim of this thesis is to examine the association between pain, sleep quality, Health-related quality of life, and disability in individuals presenting to healthcare clinics around New Zealand.

### Objectives

1. To measure self-reported sleep quality using the Pittsburgh Sleep Quality Index (PSQI) in individuals presenting to healthcare clinics around New Zealand.
2. To measure Health Related Quality of Life (HRQOL) using the SF-12v2 self-report questionnaire in individuals presenting to healthcare clinics around New Zealand.
3. To measure disability with the Physical Disability Index self-report questionnaire in individuals presenting to healthcare clinics around New Zealand.
4. To measure the impact of pain on sleep with the Pain and Sleep Questionnaire in individuals presenting to healthcare clinics around New Zealand.
5. To examine the associations between measures of pain and sleep quality, on HRQOL and disability in individuals presenting to healthcare clinics around New Zealand.
6. To assess the impact of factors, such as type of pain, region of pain, age, and gender on the association of pain and sleep with HRQOL and disability (to be performed if sample size permits).

## CHAPTER 3 - LITERATURE REVIEW

This chapter provides a review of literature regarding sleep, pain, wellbeing, and physical disability – the primary aspects of health that were the main focus of this study. The chapter is organised as follows: Defining sleep and sleep health, sleep quality, components of sleep, the role of sleep in musculoskeletal pain and the mechanisms involved in pain sensitivity, the association of sleep and pain in wellbeing, and the association of sleep and pain in physical disability. The final part will involve a review of the instruments used in this study.

### Defining sleep health and influence of sleep on overall health

Sleep is an essential part of daily life. It is a complicated physiological process with a wide variation of factors influencing and mediating its initiation, maintenance, and outcomes. The definition of sleep is primarily based on behavioural and physiological criteria. Behavioural criteria include, but are not limited to, characteristics such as: a state of reversible unconsciousness, low or no level of mobility, slowed eye movements, decreased response to external stimulation, slowed reaction times, and decreased cognitive function (Chokroverty, 2010). The physiological criteria of sleep are based on findings from methods such as electroencephalography (EEG), electrooculography (EOG) and electromyography (EMG), investigating the activity of the brain, eyes, and muscles respectively. The findings from these tests primarily relate to the various stages of sleep which will be discussed below.

The stages of sleep are commonly referred to as occurring in “waves”, in which the body alternates between Rapid Eye Movement (REM) sleep, and non-Rapid Eye Movement (non-REM) sleep. Both REM and non-REM sleep have important physiological significance for a variety of aspects of health. REM sleep is closely associated with the development and modulation of an adaptive immune response, consolidation and processing of memories, and emotional regulation (Rasch & Born, 2013; van der Helm & Walker, 2010). Slow-wave sleep in particular, referring to the later stages of non-REM sleep, has important considerations in physical recovery, emotional health, learning, and memory retrieval (Cairney, Sobczak, Lindsay, & Gaskell, 2017; Nadler et al., 2003; Vyazovskiy, 2015; Walker, 2009)

Non-REM sleep has three stages, with stage one occurring from the time of wakefulness changing to sleep. Stage one is a several minute-long phase of light sleep. Throughout

this phase, there is a decreased heart rate, eye movement, and respiration rate. Additionally, there is reduced muscle tone accompanied by occasional twitches. Stage two is a “deeper” sleep than stage one but is still relatively light. Heart rate and breathing rate slow down, muscle tone decreases further, body temperature drops, and there is no longer any eye movement. Brain activity begins to slow in this phase, but there are still bursts of brain activity. More sleep time is spent in stage two than any other stage. Stage three is commonly referred to as “deep” sleep, the stage that is required to feel sleep has been refreshing or of high quality. Throughout this stage, breathing rate and heart rate are at their lowest point. This stage is the hardest to wake from. REM sleep commonly first occurs approximately 90 minutes after falling asleep, cycling in and out of this stage approximately every 90 minutes, though there is variability in latency of REM onset between individuals. REM refers to the fast motion of the eyes throughout this sleep stage, moving rapidly left to right behind closed eyelids. Breathing rate speeds up and becomes irregular, with heart rate and blood pressure increasing to levels close to that of waking levels. Most dreaming occurs throughout the REM sleep phase, which coincides with some muscular paralysis to prevent acting out dreams (Briancon-Marjollet et al., 2015; Institute of Medicine (US) Committee on Sleep Medicine and Research, 2006; National Institute of Neurological Disorders and Stroke, 2018).

A review of the sleep literature shows infrequent mentions of “sleep health”, with no typical definition in the pertinent research. However, using lessons from definitions of “health” and models of health, along with incorporating the concept of sleep and sleep health being multifaceted, a definition of sleep health has been constructed by Buysse (2014), with a particular focus on sleep health being promoted not as ‘absence of dysfunction’ but aimed toward measurable characteristics that are most clearly associated with physical, mental, and neurobehavioral well-being:

“A multidimensional pattern of sleep-wakefulness, adapted to individual, social, and environmental demands that promote physical and mental well-being. Good sleep health is characterized by subjective satisfaction, appropriate timing, adequate duration, high efficiency, and sustained alertness during waking hours” (p.12).

The five facets that are mentioned as characteristics in the above definition provide fundamental outcome measures for sleep and sleep health. Satisfaction/quality of sleep, timing of sleep (chronotype), sleep duration, efficiency of sleep (sleep latency and waking after sleep onset), and sustained alertness encompass the most pertinent concepts of sleep health. Satisfaction/quality of sleep and sleep duration were identified as the most

congruous measures of sleep for this research project, topics that are investigated more thoroughly below.

## Sleep quality

Sleep quality is a term that is commonly used in the sleep literature but is not well understood. This may be partly due to the varying degree of perception about the quality of sleep, which is difficult to measure or generalise. Due to inherent difficulty in measuring or generalising, the assessing quality of sleep is very subjective. Buysse et al. (1989) proposed that the main qualities used to measure “sleep quality” should include: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction, all of which are very similar to the same researcher’s work in 2014 on sleep health, as described above in the previous section. In a study on the subjective meaning of sleep quality in those with and without insomnia, notably the most common sleep disorder, the research indicated that a definition of sleep quality should include reference to “tiredness on waking and throughout the day, feeling rested and restored on waking, and the number of awakenings in the night” (Harvey, Stinson, Whitaker, Moskovitz, & Virk, 2008, p. 392).

Considering this, there are very few comprehensive questionnaires on sleep quality. The Pittsburgh Sleep Quality Index (PSQI) (Buysse et al, 1989), is a commonly used self-report questionnaire of sleep quality measurement. Self-report questionnaires are commonly implemented in studies on sleep due to their ease of use. A downside to the use of self-report questionnaires is the subjective nature of the results, limiting the absolute clinical relevance of the data. The objective alternative to self-report questionnaires and subjective measurement is polysomnography, in which a patient is connected via channels to a central box, which measure a wide variety of body functions such as brain activity, eye movements, muscle activity, and heart rate and rhythm. Objective measures are superior to subjective measurements due to a lack of potential biases that inevitably occur with use of subjective measures of sleep. The high usage rate of the PSQI in measuring sleep quality may be heavily influenced by the fact that the most prominent definitions for sleep health and sleep quality were developed by the same author that developed the PSQI questionnaire. Each of the indicated aspects of sleep quality that were indicated by Harvey et al. (2008b) are included in the PSQI, which, with its ease of application, easy scoring methods, and good psychometric properties, including a sensitivity and specificity of 89.6% and 86.5% respectively, allows it to exist as the flagship method for measuring sleep quality. Though no questionnaire is perfect, there is

an inherent benefit in consistency of measurement across a variety of research. The confidence in the knowledge that the exact same factors are being considered in every population across an extensively wide range of health factors and components provides a congruency across the literature that helps contextualise the natural heterogeneity of research across different topics.

For researchers, clinicians, and individuals, the same benefit exists. That is, having a more intimate understanding of one comprehensive measure is superior to having heard of several measures that investigate the same concept but may differ slightly from each other, particularly regarding situations where the outcome is subjective in nature. This is not without downsides, however, as having a unilateral approach to research eliminates the possibility of progression and development of measures that may be better than the one being used. In the case of sleep quality specifically, it may be beneficial to focus on using the PSQI as the primary measurement tool while the concept of sleep quality is propagated among the general population, uniting researchers, clinicians, and individuals in their understanding of an important, yet underutilised, aspect of daily and long term health.

A proposed reason for the ambiguity surrounding a definition for sleep quality is that there are also correlations with non-sleep outcomes such as health status, pain, mood, or anxiety (Krystal & Edinger, 2008). Additionally, sleep quality may represent different phenomena to different people. In an individual who has significant trouble with awakenings at night, ratings of sleep quality for an evening may be dominated by the experience of the number of times they woke up at night, whereas in an individual who struggles to achieve sleep onset, the number of times they awoke in the night would be less significant (Kryger, Steljes, Pouliot, Neufeld, & Odyński, 1991). Clinically, more objective measures of sleep quality would be useful to provide clearer data on sleep outcomes, but due to the complexity of the components of sleep quality, this is a difficult outcome to achieve. Additionally, providing clinical framework and guidelines for “sleep health” as a distinct concept through additional research in this area may provide significant benefit in the evaluation and resolution of sleep problems.

Sleep quality and its components have consistently been linked to a wide variety of health outcomes, particularly coronary heart disease (Frost, Kolstad, & Bonde, 2009; Hoevenaar-blom, Spijkerman, Kromhout, & Berg, 2011; Laugsand, Vatten, Platou, & Janszky, 2011; Sabanayagam, Shankar, Buchwald, & Goins, 2011), diabetes and impaired glucose metabolism (Buxton et al., 2013; Knutson, Van Cauter, Zee, Liu, & Lauderdale, 2011; Pyykkonen et al., 2012; Reutrakul et al., 2013), and as a predictor of mortality,

among others. (Akerstedt, Kecklund, & Johansson, 2004; Dew et al., 2003; Mallon, Broman, & Hetta, 2002; Nilsson, Nilsson, Hedblad, & Berglund, 2001). These important health-related outcomes regarding sleep highlight the importance of sleep – as well as sleep quality – and the need for more objective measures with regard to sleep quality in order to help achieve better health outcomes through sleep management. Appropriately investigating and treating dysfunctional sleep may have large ramifications on an individual's health due to the morbidity associated with poor sleep (Buysse, 2014).

Sleep and the circadian rhythm that underpins the timing of our sleep exerts a very strong influence on the regulation of human immune function (Besedovsky, Lange, & Born, 2011). Sleep also has very close connections to a variety of hormonal and metabolic processes in the body. It has an important role in maintaining metabolic homeostasis in many of these processes (Sharma & Kavuru, 2010). Existing research indicates that sleep dysfunction is implicated in metabolic disorders such as obesity, glucose metabolism, and heart disease. A common mechanism that is linked to each of these health outcomes is the process of insulin resistance and glucose dysregulation (Horwich & Fonarow, 2010; Ormazabal et al., 2018). Laboratory-based studies have shown that even one night of sleep deprivation can cause reduced insulin sensitivity, and research also indicates that a week of sleep deprivation can result in a significant increase in insulin resistance (Spiegel et al., 2005; Spiegel, Leproult, & Cauter, 1999; VanHelder, Symons, & Radomski, 1993).

Insulin resistance is indicated in changes to systemic lipid metabolism, which is a key component to the development of dyslipidemia (Ormazabal et al., 2018). Dyslipidemia and endothelial dysfunction, which may develop through abnormal insulin signalling, lead to the formation of atherosclerotic plaque and heart disease (Ormazabal et al., 2018). Through sleep loss and the subsequent changes in glucose metabolism, there are links to obesity through sympathetic activation and the release of hormones integral to energy balance such as leptin and ghrelin (Beccuti & Pannain, 2011; Sharma & Kavuru, 2010). With an increasing prevalence of sub-optimal sleep duration and quality in the western world due to our highly stimulatory environment, there is also an increasing need to be aware of sleep as a potential contributor to these negative health outcomes and provide intervention where indicated.

## Sleep Duration

Sleep duration may be the most well-known measure of sleep for the general public, primarily due to the lack of complexity in measurement of sleep duration outcomes, and

its ease of access for the public, with trackers based on movement and heart rate becoming increasingly affordable and popular. Colloquially, the average person may know that they need “8 hours of sleep”, but studies reviewing the literature on the quantity of sleep duration report that sleep duration of more than seven hours but less than eight hours per night is associated with the best health outcomes related to sleep (Alvarez & Ayas, 2004a; Pilcher, Ginter, & Sadowsky, 1997). Culture may play a part in sleep duration, leading to ethnic inequality in health outcomes such as those related to sleep. In a large sample of New Zealand adults (n= 9100) between the ages of 20-59, it was indicated that 28.6% of the Māori population and 22.1% of the non-Māori population report ‘short’ sleep (less than seven hours) on days where they have family, work, or other commitments, and 15.8% of Māori and 11.5% of non-Maori report ‘long’ sleep (more than nine hours) on those same days (Paine & Gander, 2016).

Significant systematic reviews of both short (defined as 6 or fewer hours) and long (defined as 9 or more hours) sleep duration, including over 5,000,000 people from over 130 studies in each review, showed significant associations with, and increased risk for, common health outcomes, including mortality, incident diabetes mellitus, stroke, cardiovascular disease, coronary heart disease, and obesity (Itani, Jike, Watanabe, Buysse, & Kaneita, 2016; Jike, Itani, Watanabe, Buysse, & Kaneita, 2017). In addition to health outcomes, sleep restriction can also cause a host of neurocognitive consequences with regard to cognitive processing, executive functioning, sustained attention, and long term memory (Lowe, Safati, & Hall, 2017). Lifestyle behaviour may also be affected by sleep insufficiency, with those that report frequent sleep insufficiency being significantly more likely to smoke, be physically inactive, and, among men, to drink heavily (Strine & Chapman, 2005). Social, cultural, environmental, and physical aspects of life all have an impact on sleep, or a lack thereof (Banno et al., 2018; Giannotti & Cortesi, 2009; Grandner et al., 2013). As its own health outcome, sleep duration has important considerations, but due to its role as a component of sleep quality and its ease of measurement, there may be more value in contextualising sleep duration as part of sleep quality and use it as an additional tool to develop more objective measures of sleep quality as a primary outcome measure of sleep.

## Role of sleep in pain and mechanistic considerations

While research surrounding the complex relationship between sleep and pain has grown over the last decade, the mechanisms involved in the relationship are yet to be fully understood, and to an extent remain ambiguous. Despite this ambiguity, it is well accepted

knowledge that there is enough evidence to support a bidirectional relationship between sleep and pain. Pain may disrupt aspects of sleep and decreased or disrupted levels of sleep components may contribute to or exacerbate the perception of pain in an individual. In turn, this may increase pain and the continuation of the disease. In population-based longitudinal studies, a reciprocal relationship has been observed pertaining to sleep being a predictor of pain, and pain being an indicator of sleep problems. Microlongitudinal studies with comprehensive subjective and objective measurements, demonstrate the concept that sleep problems are a stronger and more reliable predictor of pain than pain is of sleep problems (Edwards, Almeida, Klick, Haythornthwaite, & Smith, 2008; Finan, Goodin, & Smith, 2013).

Despite an increasingly large amount of research on the reciprocal relationship between sleep and pain, there are a number of mechanisms that are still yet to be fully understood. A prominent mechanism proposed to underlie the relationship is that of the homeostasis of pain-regulatory processes in the presence of sleep problems. The perception of pain occurs when nociceptors are stimulated enough to activate Group A (A $\delta$ ) nerve fibres, resulting in a subjective sensation of “sharp” pain (Garland, 2012). The activation of nociceptors is then transduced through the axons of the peripheral nerves in the affected area, terminating at the dorsal horn of the spinal cord. The signal is then transmitted through the spinothalamic tract of the spinal cord to the thalamus, and onto the cerebral cortex, where nociception from the periphery is processed (Garland, 2012). Though pain levels are primarily dictated by the intensity of the ascending signal, descending pathways from the brain may modulate the perception of pain by either suppressing (descending inhibition) or potentiating (descending facilitation) the pain signal (Millan, 2002).

Sleep may modulate this process by impairing the descending pain modulatory systems (Finan et al., 2013) A number of studies have reported disruption of pain modulation as a result of hyperalgesia stemming from experimental or naturally occurring sleep deprivation (Kundermann, Sernal, Huber, Krieg, & Lautenbacher, 2004; Onen, Alloui, Gross, Eschallier, & Dubray, 2001; Simpson, Scott-Sutherland, Gautam, Sethna, & Haack, 2018). However, some of these studies were limited, primarily in their low sample sizes, use of healthy subjects, and/or usage of ‘total’ sleep deprivation or selective sleep stage deprivation as opposed to partial sleep deprivation. The latter may give more accurate results with regard to the kinds of sleep restriction that may happen organically for a given population (Finan et al., 2013)

Particularly in chronic instances, there is a large negative impact on health involved in both sleep and pain systems in humans. Sleep problems are reported in up to 67-88% of

chronic pain disorders (Morin, LeBlanc, Daley, Gregoire, & Mérette, 2006; Smith & Haythornthwaite, 2004) and at least 50% of those suffering from insomnia, the most common sleep disorder, are affected by chronic pain (D. Taylor et al., 2007). Longitudinal studies also demonstrate symptoms of insomnia predicting future chronic pain complaints in those who were previously pain-free (Finan et al., 2013).

Literature on the relationship between pain and sleep indicates that research surrounding chronic pain is much more prevalent than that of acute pain. This may be due to the mechanisms of pain involved in chronic pain as opposed to acute pain. The development of central sensitisation is paramount to the diagnosis of chronic pain, rather than purely duration based pain characteristics (Pergolizzi et al., 2013). Though there are a number of reasons for the manifestation of central sensitisation, the common theme of central sensitisation in cases of chronic pain, along with the inherent long-term nature of chronic pain, allows chronic pain research to be significantly easier to achieve. Additionally, chronic pain is a significant burden to society, particularly healthcare and the economy.

In 2010 prices, total costs associated with persistent pain in adults in the United States was estimated to be \$560-635 billion, more than heart disease (\$309 billion) and cancer (\$243 billion) put together (Gaskin & Richard, 2012). Prevalence of chronic pain among adults in the United States in 2016 was estimated to be about 50,000,000, or about 20.4% of the population (Dahlhamer, Lucas & Zelaya, 2016). Estimates for New Zealand in 2007 suggest approximately 17% of New Zealanders suffer from chronic pain (Dominick, Blyth & Nicholas, 2011). The mechanistic considerations of the relationship between chronic pain and sleep problems are less understood as a result of the complexity and heterogeneity of chronic pain and the comorbidities that are associated with it, particularly with psychiatric conditions such as depression and anxiety (Timothy Roehrs & Roth, 2005). On average, up to 75% of people experiencing chronic pain display symptoms of anxiety and depression, and about three quarters of people experiencing depression have insomnia symptoms (Dahan et al., 2014; Nutt et al., 2008). Importantly, the presence of depression may increase the severity of pain, exacerbating the debilitating experience of chronic pain through mechanisms related not only to the onset of chronic pain, but also sleep problems, in addition to the neuropsychiatric disease pathway (Dahan et al., 2014).

Those experiencing moderate to severe pain have been found to be more likely to have a lower quality of life and decreased work function, and were more likely to have complex chronic illnesses such as heart failure and diabetes (Butchart, Ker, Heisler, Piette, & Krein, 2009; Davis, Robinson, Le, & Xie, 2011). The primary sleep complaint reported by those with chronic pain is multiple nocturnal awakenings due to pain-related arousals

throughout the night (Finan, Goodin, & Smith, 2013). The higher level of sleep disturbance is associated with worse pain severity (Ohayon, 2005), and the duration of sleep on the previous night is a highly significant predictor of the current day's pain (Edwards et al., 2008). Conversely, in individuals that experienced a day of increased pain, there was significantly more sleep disruption that night in comparison to days of lower pain levels (Affleck, Urrows, Tennen, Higgins, & Abeles, 1996). The immense burden on both healthcare and individual life that occurs as a result of chronic pain indicates the importance of managing pain and sleep on a population level.

There is significantly less research on the inverse of this relationship: the amelioration of pain through restorative sleep. A small number of studies have reported decreased pain levels and/or pain sensitivity through extending sleep duration, whether it be nocturnal sleep or adding a nap (Faraut et al., 2015; Simonelli et al., 2019). Additionally, self-reported restorative sleep was found to be the only sleep factor related to the resolution of chronic widespread pain, and the return to musculoskeletal health, in a longitudinal sample of 679 individuals with chronic widespread pain (Davies et al., 2008). A limitation of this study, however, was that it was unclear whether restorative or refreshing sleep was a mechanism for recovery or a marker of recovery. Despite this, in light of more recent studies mentioned above, it would not be unreasonable to suggest that through the improvement of self-reported restorative or refreshing nature of sleep, there may be a decrease in pain levels for some people.

More research is required on intervention techniques to improve sleep quality/outcomes and the effect it has on the resolution of pain. Particular health modalities that may be well-placed to participate in research, while also benefiting from it, are professions that deal with health conditions in a holistic manner such as in osteopathy, physiotherapy, or massage therapy.

## Health-Related Quality of Life and wellbeing in the context of pain

The physical aspect of pain is the most prominent with regard to an individual's perception of pain, but is not the only element. There are other important considerations of the pain experience in addition to the physical manifestation of pain, including emotional, behavioural, and cognitive facets of pain. As a result, while research purely on intensity and chronicity of pain as outcomes with relation to other health conditions can be valuable, there may also be an inherent value in measuring perceived quality of life of an individual, through investigating the non-physical manifestations of pain such as those

mentioned above. Health-related quality of life is a multi-dimensional concept that takes into account these varied aspects of life that contribute towards health, such as physical health, mental health, emotional wellbeing, and social functioning. With both pain and sleep disturbance being able to affect each of these domains, health-related quality of life can measure the impact that those outcomes have on health, and how an individual's health status affects quality of life.

Health-related quality of life (HRQOL) represents an individual's perception of their physical, mental, and social health status by measuring various aspects of their overall health (e.g., physical function, pain experience, general health, vitality, social function, emotional state, mental health etc.). Factors such as age, employment status, and physical activity levels can have effects on HRQOL. Research supporting the effect of these factors has been well established over the past 10-12 years. Studies suggest that progressions in age are associated with lower scores of HRQOL (Lima et al., 2009; Michel, Bisegger, Fuhr & Abel, 2009). Current literature also shows that higher levels of physical activity, measured both objectively and subjectively, is associated with better HRQOL scores (Anokye, Trueman, Green, Pavey & Taylor, 2012; Bize, Johnson & Plotnikoff, 2007). Less physical factors, such as employment status may also have an effect on HRQOL scores, highlighting the wide scope of health influence that HRQOL may capture. Being in paid employment is consistently associated with higher HRQOL scores than being disabled for work or not being in paid employment (Åberg et al., 2009; Patti et al., 2007)

There is evidence that HRQOL is a stronger predictor of mortality than many objective measures of health (Guallar-Castillón et al., 2014). As a function of the broad and multidimensional concepts that HRQOL integrates into a single measure, it is commonly used to help provide direction and quantify policy interventions that address a cohort of areas, particularly in the medical, social, and mental services (CDC, 2018). A change in HRQOL from baseline measurement to follow up is becoming increasingly accepted as an important outcome of interventions in health-related sectors.

An additional tool that has been used in population-based policies is the concept of Quality Adjusted Life Years (QALYs). QALYs are a measure of the value of health outcomes. As health is comprised of length of life and quality of life, the concept of QALYs was constructed as a way to quantify both these constructs into a numerical value (Prieto & Sacristán, 2003). Throughout the last 20 years, QALYs have become increasingly popular as a measure of health outcomes within a healthcare setting. This is primarily due to three main factors: QALYs integrate changes in both morbidity (quality) and mortality (amount) simultaneously. QALYs are also easy to calculate, through simple

multiplication; thus potential barriers of difficulty of use are not applicable. Thirdly, QALYs are an important part of a specific type of economic analysis within healthcare: cost-benefit analysis (Prieto & Sacristán, 2003).

Pain, sleep, and health-related quality of life are intrinsically related through how problems in each sector of life can negatively affect the others. The relationship between pain and HRQOL has been elucidated above, and research indicates that in the same manner that pain and sleep are interrelated, both pain and sleep are also associated with HRQOL. Individuals that obtain short (6 hours or less) and long (9 or more hours) nighttime sleep duration are associated with greater risks of metabolic disease (Alvarez & Ayas, 2004b) and general mortality (Gallicchio & Kalesan, 2016). Individuals that suffer from either severe or mild insomnia have been shown to have significantly poorer physical and mental health than those that sleep well, even after accounting for psychiatric disease such as anxiety or depression, conditions that affect both pain and general health status (Leger, Scheuermaier, Philip, Paillard, & Guilleminault, 2001). International cross-sectional data using a 4,067 sample population from the U.S. (n=1298), France (n=1858), and Japan (n=911) indicated that chronic insomnia (<6 months) was associated with lower HRQOL scores in all applicable health domains in comparison to good sleepers (Léger et al., 2012). The experience of chronic insomnia also relates to a substantial socio-economic burden due to its given association with falls, accidents, and decreased cognitive functioning (Brassington, King, & Bliwise, 2000; Moul et al., 2002). Through these close associations between sleep, pain, and HRQOL, any factor that impacts on one health outcome may affect others, in a direct or indirect manner.

With regard to pain and sleep, HRQOL also has important predictive qualities. One study found the health factor that was the most consistent in predicting better health outcomes over an eight-year follow up was feeling rested after sleep (Arvidsson, Arvidsson, Fridlund, & Bergman, 2008). A three-year follow-up study of 2357 people using the SF-36 HRQOL survey indicated that baseline HRQOL scores predicted pain outcome three years later (Bergman, Jacobsson, Herrström, & Petersson, 2004). These findings suggest that correctly diagnosing or identifying sleep disorders, particularly those relating to subjective sleep quality, may be an important part of improving an individual's HRQOL.

### Physical disability

Physical disability refers to decrease in physical activity or physical function; the relative ability of an individual to perform a situation or set of situations involving a physical

aspect. Disability is defined as “difficulty or dependency in carrying out activities essential to independent living, including bathing and dressing, and desired activities that improve one’s quality of life” (Fried, Ferrucci, Darer, Williamson, & Anderson, 2004, p. 255). Despite daily physical function being embedded within HRQOL, the change in physical function as a result of an increase of pain or the presence of pain is colloquially the most prominent manifestation of the experience of pain. Due to this, particular interest on the effect of pain and sleep on an individual’s physical function may help to further contextualise their overall health status.

A significant part of research on physical disability involves populations of older individuals. Physical function, or a decrease thereof, is a natural part of aging, but there are a number of contributing factors that may decrease an individual’s functional ability that are not directly related to age. Some of these factors include cognitive impairment (Gill, Williams, Richardson, & Tinetti, 1996; Hebert, Brayne, & Spiegelhalter, 1999) and conditions that affect psychosocial aspects of health, such as depression (Penninx, 1998) and pain.

Chronic pain dominates research surrounding pain, physical function, and daily activity levels. Studies have highlighted a strong relationship between chronic pain and a reduced level of physical activity or increased symptoms during or following physical activity (Azevedo, Costa-Pereira, Mendonça, Dias, & Castro-Lopes, 2012; Lerman, Rudich, Brill, Shalev, & Shahar, 2015; Turk et al., 2008). A number of different factors relating to pain also modify physical performance and activity, including pain intensity, location of pain, and duration of pain (Jones, Rutledge, Jones, Matallana, & Rooks, 2008). A survey of 4839 individuals with chronic pain across Europe and Israel examined the most affected physical activities in those with chronic pain (Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006). The most frequently affected activities were: The ability to walk, perform domestic chores, participate in social activities, do intense physical exercise, and maintain an independent lifestyle (Breivik et al., 2006).

Sleep has also been consistently associated with changes in physical disability. Short sleep duration has been linked to higher levels of various forms of physical disability (Lorenz, Budhathoki, Kalra, & Richards, 2014; Song et al., 2015). In older adult men and women comparable results were found: Poorer sleep outcomes were associated with lower levels of mobility in daily activities or physical function (Dam et al., 2008; Goldman et al., 2007; Stenholm et al., 2010). Goldman et al. (2007) found a U-shaped relationship between sleep duration and mobility: Individuals sleeping for fewer than 6 hours and those that slept for more than 7.5 hours had a higher likelihood of having mobility

difficulty in comparison to those that slept between 6 and 7.5 hours. Pain is considered to have instinctual properties, and is often accompanied by an emotional experience that acts as a preventative mechanism to avoid further damaging affected tissues (Yam, Chun, Id, & Tan, 2018). As a result, pain itself has an intrinsic effect on physical function, as pain is commonly felt when moving a body part that is injured or indicated in the particular experience of pain. Consequently, the triad of pain, sleep, and physical disability are associated and indicated together, as discussed in literature previously in this review.

There is a significant limitation in relevant research identifying the level of knowledge that healthcare practitioners, and particularly those in manual therapy-based professions, understand about sleep as a healthy behaviour. No research exists on New Zealand healthcare professionals' understanding or knowledge of sleep. In a study of 121 primary care clinics in the Minneapolis/St. Paul metropolitan area of the US, only 43% of the clinics included sleep-related questions on their screening questionnaires (Sorscher, 2008). This figure was in comparison to 100% of screening questionnaires having items for smoking and alcohol, 93% for healthy eating, and 86% for physical activity (Sorscher, 2008). The research did not make it clear why sleep had less of a focus in the studied health screenings, but it was hypothesised that it may be related to clinicians' lack of knowledge of the significance of sleep. In a separate study in the US in 2002, only 10% of primary care providers were found to describe their knowledge of sleep or sleep disorders as 'good' (Papp & Penrod, 2002).

A lack of research on healthcare providers' knowledge of sleep may indicate a lack of knowledge, a lack of awareness, or the implication that sleep is not a primary health concern. Additionally, there is a scarcity of research on using sleep as a therapeutic target to achieve more favourable health outcomes, particularly in experiences of pain or injury. Within New Zealand, there is a growing body of research in the area of pain, sleep, and quality of life. This research is mainly concentrated in the last 10 years, highlighting the increasing interest in this area of literature. This review of literature found three instances of research that had direct interest in pain, sleep, and quality of life in populations within New Zealand, one piece of research comprised of a group of studies, one standalone study, and a master's thesis (Arthritis New Zealand & Pfizer, 2012; Dillon, 2017; Gibson et al., 2016). Additionally, there is consistent research in a New Zealand context that investigates two out of the three health aspects (i.e. pain, sleep, and quality of life), primarily in the last 12 years (Burri et al., 2018; Dominick et al., 2011; Gibson et al., 2018; W. Taylor, 2005; University of Otago & Te Rōpū Rangahau Hauora a Eru Pōmare, 2007). The studies completed by Dillon (2017) and Gibson et al. (2016) were of particular interest in this current study, as they comprise the only existing research in a New Zealand

population that specifically investigates pain, sleep, and HRQOL (as measured by the 12-Item Short Form Survey). These studies provided evidence that poor sleep quality and short sleep duration are associated with decreases in health-related quality of life scores, as measured by the SF-12v2. These studies thus formed the primary basis of the rationale for this current study, with particular focus on Dillon's thesis (2017), due to its more comprehensive measurement of pain complaints. With strong evidence for changes in HRQOL scores in those with musculoskeletal pain and/or sleep problems in New Zealand, there was clear potential to extend the scope of the current research to include a more representative New Zealand population. Investigating pain, sleep, and HRQOL in a wider population may help provide a clearer understanding of the associations between each aspect of health and serve as rationale to future research on sleep as a public health concern or a therapeutic target in those with pain or other unfavourable health outcomes.

## Common measures employed in assessing sleep, pain, disability, and HRQOL

Wellbeing, health-related quality of life, sleep quality, impact of pain on sleep, and physical disability were the primary variables in this study. Self-report measures such as multi-item questionnaires constitute the predominant measures for this study, with questionnaires showing strong psychometric properties have come into continuous use in this area of research with regard to the current studies' variables. In addition, multiple individual questionnaires are often combined into composite questionnaires in order to assess multifactorial relationships. Wellbeing can be measured by the World Health Organisation Well-being Index (WHO, 1998). Health-related quality of life (HRQOL) may be measured by the 12-Item Short Form Survey Version one (Ware, Kosinski, and Keller, 1996) and sleep quality by the Pittsburgh Sleep Quality Index (Buysse et al., 1989). The impact of pain on sleep can be measured by the Pain and Sleep Questionnaire (Ayearst, Harsanyi, & Michalko, 2012), and the assessment of physical disability may be measured through the use of the Physical Disability Index. The following section briefly summarises these measures and reports the most important properties.

### Wellbeing

The World Health Organisation Well-Being Index (WHO-5) is a five-item questionnaire that has been widely used to assess subjective psychological wellbeing (WHO, 1998). The five items are scored on a six-point Likert scale (zero to five, ranging from 'at no time'

to ‘all the time’). Summing the individual items and multiplying the score by four provides a score that ranges from zero to 100. A systematic review of 213 articles that used the WHO-5 indicates that it may be used as an outcome measure balancing the wanted and unwanted effects of treatments. It was also found that the WHO-5 is sensitive and specific in its ability to screen for depression (Topp, Østergaard, Søndergaard, & Bech, 2015). Though a systematic review of 213 articles concluded that the WHO-5 performed well in the four primary aspects of use it was designed for, being clinimetric validity, responsiveness/sensitivity in controlled trials, potential as a screening tool for depression, and applicability across study fields, it was developed without any diagnostic specificity (Topp, Østergaard, Søndergaard, & Bech, 2015). Though this does not decrease the usefulness of the measure in this study, it may limit the total effectiveness as a screening tool for depression and other health outcomes due to the high subjectivity of the concept of “wellbeing”.

#### Health-related quality of life

The Short-Form 12 Health Survey (SF-12v1) is the most widely used measure for HRQOL. The SF-12v1 is a questionnaire that assesses the burden of illness on health, as well as measuring clinical effectiveness of care and treatment of that illness or issue. The SF-12v1 was developed in 1994 and functions as an alternative to the SF-36v1, for situations in which the full-length 36 question form is too long. Studies investigating the comparative validity of the 12-item form versus the longer 36-item form had multiple R squares of 0.911 and 0.918 in predictions of the SF-36 Physical Component Summary and SF-36 Mental Component Summary scores, respectively (Gandek et al., 1998; Jenkinson et al., 1997; Ware, Kosinski, & Keller, 1996). The SF-12v1 differs from the more recent SF-12v2, with the second version changing various wordings of questions, as well as changing four items from dichotomous to five-level responses, and six-level response categories were changed to five-level response categories to simplify items in the Mental Health and Vitality subscales. The SF-12v1 consists of 12 items which assess eight different aspects of health, made up of one to two questions each: physical functioning (PF), role-physical (RF), bodily pain (BP), general health dimensions (GH), vitality (VT), social functioning (SF), role-emotional (RE), and mental health (MH). Each item contributes to two global scores: The Physical Component Summary (PCS) and the Mental Component Summary (MCS), both of which range from 0-100. Both the PCS score and MCS score is normalised for the American population. Scores for an individual or group is reported relative to a mean of 50 and a standard deviation of 10 in the general American population (Johnson & Pickard, 2000). A higher score denotes a higher level

of health in that particular health dimension. One downside to the usage of the shorter SF-12v1 rather than the SF-36v1 is that there may be some confounding of MCS scores, as there have been situations in which the relationship of MCS scores in the 12-item form and the 36-item form was modified by age, a finding that is not likely to have been intended (Pickard, Johnson, Penn, Lau & Noseworthy, 1999).

#### Single item physical activity measure

This single item physical activity measure utilises a multiple-choice scale, with options ranging from one to seven days and states the following: “In the past week, on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate. This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that may be part of your job”. The physical activity single-item assessment used here shows strong reproducibility of  $r=0.72-0.82$ , using Spearman’s rank correlation coefficients (Milton, Bull, & Bauman, 2011), and single-item assessments used to estimate physical activity have been suggested to be feasible, cost-effective, and efficient to assess physical activity in large-scale studies (Jackson et al., 2007). A downside to the physical activity measure in this study was the lack of an option of “0 days”, which may confound the resulting data as there are likely participants who are physically unable to fulfil the criteria for having achieved at least one day of physical activity.

#### Sleep Quality

The PSQI (Buysse et al., 1989) is composed of 19 individual items that are used to assess sleep quality over a one-month time interval. The PSQI is one of the most frequently administered questionnaires for evaluating sleep quality, or a lack thereof (Mollayeva et al., 2016), with well-established positive psychometric properties. For example, good test-retest reliability (correlation coefficient of 0.87) and sensitivity and specificity (98.7% and 84.4%, respectively for PSQI global scores  $>5$ ) have been demonstrated (Backhaus, Junghanns, Broocks, Riemann, & Hohagen, 2002; Hinz et al., 2017; Spira et al., 2012). A final score ranging from zero to 21 is compiled from the 19 questions being grouped into seven component scores: Subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction, which are then summed to create a “PSQI global score”. A PSQI global score of five or below indicates the participant has “good” sleep quality, and a score above five indicates “poor” quality sleep. The primary limitation of the PSQI is the subjective nature

of the questionnaire, though this is consistent with all other questionnaires in this study. Self-report questionnaires may reflect inaccurate information as a result of recency or social desirability biases.

### Pain and Sleep Questionnaire

The Pain and Sleep Questionnaire Index (PSQ) (Ayearst, Harsanyi, & Michalko, 2012). is made up of six items described below that are each scored on a 100-millimetre Visual Analogue Scales (VAS), with end points on the scale being ‘never’ and ‘always’. The index covers six questions on how often participants have trouble falling asleep (Item one), how often pain medication is needed to fall asleep (Item two), how often sleeping medication is needed to fall asleep (Item three), how often they are awakened by pain during the night (Item four), how often they are awakened by pain in the morning (Item five), and how often their partner is awakened (Item six).

The scores for items one, four, and five of the PSQ are summed to create a truncated version of the PSQ, called the PSQ-3, with good psychometric properties including a range of internal consistencies (Chronbach’s alpha = 0.82-0.93) and good validity with regard to the direct measure of the impact of pain on sleep, including a higher reliability and validity than the full PSQ questionnaire (Ayearst et al., 2012). The other three items not included in the PSQ-3 were less relevant to the impact of pain on sleep than items one, four, and five. This was reflected in the superior psychometric properties of the PSQ-3 versus the full item PSQ. The three items are summed to create a score ranging from zero to 300, with higher scores indicating a greater interference of pain on sleep. This process of summing and scoring the three pertinent items to create the PSQ-3 score was completed in the present survey. The PSQ-3 is a commonly and widely used questionnaire to measure the impact of pain on sleep, primarily due to its short nature, being three items long, and its psychometric qualities. Similar to the PSQI, the primary disadvantage of the PSQ-3 is the potential for biases being present in the self-reporting of the participants in this study.

### Physical Disability Index

The Physical Disability Index is a seven-item questionnaire that investigates day-to-day difficulties as a result of health conditions. The questionnaire measures how much difficulty in a particular domain an individual had in the past 30 days. The following six domains of health and function are considered: Cognition (understanding and communicating), mobility (ability to move and get around), self-care (hygiene, dressing,

and eating), interpersonal relationships, life activities (ability to attend to everyday responsibilities), and participation in society. Each question is a five-point Likert scale running from “None” to “Extreme or cannot do”, with each response correlating to a number from zero-four, with “None” being zero, and “Extreme or cannot do” being four. Each of the seven items are summed to create a global score ranging from 0-28, and then converted to a percentage score ranging from 0-100%, with higher scores indicating a higher level of physical disability. The six health domains mentioned above, as well as the scoring method, are the same that are used in the WHODAS 2.0 12-item questionnaire. The seven questions here are the same as the final seven questions in the WHODAS 2.0. The psychometric properties of this questionnaire were not explored for this study, which is the main disadvantage to this questionnaire.

## Conclusion

To conclude, there is a well-established, bidirectional link between sleep problems and pain. A primary component of health that contributes to both sleep problems and exacerbation of an individual’s pain experience is that of psychosocial conditions such as depression. Through measuring health-related quality of life, each of these three important aspects of health are integrated into a measure that has predictive value for health outcomes in a clinical setting. While there is a dearth of research surrounding sleep as a specific intervention target to improve pain levels, there is sufficient evidence that points towards this being an area of research that has potential to be clinically relevant to all healthcare practitioners that deal with pain on a regular basis. Manual therapy providers, such as osteopaths, are situated well to not only investigate chronic pain, but also sleep-related problems that may impact on the quality of sleep, which has been consistently highlighted as the most important aspect of sleep as a health determinant. Identifying, investigating, and treating sleep problems in addition to the conservative treatment of musculoskeletal pain may be an important and valuable approach as a non-pharmacological treatment plan, and may be more effective than treating the pain or cause of pain alone.

## CHAPTER 4 – METHODS

### Study Design and Setting

A cross-sectional survey design was used. An online questionnaire was created using SurveyMonkey®. Facebook was used as the primary medium of attaining and boosting survey responses. A page named “Pain and Sleep Research NZ” (URL: <https://www.facebook.com/painandsleep/>) was established and a public post made to advertise the survey (completed via SurveyMonkey), on other Facebook user’s pages (See appendix item B). Additionally, a LinkedIn profile was made, with the same post created for others to share on their LinkedIn pages. Posters were created that advertised the survey with contact details for the primary researcher and the research supervisors and a website link (See Appendix C), that people were able to input into their chosen internet enabled device to participate in the survey. These posters were put up around Unitec and in a library in close proximity to the Unitec Mount Albert campus. The survey was conducted over a seven-month period, between December 22<sup>nd</sup>, 2017 and June 7<sup>th</sup>, 2018.

The following initial inclusion criteria were used for recruiting the participants: (1) 18 years old or above; (2) those that could read and write in English; (3) must live in New Zealand; (4) must have visited an osteopath in the last three months. Even though a potential respondent having a condition that affected pain or sleep in an individual was not an inclusion criterion, it was assumed that by having visited an osteopath, there would be a certain level of dysfunction in either pain or sleep-related domains. In order to obtain a wider view of the population and their respective pain and sleep situations, the last inclusion criterion was changed to “must have visited a health professional in the last three months” on 14<sup>th</sup> March 2018. The type of pain that was being investigated in this study was not limited to any particular cause, thus any potential participant having pain of any sort was able to participate in this study. Completion of the survey, or part thereof, was taken as implied consent. The study was approved by the Unitec Research Ethics committee (UREC 2017-1075, refer to appendix A) prior to the distribution of the survey link.

An opportunity to enter into the draw to win a \$75 Westfield voucher was offered to all participants; for this purpose, willing participants provided anonymised email address or contact numbers.

## Questionnaire

A composite questionnaire (see Appendix C) was compiled using the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989), the Pain and Sleep Questionnaire (PSQ) (Ayearst et al., 2012), the Health-Related Quality Of Life (HRQOL) index (SF-12v1) (Ware, Kosinski, & Keller, 1996), the World Health Organisation (Five) Well-being Questionnaire (WHO-5) (WHO, 1998) and a Physical Disability Index. In addition, a section inquiring about demographic data, recent physical activity levels and clinical information (information pertaining to intensity of the participant's main pain complaint, the chronicity of the pain complaint, and if the complaint was covered under Accident Compensation Corporation (ACC) was included. In the next section, the purpose for including each of the above instruments and details including their psychometric properties will be discussed in the order of inclusion in the composite questionnaire that was administered.

### Demographic information

Basic demographic questions were administered to garner information on participant's age, gender, ethnicity, employment status, and country of residence (See Appendix C). Employment status was included as the link between socioeconomic factors and sleep (Anders, Breckenkamp, Blettner, Schlehofer & Berg-Beckhoff, 2013; Grandner et al., 2010; Mezick et al., 2008), as well as between socioeconomic factors and pain (Erdek, Finnerup & Loeser, 2013) have been noted by various studies.

### Clinical information

Information pertinent to respondents' clinical presentation was gathered to indicate prior visits to osteopaths or other healthcare providers, Accident Compensation Corporation (ACC) claim status, and bodily area of main pain complaint. A body map was used for participants to select main area(s) of pain from 20 possible areas. Body maps are drawings that include the front, back, and sides of a body, which may be used to specify an area or areas of perceived pain. The usage of body maps has exhibited a high inter-rater reliability ( $r=0.96-1$ ), and have been used widely in research due to their ease of both administration and understanding (Baeyer, Lin, Seidman, Tsao, & Zeltzer, 2011; Margolis, Tait, & Krause, 1986). Items to collect information on chronicity and intensity of pain were also

administered. As per the well-established medical definitions of pain chronicity (King, 2013), chronicity was broken into three time frames: “Less than six weeks”, “Between six weeks and three months”, and “Greater than three months”. Intensity of the pain during the indicated period was measured by a question asking “Generally, how severe has the pain been throughout this time”, participants were provided with a 100-mm Visual Analogue Scale (VAS) to mark the severity out of 10. This approach was in line with previous studies investigating pain severity using a VAS (Hawker, Mian, Kendzerska, & French, 2011). A VAS is a continuous scale comprised of a line, usually 10cm/100mm in length, anchored at each end by two verbal descriptors, one for each symptom extreme for a given question of concept. The point on the line that the participant marks is taken as a number from 0-100 based on how far along the line a mark is drawn, with each mm corresponding to a consecutively higher number.

## Procedures

After the composite questionnaire was collated, a page was created on Facebook called ‘Pain and Sleep Research NZ’ that all posting and interacting was done through. A link to the main survey created on SurveyMonkey was provided on the Facebook page. Prior to starting the survey, participants read through and accepted a Patient Information form explaining the rationale for the survey and the inclusion criteria (see Appendix D). Taking part in the study was taken as informed consent. Pre-study pilot testing suggested that the entire survey would take approximately 15-18 minutes to complete. Five people of various academic backgrounds were asked to fill out the questionnaire and provide feedback where they thought appropriate. No concerns were raised throughout the pilot testing.

## Data Analysis

### Data extraction

Raw data from the composite questionnaire (See appendix E for full questionnaire) was extracted from SurveyMonkey and exported to an Excel spreadsheet with all individual responses. After data processing, described in the following section, the data was imported into statistical software as required; for this study, Statistical Package for the Social Sciences (SPSS), version 25) was used.

### Data processing

The following data processing steps were undertaken in order to allow for meaningful scoring and interpretation of data in the event of incomplete responses. Individual responses were removed if they did not meet the inclusion criteria set out in the Patient Information Sheet at the beginning of the survey, such as if they did not live in New Zealand, were under 18 years old, could not read or write English, or had not seen a health professional in the last three months. 284 respondents initially started the questionnaire, with 136 completing any or all individual questionnaires, comprising the final 136 individuals' responses used for data analysis. If a respondent had completed only part of an individual questionnaire, the rest of their response was kept but the incomplete individual questionnaire was removed. Non-applicable answers to individual items within questionnaires were treated on a case-by-case basis. If a range of numbers was given by the participant for an item (e.g., "amount of time in minutes taken to fall asleep: 15-60"), the mid-point between the two numbers was taken as the average, with the average being used as the individual response to the item for scoring purposes. This particular example would have resulted in an answer of 37.5 minutes. In instances where worded answers were provided, information was parsed at face value. For example, the answer "not long" in response to the question "On average, how long (in minutes) has it taken you to fall asleep each night?" (See Appendix E, Q14), would be interpreted as a short time, therefore falling under the "less than 15 minutes" bracket. If a response was provided as a minimum (e.g., 30+ minutes), this was interpreted as being a number that is under the minimum criteria for being included in the next highest answer bracket. In this example, using the same question as the prior example, applicable answer ranges included 16-30 and 31-60 minutes. Applying this principle, the participant's answer would fall into the 31-60 minute range. After all aberrant questionnaire responses were appropriately cleaned, data analysis was performed.

A fault in the methodology, data processing, and resulting data outcomes was that a non-complete version of the WHODAS 2.0 questionnaire was provided for the SurveyMonkey survey that was distributed to participants. This led to the Physical Disability Index being formed as a proprietary version of the WHODAS 2.0, albeit with no psychometric validity. This impacted the clinical usage of the data pertaining to physical disability in this study. Despite this, it was assumed that due to the similarity

### Pittsburgh Sleep Quality Index - PSQI

The 19 items in the PSQI were extracted from each questionnaire response and scored according to the instructions laid out by Buysse et al.,(1989). The seven components that comprise the Global PSQI score are scored on a 4-point Likert scale from zero to three, with three representing the negative extreme, each component being weighted equally. These seven components were summed to obtain the Global PSQI score, which has a range of zero to 21, with higher scores indicating worse sleep quality (D. Buysse et al., 1989). A Global PSQI score that is over five denotes that the respondent's sleep quality is poor ('poor sleeper'), while a score of five or fewer indicates that the sleep quality of the respondent is good ('good sleeper'). This dichotomy of "good" versus "poor" sleepers was as a result of the psychometric properties of the PSQI: A global PSQI score greater than 5 yielded a diagnostic sensitivity of 89.6% and specificity of 86.5% (kappa = 0.75,  $p$  less than 0.001) in distinguishing good and poor sleepers (D. Buysse et al., 1989). Items that were to be filled out by the participant's roommate/bed partner were removed from the questionnaire in its application here. The rationale supporting this decision was that by removing questions that did not contribute to the global PSQI score, it was more likely that the participant would complete the questionnaire, as there were fewer questions and no other person needed to be involved in order to complete the survey

### Pain Sleep Questionnaire - PSQ-3

The six items that comprise the questionnaire were scored on 100mm visual analogue scales. To score, items one, four and five were extracted and summed to create a PSQ-3 score ranging from zero to 300, with higher scores suggesting a greater interference of pain on the respondents' sleep.

### Health-related quality of life – SF-12v1

The two primary scores (PCS and MCS) were extracted and calculated using the manual scoring instructions within the 'Scoring Instructions for the Expanded Prostate cancer Index Composite Short Form' (Sanda, Wei, & Litwin, 2002). Each question in the SF-12v1 contributes to both PCS and MCS scores, adding and/or taking away from each score dependent on each answer. With PCS and MCS scores being normalised around a U.S. national norm of 50.0, with a standard deviation of 10.0. Higher scores (towards a maximum of 100) indicate a greater level of health, while lower scores (towards a minimum of zero) suggested poorer health. In the general population, scores of 40-49

indicate mild disability, scores of 30-39 indicate moderate disability, and scores below 30 indicate severe disability in quality of life (Mystakidou. et al., 2007). The SF-12v2, as opposed to the older SF-12v1, was intended to be used, but it was only noted after the composite questionnaire was administered over SurveyMonkey that it was the SF-12v1 rather than the SF-12v2. Since both versions measure the same aspects of health and have similar scoring mechanisms, this was not rectified or changed.

### Physical Disability Index

The seven items that made up the disability index were scored on a five-point Likert scale from zero to four, with zero meaning 'none' and four meaning 'extreme or cannot do'. Out of a possible score ranging from zero to 28, high scores indicate a higher level of physical disability. This raw score was then converted into a metric ranging from zero to 100. This scoring was done in conjunction to the World Health Organisation's standards for the WHODAS 2.0 (WHO, 2018).

### Wellbeing – WHO-5

One primary score was calculated from summing the five items that comprise this questionnaire. Each item is scored on a six-point Likert scale. A score of zero on an item meant 'at no time', while a score of five indicates 'all of the time'. The raw score, ranging from zero to 25, was multiplied by four to give the final score of zero to 100. A score of zero represented the worst imaginable well-being, while a score of 100 represented the best imaginable wellbeing (Topp et al., 2015).

### Statistical analysis

IBM SPSS Statistics (v. 25) software was used to analyse data. Initially, data was separated into male and females for analysis. After preliminary analysis between males and females, it was indicated that there were no significant differences between male and female scores in all questionnaires. As a result, data for males and females were pooled for further analyses of variables affecting sleep and pain. Demographic data, clinical data, and questionnaire aggregate scores were explored through basic descriptive analyses of mean, standard deviation, median, and range. All data was screened for assumptions of normality using the Shapiro-Wilk Test and based on those results, parametric or non-parametric inferential tests were used to investigate differences in factors affecting sleep, pain, health-related quality of life, wellbeing, and physical disability. Levene's test was

administered to evaluate equality of variance in Independent Sample T-tests. Mann-Whitney U tests were used to evaluate differences in non-normally distributed variables such as sleep (PSQI and PSQ-3), clinical information (pain chronicity and intensity), and physical disability (Disability Index). Depending on the normality of the data, Pearson's or Spearman's correlation coefficients were calculated to test the relationship between sleep variables (PSQI and PSQ-3), health-related quality of life variables (PCS, MCS), pain variables (duration and intensity of pain), physical disability, and wellbeing (WHO-5). The composite table of all correlation analyses performed can be seen in the Appendix F. The following section will include some of the most relevant results.

## CHAPTER 5 - RESULTS

### Survey response and demographic data of participants

There were a total of 286 responses to the survey via SurveyMonkey. Of the 286 surveys started, 150 did not meet all inclusion criteria and thus were excluded from the study. SurveyMonkey was set to exclude any one who did not present to an osteopathic clinic in the past three months. These questions were set up in the beginning of the survey. As a result, the majority of initial participants were automatically excluded. After reviewing the response rate and upon approval of the original ethics amendment, the inclusion criterion related to osteopaths was changed to requiring participants to have seen any health professional in the past three months to boost participant numbers. This change to including any healthcare professional was considered appropriate to achieve the objective of this study. As a result of automatic exclusion by the webpage builder, it was not possible to include previous questionnaire responses to those who had checked 'no' to having presented to an osteopath in the last three months, but may have been to any healthcare professional in the same time period. Of the 136 remaining, all respondents filled out a minimum of demographic data, clinical data on their pain presentation, and the SF-12v1 questionnaire.

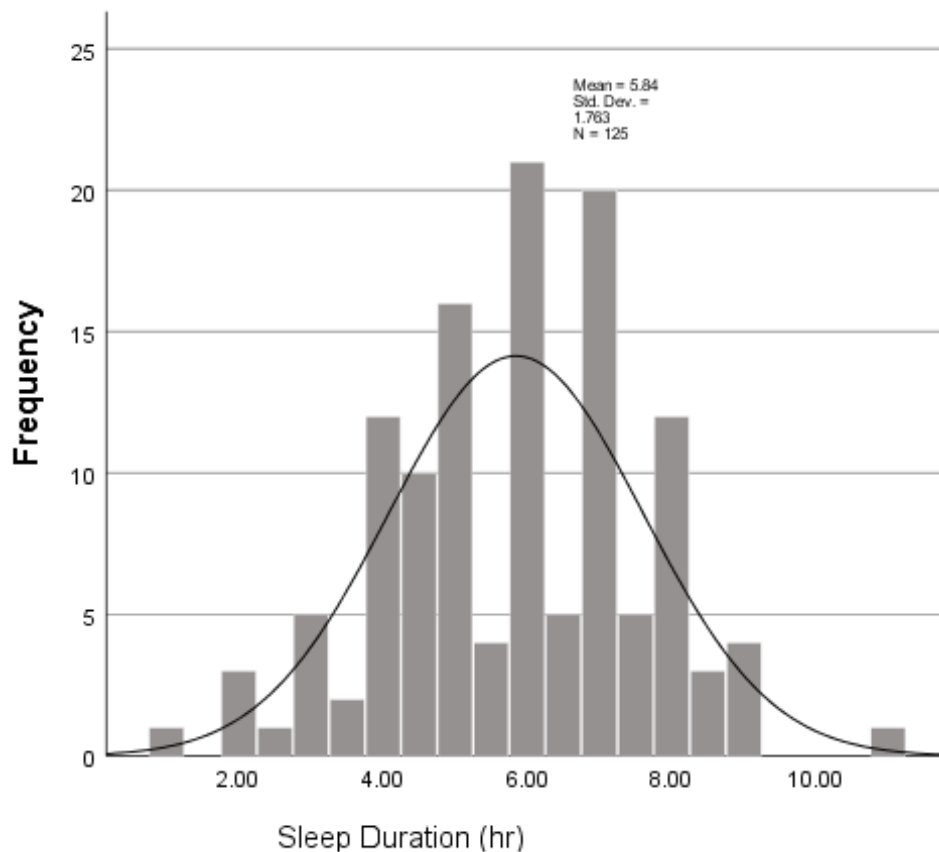
The majority (94%) of respondents in this New Zealand sample were female. The mean age of females was 40.54 years, and that of males 45.50 years. New Zealand European was the most commonly reported ethnicity at 79%, followed by an equal number of Māori and "Other" ethnicities at 6%, followed by British at 4%. The most frequently reported employment status was "employed" (55%). Students made up 18% of the sample, with a similar number of unemployed people (18%) participating in the survey. Retirees made up 9% of the sample, with only one person reporting having never been employed.

The majority of respondents reported pain for more than three months (85%), whilst 7% of respondents reported their pain duration to be less than six weeks. The mean pain intensity for respondents throughout the duration of their complaint was 56/100, with a higher score indicating a higher level of pain. Independent Sample t-Tests and Mann-Whitney U Tests, for parametric and non-parametric data respectively, showed that there were no statistically significant differences between males and females in mean scores of sleep, pain, HRQOL, and disability outcomes ( $t$ -value range -1.404-1.133,  $U$ -value range 339.5-596.0, all  $p$ -values  $>.05$ ). For this reason, all data was pooled for subsequent analyses. Where possible and appropriate, the data on males and females along with the

pooled data is provided in the following sections.

### PSQI Global score and sleep duration

The average sleep duration of respondents was five hours and 50 minutes (SD = 1.76 hours, range from 1-11 hours of sleep per night) (see Figure 1). One hundred and eighteen out of 125 respondents (94%) were classed as ‘poor sleepers’ based on Global PSQI score (Buysse et al., 1989).



**Figure 1.** Histogram representing sleep duration (in hours) as measured by the PSQI of the total sample of the present study. Frequency is equal to the number of people reporting a given duration of sleep.

The overall study population had a mean Global PSQI score of 12.34 with a SD of 4.44 (No significant difference was noted between males and females, see Table 1 for full results). A Global PSQI score greater than five indicates that the respondent has a ‘poor’ sleep quality (Buysse et al., 1989). The higher the score (towards a maximum score of 21), the worse the sleep quality is.

	N	Mean	Standard Deviation	Median	Range (Min-Max)	<i>p</i> -value
Males	7	13.14	4.41	14.00	5-18	.598 <sup>a</sup>
Females	118	12.29	4.46	12.50	2-21	
Overall	125	12.34	4.44	13.00	2-21	

Notes: <sup>a</sup>=*p*-value from Mann-Whitney *U* test, comparing male and female PSQI Global score.

**Table 1.** Sleep quality of respondents as measured by the Global Score of the PSQI Questionnaire

### Interference of pain on sleep as measured by the Pain and Sleep Questionnaire

Respondents in this sample had a mean PSQ-3 score of 128.89 with a SD of 80.82 (no difference in PSQ-3 score was noted between males and females, see Table 2). PSQ-3 scores range from 0-300, with higher scores indicating a larger interference of pain on sleep. On average, respondents experienced a moderate interference on their sleep due to their pain presentation (see Table 2).

	N	Mean	Standard Deviation	Median	Range (Min-Max)	<i>p</i> -value
Males	7	181.43	63.37	205.00	83-250	.488 <sup>a</sup>
Females	115	157.52	81.78	170.00	4-300	
Overall	122	158.89	80.82	171.00	4-300	

Notes: <sup>a</sup>= *p*-value from Mann-Whitney *U* test, comparing male and female PSQ-3 score.

**Table 2.** Interference of pain on sleep as measured by PSQ-3 Questionnaire

## Health-Related Quality of Life – SF-12v1 questionnaire

The respondents in this study had a mean PCS score of 37.27 (SD = 9.78) and a mean MCS score of 39.96 (SD = 10.77, there was no significant difference in PCS or MCS scores between males and females noted, see Table 3). MCS and PCS scores of 50 indicate an average level of health, with scores that tend towards zero suggesting increasingly lower levels of health-related quality of life. That is, respondents in this sample reported mild to moderate disability in both physical and mental aspects of health.

		N	Mean	Standard Deviation	Median	Range (Min-Max)	<i>p</i> -value
PCS	Males	8	32.58	6.90	32.41	21.63-41.82	.163 <sup>a</sup>
	Females	127	37.56	9.88	37.02	11.80-61.85	
	Overall	135	37.27	9.78	36.64	11.80-61.85	
MCS	Males	8	44.14	10.98	46.65	24.74-56.33	.259 <sup>a</sup>
	Females	127	39.70	10.75	38.11	15.28-64.00	
	Overall	135	39.96	10.77	38.23	15.28-64.00	

Notes: <sup>a</sup>= *p*-values from Independent Sample *t*-test, comparing male and female PCS and MCS scores.

**Table 3.** Health-Related Quality of Life scores in males and females as measured by the SF-12v1 Questionnaire.

### Physical Disability

Physical disability levels, as measured through the Physical Disability Index, range between possible scores of 0-100 where higher scores indicate a higher level of physical disability. Respondents in this study had a mean Physical Disability Index score of 28.72 with a SD of 18.99 (no significant difference between males and females was noted in following analysis, see Table 4).

	N	Mean	SD	Median	Range (Min-Max)	<i>p</i> - value
Males	7	31.63	27.00	17.86	7.14-78.57	
Females	111	28.54	18.52	25.00	0.00-78.57	.981 <sup>a</sup>
Overall	118	28.72	18.99	25.0	0.00-78.57	

Notes: <sup>a</sup>= *p*-values from Mann-Whitney *U* Test, comparing male and female physical disability scores

**Table 4.** Physical disability in males and females as measured by the Physical Disability Index Questionnaire.

### Pain chronicity and pain intensity as assessed by PSQ-3

Table 5 and 6 below shows data for the Pain and Sleep Questionnaire, as well as descriptive data for pain intensity and duration for the total sample examined as part of this study. The Pain and Sleep Questionnaire is scored from 0-300, with higher scores indicating higher levels of interference on sleep through pain. Pain intensity was grouped into a ‘high/low’ dichotomy to investigate the overall effect of pain on the Pain and Sleep Questionnaire score in a preliminary manner. A ‘low’ level of pain was considered to be 0-50 on the Visual Analogue Scale (VAS) of pain intensity, with a ‘high’ level of pain indicated by a score of 51-100 on the same scale of pain intensity. There was a significant difference between PSQ-3 scores for those with a ‘low pain intensity’ versus a ‘high pain intensity’ ( $p < .001$ ). This initial grouping of pain intensity was done as a preliminary test of pain intensity on the impact of pain on sleep (Hawker et al., 2011). A Spearman’s rank-order correlation was computed to ascertain the relationship between pain intensity and pain chronicity. No significant correlation was found between pain intensity and pain chronicity ( $p = .138$ , see Appendix F for full correlation results)

	N	Mean	SD	Median	Range (Min-Max)	<i>p</i> -value
PSQ-3	122	158.89	80.82	171.00	0-296	
Low pain intensity	50	33.02	14.53	38.00	0-50	.000 <sup>a</sup>
High pain intensity	86	69.36	12.04	70.00	51-100	

Notes: <sup>a</sup>= *p*-values from Mann-Whitney *U* Test. *P*-value describing distribution of PSQ-3 scores across 'low' and 'high' pain intensity.

**Table 5.** Pain and Sleep Questionnaire score versus pain intensity

Further, a Kruskal-Wallis Test showed a significant difference in PSQ-3 scores between respondents with different pain durations,  $\chi^2(2) = 6.242$ ,  $p = .044$ ). Post-hoc tests confirmed a significant difference in mean PSQ-3 scores between sub-acute (six-weeks to three months) and chronic (more than three months) pain durations, and showed no significant difference between acute (less than six weeks) pain duration and chronic pain duration or between acute and sub-acute pain durations.

	N	Mean	SD	Median	Range (Min-Max)	<i>p</i> -value
<6 weeks	9	152.00	68.5	172.00	42-218	.044 <sup>a</sup>
6 weeks-3 months	5	72.80	63.76	75.00	13-170	
>3 months	103	166.11	80.58	177.00	4-300	

Notes: <sup>a</sup>= *p*-values from Kruskal-Wallis Test, comparing PSQ-3 scores between acute, sub-acute, and chronic pain durations

**Table 6.** Analysis of the impact of pain duration on sleep, as measured by mean PSQ-3 scores

## Differences in health status between good and poor sleepers

Table 7 displays differences in PSQI, PSQ-3, health-related quality of life, physical disability score, WHO-5, and physical activity between ‘good’ and ‘poor’ sleepers. In this sample, there were significant differences in mean scores for PSQI, PSQ-3, MCS, and WHO-5, relating to worse outcomes in each of those measures, between ‘good’ and ‘poor’ sleepers ( $t$ -value range 1.996-2.376,  $U$ -value range 568.0-600.0, all  $p$ -values  $< .05$ , see Table 8 for exact  $p$ -values). There were no significant differences between mean scores for PCS ( $t(122) = 1.092$ ), physical disability ( $U = 394.0$ ), and physical activity ( $U = 315.5$ ) between ‘good’ and ‘poor’ sleepers (all  $p$ -values  $> .05$ , see Table 8 for exact  $p$ -values).

There was no significant difference between the PCS scores of ‘good’ ( $M = 41.89$ ,  $SD = 7.61$ ) and ‘poor’ sleepers ( $M = 36.97$ ,  $SD = 9.93$ );  $t(122) = 1.092$ ,  $p = .277$ . In contrast, the MCS score of ‘good’ sleepers ( $M = 49.44$ ,  $SD = 9.69$ ) did show a significant difference, indicating better health-related quality of life, in comparison to that of ‘poor’ sleepers ( $M = 39.67$ ,  $SD = 19.09$ );  $t(122) = 1.996$ ,  $p = .048$ . The wellbeing score from the WHO-5 questionnaire was also significantly different between ‘good’ ( $M = 61.60$ ,  $SD = 16.64$ ) and ‘poor’ sleepers ( $M = 40.73$ ,  $SD = 19.32$ );  $t(123) = 2.376$ ,  $p = .019$ , suggesting that higher quality sleep and better wellbeing are associated with good sleep. A Spearman’s rank-order correlation was run to determine the relationship between MCS and PSQI scores. There was a moderate, negative correlation between MCS and PSQI scores, which was statistically significant ( $r_s(124) = -.410$ ,  $p = .000$ , see Appendix F for full correlation results), indicating that as MCS score increased, PSQI scores decreased. This implies that as the mental components of an individual’s life improves, this is correlated with an increase in sleep quality.

Measure	Sleep quality	N	Mean	SD	Median	Range (Min-Max)	<i>p</i> -value
PSQI	Good	5	3.40	0.89	4.00	2-4	.000 <sup>a</sup>
	Poor	120	12.71	4.13	13.00	5-21	
PSQ-3	Good	5	18.60	13.18	17.00	4-40	.000 <sup>a</sup>
	Poor	117	164.89	76.96	173.00	8-300	
PCS	Good	5	41.89	7.61	43.99	29.20-49.55	.277 <sup>b</sup>
	Poor	119	36.97	9.93	36.12	11.80-61.85	
MCS	Good	5	49.44	9.69	53.86	34.78-59.50	.048 <sup>b</sup>
	Poor	119	39.67	10.76	38.23	15.28-64.01	
Physical disability	Good	5	16.43	12.01	21.43	3.27-28.57	.135 <sup>a</sup>
	Poor	113	29.27	19.09	25.00	0.00-78.57	
WHO-5	Good	5	61.60	16.64	64.00	36-76	.019 <sup>b</sup>
	Poor	120	40.73	19.32	40.00	0-84	
Physical activity	Good	5	2.80	2.49	2.00	1-7	.841 <sup>a</sup>
	Poor	120	2.79	1.87	2.00	1-7	

Notes: <sup>a</sup>= *p*-values from Mann-Whitney *U* Test. <sup>b</sup>= *p*-value from independent *t*-test.

**Table 7.** Differences in health-related measures between participants reporting good sleep quality and those reporting poor sleep quality

### Differences in measures of health between levels of pain intensity

Table 8 shows the same outcome measures (PSQI, PSQ-3, PCS, MCS, Physical Disability,

WHO-5, and physical activity) as Table 7, but instead differences in health outcomes in pain intensity groups were investigated and analysed via Kruskal-Wallis tests. To provide a higher degree of resolution, the dichotomy of pain intensity was broken up into four groups of 'no pain', 'mild', 'moderate', and 'severe'. 'No pain' referred to intensity scoring less than 5 on the VAS, 'mild' pain was between 5 and 44 on the VAS, 'moderate' pain was between 45 and 74 on the VAS, and 'severe' pain was between 75 and 100 on the VAS scale (Hawker et al., 2011). Sleep was affected by pain intensity as indicated by the significantly higher PSQI global scores ( $\chi^2(3) = 16.53, p = .001$ ) and PSQ-3 scores ( $\chi^2(3) = 18.84, p = <.001$ ), and lower PCS scores ( $\chi^2(3) = 16.22, p = .001$ ) as pain intensity increased, indicating worse outcomes for those health measurements throughout increasingly higher levels of pain. There were no significant differences in mean scores between the pain intensity groups for the MCS ( $\chi^2(3) = .369, p = .947$ ), Physical Disability ( $\chi^2(3) = 5.52, p = .138$ ), WHO-5 ( $\chi^2(3) = 5.87, p = .118$ ), or physical activity ( $\chi^2(3) = 6.38, p = .095$ ).

Bonferroni corrected post-hoc analyses were undertaken to further investigate the overall significant differences shown by the Kruskal-Wallis tests. In PSQI scores, the difference observed between 'mild' and 'moderate' pain was significant ( $p = .033$ ), as well as the difference between 'mild' and 'severe' pain ( $p = .000$ ), with PSQI global scores increasing as pain intensity increased, indicating poorer quality sleep in those with higher levels of pain. All other differences between pain intensity conditions were not significant (all  $ps >.05$ ). PSQ-3 mean scores were significantly higher as pain intensity increased, indicating a higher level of disturbance of sleep by pain. These differences were seen between those with 'no pain' versus 'severe' pain ( $p = .032$ ), 'mild' versus 'moderate' pain ( $p = .018$ ), and 'mild' versus 'severe' pain ( $p = .002$ ). In PCS, lower health-related quality of life, seen as lower PCS scores, was associated with higher pain intensity. This was shown as significant differences between 'mild' and 'severe' pain ( $p = .003$ ), and 'mild' and 'moderate' pain ( $p = .039$ ). A Spearman's rank order correlation was run to elaborate on the relationship between PCS scores and pain intensity. There was a mild, negative correlation between PCS scores and pain intensity, which was statistically significant ( $r_s(135) = -.329, p = .000$ , see Appendix F for full correlation results). This implies that lower PCS scores are correlated with a decrease in pain intensity. There was also a statistically significant, mild, and positive correlation between pain intensity and PSQI score ( $r_s(125) = .380, p = .000$ ), indicating that higher pain intensities were correlated with a decrease in sleep quality as PSQI scores increased.

Measure	Pain intensity	N	Mean	SD	Median	Range (Min-Max)	<i>p</i> -value <sup>a</sup>
PSQI	No pain	4	11.00	1.16	11.00	10-12	.001
	Mild	27	9.81	4.36	10.00	3-20	
	Moderate	64	12.50	4.19	13.50	2-20	
	Severe	30	14.43	4.28	15.00	6-21	
PSQ-3	No pain	4	67.75	39.45	77.50	16-100	.000
	Mild	27	113.70	71.25	103.00	13-255	
	Moderate	61	169.74	78.16	177.00	4-300	
	Severe	30	189.67	75.02	213.50	8-300	
PCS	No pain	4	49.75	15.16	53.53	30.09-61.85	.001
	Mild	31	41.81	9.30	41.86	19.97-60.83	
	Moderate	70	36.24	9.17	35.77	11.80-55.20	
	Severe	30	33.30	8.11	32.82	17.70-52.88	
MCS	No pain	4	38.52	19.25	38.22	15.28-62.35	.947
	Mild	31	39.83	10.37	37.70	21.62-63.71	
	Moderate	70	40.41	10.88	30.31	17.28-64.01	
	Severe	30	39.24	10.17	37.12	24.74-56.89	
Physical disability	No pain	4	16.96	16.33	16.07	0.00-35.71	.138
	Mild	26	23.63	15.32	21.43	3.57-71.43	
	Moderate	59	28.39	17.16	25.00	3.57-78.57	
	Severe	29	39.59	23.78	35.71	0.00-78.57	
WHO-5	No pain	4	57.00	33.21	66.00	12-84	.118

	Mild	31	46.45	16.77	44.00	16-80	
	Moderate	70	40.97	19.33	40.00	0-84	
	Severe	31	36.65	18.74	36.00	4-84	
Physical activity	No pain	4	4.25	1.50	4.00	3-6	.095
	Mild	31	3.48	2.17	3.00	1-7	
	Moderate	70	2.69	1.84	2.00	1-7	
	Severe	31	2.65	1.89	2.00	1-7	

Notes: <sup>a</sup>= *p*-values from Kruskal-Wallis Test

**Table 8.** Differences in health-related measures between participants reporting different levels of pain intensity

### Differences in measures of health between varying pain durations

Table 9 outlines the differences in health outcomes between pain duration groups, including measures of PSQI, PSQ-3, PCS, MCS, Physical Disability, WHO-5, and physical activity. Kruskal-Wallis tests were used to analyse differences in mean scores of the outcomes. There were significantly higher mean scores in the PSQ-3 ( $\chi^2(2) = 6.24, p = .044$ ) and lower PCS scores ( $\chi^2(2) = 11.88, p = .003$ ) between the pain duration groups, indicating worse outcomes for both measures as pain intensity increased. There were non-significant differences in the pain duration groups for the mean scores of PSQI ( $\chi^2(2) = 2.16, p = .339$ ), MCS ( $\chi^2(2) = .303, p = .859$ ), Physical Disability ( $\chi^2(2) = .816, p = .665$ ), WHO-5 ( $\chi^2(2) = 5.25, p = .073$ ), and Physical activity ( $\chi^2(2) = 1.47, p = .481$ ) outcomes.

Bonferroni corrected post-hoc analyses were undertaken to further investigate significant differences shown by the Kruskal-Wallis tests. In the PSQ-3 scores, there was a significant difference between the ‘sub-acute’ and ‘chronic’ ( $p = .043$ ) pain durations. In PCS, there was a significant difference between ‘sub-acute’ and ‘chronic’ pain durations ( $p = .010$ ).

Measure	Pain Duration	N	Mean	SD	Median	Range (Min-Max)	<i>p</i> -value <sup>a</sup>
PSQI	Acute	9	13.00	4.87	12.00	6-20	.339
	Subacute	5	9.20	4.82	8.00	3-15	
	Chronic	106	12.42	4.36	13.00	2-21	
PSQ-3	Acute	9	152.00	68.50	172.00	42-218	.044
	Subacute	5	72.80	63.76	75.00	13-170	
	Chronic	103	166.11	80.58	177.00	4-300	
PCS	Acute	10	41.93	7.71	41.03	29.29-50.86	.003
	Subacute	6	47.47	6.15	50.29	37.92-52.88	
	Chronic	114	35.70	9.23	35.63	11.80-61.53	
MCS	Acute	10	38.90	8.42	37.68	27.11-56.45	.859
	Subacute	6	40.79	9.07	39.61	30.34-54.00	
	Chronic	114	40.58	10.89	39.77	17.28-64.01	
Physical disability	Acute	8	32.59	17.33	32.14	7.14-57.14	.665
	Subacute	5	23.57	10.29	17.86	14.29-39.29	
	Chronic	100	28.64	19.92	25.00	0.00-78.57	
WHO-5	Acute	10	38.80	13.07	38.00	20-64	.073
	Subacute	6	58.67	12.31	56.00	40-76	
	Chronic	115	41.39	19.97	40.00	0-84	
Physical activity	Acute	10	3.10	1.97	2.50	1-7	.481
	Subacute	6	2.33	2.42	1.00	1-7	
	Chronic	115	2.94	1.96	2.00	1-7	

Notes: <sup>a</sup>= *p*-values from Kruskal-Wallis Test

**Table 9.** Differences in health-related measures between participants reporting different pain durations

## CHAPTER 6 – DISCUSSION

This study aimed to further the understanding of the association among sleep, pain, and wellbeing (including both physical and mental components), particularly within the context of a New Zealand population. Given the significant links between sleep, pain, and wellbeing, there is a case for an increased focus on using sleep as a therapeutic target in those with chronic pain or poor quality of life. Existing literature investigating sleep, pain, and quality of life is limited, but has growing academic interest. Within this area, there are only two studies that specifically investigate pain, sleep, and HRQOL in populations within New Zealand (Dillon, 2017; Gibson et al., 2016). The rationale behind this study was thus to extend upon the knowledge and results of current literature of these aspects of health in New Zealand. While international data shows significant relationships between pain, sleep, functional disability, and HRQOL (Luyster, Chasens, Wasko, & Dinbar-Jacob, 2011), few studies have examined this within a New Zealand context. Using the results and recommendations of this study may help to influence New Zealand policies within healthcare such as best practice for dealing with the common comorbidities of chronic pain, namely quality of life changes, negative mental health changes, and sleep problems. Extending the scope of the current research was achieved through adding nuance to the current research, which was primarily limited in Dillon's (2017) research by the population being only from one clinic in New Zealand, and a lack of multivariate data analysis and in Gibson et al.'s (2016) research by the advanced age (79-90) of the population of the respondents in the study. By extending research to include measures of physical disability, and pain intensity, while increasing the potential population to one that may be representative of the New Zealand population and undertaking a series of inferential analyses, it was the long term arm of this thesis that the results will shed more light on the understanding of these associations and help guide future policy or research more closely than data from one clinic in New Zealand. The choice to make the study design a cross-section study was due to the scope of a 90-credit thesis. A long-term longitudinal study design looking at causal relationships could be the next step of a 120-credit thesis or a PhD thesis.

The results of this study show compelling evidence, consistent with the wider literature, that poor sleep quality, higher levels of pain intensity, and longer pain duration are closely linked. In addition, they are also associated with decreases in health-related quality of life and wellbeing status, primarily the physical component. A primary limitation in the data of the current study was the large differences in population sizes for components such as sex, pain duration, and sleep quality. Above 90% of the total sample population were

female, and a similar number suffered from chronic pain and were considered poor sleepers as measured by mean scores of the PSQI. This may have happened because it is likely that those with acute pain may not realise that their sleep or quality of life is being affected. These differences in sub-populations made analysis between these groups (i.e. sex, pain duration, and sleep quality) not feasible. Despite this, the results that were obtained through the study indicated strong evidence for worse health and disability outcomes in poor sleepers in the available population. An extension of this study with more comparable numbers of males and females in New Zealand, as well as a larger total sample size, would provide valuable information in line with international studies on promising therapeutic management strategies revolving around the relationship between sleep, pain, and wellbeing.

### Demographic characteristics of the study population

In the thesis by Haley Dillon (Dillon, 2017), the mean age of females and males were 35 and 38 years respectively, lower than the mean for each sex in this study. New Zealand Europeans (60.9%) comprised most of the total respondents, followed by Māori (11.5), Indian (4.9%), and multiple ethnicities (4.9%). An explanation for the increased proportion of Māori patients in Dillon's study (Dillon, 2017) in comparison to this study may be due to the fact that the osteopathic clinic that surveys were distributed within was a teaching clinic. The easily-accessible location of the clinic, coupled with the comparatively very cheap treatment costs for osteopathic treatment, may attract a higher proportion of patients from lower-socioeconomic backgrounds (Statistics New Zealand, 2013). The sample in this study was not similar to any other population sample investigating the same health outcomes of pain, sleep, HRQOL, and physical disability. This is most likely due to the phenomenon of women being more likely to participate in online surveys, but does not fully explain the vast difference in numbers of males and females.

An important, and significant, difference between the current study and Dillon's thesis (Dillon, 2017) was the discrepancies in the female :male ratio of respondents. In the current study, 94.1% of respondents were female, and 5.9% male. In Dillon's research, 68.8% of respondents were female, which matched closely with the proportion of females that historically presented to the clinic (65%) where the study was set (Dillon, 2017). Literature on survey response rate by sex indicates a strong female dominance in response rates for both traditional and online surveys (Curtin, Presser, & Singer, 2000; Porter & Whitcomb, 2005; W. Smith, 2008). The responses analysed in this online research survey

reflected this tendency: out of 135 total respondents, eight were male (5.9%) and 127 were female (94.1%). This result made investigating differences in health outcomes between men and women not feasible in a majority of cases, due to the significant difference in population sizes. Literature surrounding sleep and pain with regard to sex differences suggest that females are at higher risk for shorter sleep duration, poorer quality of sleep, sleep disturbances, and insomnia (Lo & Lee, 2012). The current study could not comment on this aspect of literature due to large differences in sample size for males and females within the current research project. The increased likelihood of females experiencing poor sleep may also help to explain why there was a higher proportion of women that participated in this study.

The relationship between pain and sleep has been well established over a number of years. A common accompanying complaint in those in pain is sleep disturbance, with up to 88% of those experiencing chronic pain reporting current sleep disturbances (Morin et al., 2006; Michael T Smith & Haythornthwaite, 2004). Fifty percent of those suffering from insomnia, the most common sleep disorder, also report experiencing chronic pain (D. Taylor et al., 2007). Independently, presence of pain and sleep dysfunction are associated with decreases in health-related quality of life, poorer physical and mental health, and increased general mortality (D. Buysse, 2014; Gallicchio & Kalesan, 2016; Leger et al., 2001; Ohayon, 2005; Strine & Chapman, 2005). There is considerable evidence suggesting that the relationship between pain and sleep is bidirectional. Pain appears to enhance arousal and disrupt sleep, and sleep disruption or deprivation increases pain sensitivity and vulnerability to pain (Finan, Goodin, & Smith, 2013; Lautenbacher, Kundermann, & Kreig, 2006; Roehrs & Roth, 2005; Smith & Haythornthwaite, 2004). A vicious cycle of sleep and pain perpetuating and exacerbating symptoms of each other may result when both conditions are present simultaneously (Lautenbacher et al., 2006).

Research has consistently ascertained correlational relationships between sleep and pain, but the direction of causality and mechanisms of the relationship are not fully understood. This was also apparent in this study, with a mild, positive correlation between pain intensity and PSQI scores ( $r_s(125) = .380, p = .000$ ) being calculated via Spearman's rank-order. Despite large differences in group size in a number of important demographic characteristics for this study population, there were statistically significant correlations noted between pain intensity, sleep quality, and HRQOL. In addition to the correlations referenced in the results chapter above, there were a number of other statistically significant correlations found within this study between PCS, MCS, PSQI, PSQ-3, PDI, and WHO-5 scores. Each correlation run was a Spearman's rank-order correlation. A full table of results for all correlations done may be seen in Appendix F.

The most prevalent mechanistic explanation between pain and sleep is that the modulation of pain and sleep-wake regulation share common neurobiological systems, with sleep disruption, particularly slow wave sleep disruption, affecting the descending pain inhibitory control system (Lautenbacher et al., 2006). Examples of studies indicating higher pain levels, higher pain sensitivity, and/or decreased pain tolerance as a result of sleep disruption or dysfunction are well documented in the sleep literature (Davies et al., 2008; Haack et al., 2012; Irwin et al., 2012; Onen et al., 2001; T Roehrs, Hyde, Blaisdell, Greenwald, & Roth, 2006). A number of significant systemic reviews of short (<six hours) and long (>nine hours) sleep of over 5,000,000 people showed significant associations with, and increased relative risk for, health outcomes such as incidents of diabetes mellitus, stroke, cardiovascular disease, coronary heart disease, and obesity (Itani et al., 2016; Jike et al., 2017). Comorbidities such as these, along with mental health conditions, present with their own difficulties and contribute independently to the sleep-pain relationship, often impeding an individual's quality of life.

Musculoskeletal disorders, including painful presentations, are a major contributor to morbidity in the world, and have a strong negative influence on health-related quality of life (WHO Scientific Group, 2003). Early identification of musculoskeletal disorders may have the effect of reducing the burden or impact that the disorders have on an individual's health status and also may reduce the burden on public and private healthcare. There is a dearth of research on musculoskeletal pain and sleep outcomes in those presenting to healthcare clinics seeking treatment within a New Zealand population. Manual therapy practitioners such as osteopaths, physiotherapists, chiropractors, and massage therapists are able to manipulate management techniques to incorporate different health aspects with various therapeutic approaches. This individualised management provides potential steps forward towards early identification and treatment of both sleep dysfunction and pain-related presentations.

### **Influence of sleep quality on pain outcomes**

It is well recorded in literature that those experiencing chronic pain, defined as pain lasting for longer than three months, are highly likely to report sleep problems (Morin, LeBlanc, Daley, Gregoire, & Mérette, 2006; Smith & Haythornthwaite, 2004). Conversely, the majority of those suffering from insomnia report the presence of existing chronic pain (D. Taylor et al., 2007). In the current study there were descriptive differences in sleep quality, as indicated in the mean PSQI global scores between those

suffering from acute pain (duration less than six weeks), subacute pain (duration between six weeks and three months), and chronic pain. However, the differences in scores did not reach statistical significance. A reasonable explanation for this outcome is the discrepancy between sample numbers in each of the groups, with the 'acute' and 'sub-acute' pain duration groups being much smaller sample sizes in comparison to the 'chronic' pain group.

In this study, pain duration of more than three months was associated with poor sleep quality, in accordance to the prevailing research. Additionally, the pain that respondents experienced throughout this duration had a higher impact on their sleep, as indicated in mean PSQ-3 scores. These scores were consistent with and similar to a sample of 103 people with chronic non-cancer-related pain in a study investigating the reliability and validity of the PSQ-3 questionnaire (Ayearst et al., 2012). These findings suggest that irrespective of the cause of the pain, the duration of the pain was found to potentially affect the impact of pain on sleep. While no inference on the effect of pain duration and pain interference on sleep can be made in this sample, the similarity in score to other study populations measuring the same outcomes is encouraging. This outcome also suggests that the sample population in this study may be able to be used as a representative of the impact of chronic pain on sleep, as indicated by PSQ-3 scores.

The mechanisms that mediate the relationship between chronic pain and the effect it has on sleep outcomes are not fully understood. This may be due to the complexity of chronic pain and the comorbidities that are often associated with chronic pain, particularly psychosocial conditions. The most prevalent mechanistic explanation, however, is that sub-optimal sleep behaviour and outcomes result in neurological changes related to the perception of pain. This occurs through the modulation of descending and ascending pain pathways as a function of sleep deficiency, resulting in increased pain sensitivity and decreased pain tolerance (Edwards et al., 2008; Timothy Roehrs & Roth, 2005; Michael T Smith & Haythornthwaite, 2004). Conversely, this mechanism has also been examined through the application of restorative sleep through adding sleep duration either via a nap or by extending nocturnal sleep. In both cases, pain levels and/or pain sensitivity were decreased (Faraut et al., 2015; Simonelli et al., 2019).

Emotional and cognitive factors exert a strong influence on the perception of pain. With up to 75% of those experiencing chronic pain displaying symptoms of depression or anxiety, and a similar percentage of those experiencing depression reporting insomnia symptoms, it is clear that there is a significant interplay between an individual's pain experience, sleep dysfunction, and psychosocial condition (Dahan et al., 2014; Nutt et al.,

2008). Literature reports a high frequency of people suffering from chronic pain, sleep disturbances, or psychosocial condition, while also reporting the presence of at least one of the other two issues. This highlights the need for therapeutic management to incorporate assessment of all three comorbidities (being chronic pain, sleep disturbances, or psychosocial conditions), with applicable treatment or management provided as required. This relationship is observed in this research population regarding the association between pain intensity, sleep outcomes, and mental health outcomes. Respondents considered to have 'poor' quality sleep had a mean MCS score of 39.67, indicating moderate levels of disability to mental wellbeing. Of note, and contrary to current literature that has been discussed immediately prior, in this sample neither pain duration nor pain intensity were statistically significantly correlated to mental health outcomes in the forms of MCS score or wellbeing via the WHO-5 questionnaire. It is likely that this may be a function of the novel population of this study, with little variation in duration of pain or pain intensity in the study group.

In this study, worsening pain intensity was associated with worse sleep quality, as indicated by higher PSQI global scores, suggesting poorer sleep quality as pain levels increase. This is consistent with studies showing a significant but relatively moderate positive relationship between pain intensity and sleep complaints (Sayar, Arikan, & Yontem, 2002; M. T. Smith, Perlis, Smith, Giles, & Carmody, 2000). Pain intensity also had a significant effect on PSQ-3 scores, with higher severities of pain trending towards higher levels of interference of pain on sleep, a finding consistent with research in this subject (Vaughan, Galley, & Kanakarajan, 2018). While the intensity of pain is often the most noticeable manifestation of pain in those that are experiencing pain, other research suggests that it is not the most important factor when investigating the contributions pain has on sleep outcomes. It is suggested that physical function, duration of pain, age, and pre-sleep cognitive arousal are stronger predictors of sleep quality (Menefee et al., 2000; M. T. Smith et al., 2000).

### The effect of health-related quality of life (HRQOL) on sleep and pain outcomes

Existing literature suggests that those that experience both musculoskeletal pain and have sleep difficulties tend to have worse psychological health, including conditions such as depression and decreased emotional function (Harrison, Wilson, Heron, Stannard, & Munafò, 2016). In the current study, there was a large proportion of respondents with pain

conditions lasting for longer than three months that also had sleep problems in at least the last month (88.3%). This may indicate that there is a high likelihood of poor psychological health in a number of the respondents, exacerbating both pain and negative sleep outcomes in this research population.

In the sample population of this research, there were significant decreases in the Mental Component Summary (MCS) scores between good sleepers and poor sleepers, with the lower MCS scores indicating higher disability in mental aspects of health, but no significant difference in Physical Component Summary (PCS) scores between good and poor sleepers. The lack of difference in PCS was not consistent with results from Haley Dillon's thesis (Dillon, 2017) but MCS scores in poor sleepers was similar. This was unexpected, but the variance may be explained by the small number of good sleepers ( $n=5$ ) in comparison to the number of poor sleepers ( $n=120$ ) and the lack of correlation found. As a result, it is difficult to make claims comparing groups where the sample size has a large difference, such as in this study. Future research may benefit from having larger and more comparable population sizes in at least one of the major outcomes being measured to allow comparison between groups.

Despite a lack in statistical significance between groups of good and poor sleepers, it was indicated that health-related quality of life was decreased in the respondents in this study. In the larger group of poor sleepers, both mean PCS and MCS scores in this sample were between 30-39, indicating moderate disability to both the physical and mental components of 'poor' sleepers' health-related quality of life (Mystakidou et al., 2007). Additionally, while there was a statistically significant mild, negative correlation found between PCS and pain intensity ( $r_s(135) = -.329, p = .000$ ), there was no correlation found between MCS score and pain intensity ( $r_s(135) = -.022, p = .800$ ). Correlational results also showed statistically significant, moderate, negative Spearman's rank-orders between PCS and PSQI ( $r_s(124) = -.497, p = .000$ ), as well as MCS and PSQI ( $r_s(124) = -.410, p = .000$ , see Appendix F for full correlation results). These results were promising, though expected, and will help to form a basis of data within New Zealand centring on the increasing amount of data supporting hypotheses of HRQOL, pain, and sleep being correlated to at least a moderate extent.

As a result of analysis between groups not being feasible, the level of disability of participants in this study is consistent with the wider literature that suggests that those suffering from sleep problems tend towards having a compromised mental and physical health status (Strine & Chapman, 2005). As sleep disturbance becomes more severe, the quality of life of an individual also worsens, a trend that has preliminary evidence in this

sample (Katz & McHorney, 2002).

Pain outcomes had a significant negative relationship with PCS scores, compared to the non-significant relationship with MCS scores. As pain intensity increased, PCS scores decreased, indicating moderate disability. In MCS scores, as pain intensity from 'no pain' to 'severe pain' increased, the scores stayed consistent within 1.5 points of 40. On the basis of strict cut off points for HRQOL outcomes, an MCS score of 39.24 in those with severe pain is also deemed moderate disability. No causality or relationship can be inferred from this outcome, outside of observing that given the high frequency of those experiencing chronic pain and a poor sleep quality in this sample, MCS scores in this research sample tend to indicate a mild-moderate level of disability (Mystakidou et al., 2007). These findings were not consistently in keeping with current literature, which indicates that as pain intensity increases, there is a significant decrease in HRQOL, as seen in reduced mean scores of the PCS and MCS within the SF-12v1 (Bindawas, Vennu, Alfadel, Al-otaibi, & Binnasser, 2018; Pang et al., 2015)

A similar pattern was observed in HRQOL scores between participants reporting different pain duration, the other pain outcome investigated in this study. As pain duration increased, PCS scores significantly decreased, tending towards higher levels of disability, while MCS scores were consistent within 1.1 points of 40 as pain duration increased. Reportable inference is again not feasible due to the cross-sectional nature of the data, and the vast majority of participants reporting suffering from chronic pain. Everyday pain, severe pain, and more than three years since the last episode without pain are strong contributing factors to lower HRQOL scores (Ludwig, Luthy, Allaz, Herrmann, & Cedraschi, 2017). In this sample, consisting mainly of individuals with chronic moderate-high intensity pain, the presence of moderate disability towards HRQOL was found as expected, given the risk factors and contributors to decreased HRQOL.

Physical disability was not significantly associated with sleep quality, pain intensity, or pain duration. While this may be a legitimate finding, it is contrary to existing literature. A more reasonable explanation is that the measure used was unable to capture the respondents' physical disability levels accurately due to the measure not having any previously studied psychometric validity, thus the sensitivity and specificity are not known. The limitation of large differences in sample size for sex, sleep quality, and pain duration may also have contributed to a lack of significant differences in physical disability levels. Future research investigating physical disability in a similar study should aim to provide a sufficiently validated study and consider a case-control methodology to

enable the investigation or studying of these associations appropriately. Wellness, as measured by the WHO-5 questionnaire, was significantly decreased, indicating a lower level of wellness, in those with poor sleep quality compared to those with good sleep quality. Similar to other analysis, despite a significant difference being found, the large difference in sample size obfuscates this finding, as there is a high likelihood of the statistical difference being due to chance. As mentioned previously, this may be remedied in future research by ensuring there is a control population, to allow for clearer understanding of any association found between outcomes such as pain or sleep-related outcomes.

### Future research and implications for healthcare modalities

Despite only preliminary evidence around the efficacy of an intervention focusing on improving sleep outcomes as part of a management or treatment approach for chronic pain, there are strong links to higher levels of HRQOL, as measured by tools such as the SF-12v1 used in this study. These links are consistent over multi-year long time frames when refreshing/good quality sleep is obtained by individuals (Arvidsson et al., 2008). Though this study can add no commentary on intervention-based research, it provides evidence that those presenting to healthcare clinics who are in chronic pain also have combined issues with sleep and wellbeing. Considering the bidirectional relationships between these aspects of health, this supports the need for future research which may trial sleep-related interventions to help people affected by chronic pain live well.

There are three main future paths of research that are implicated from the results of the current study and existing research: mechanistic/causal research, professional knowledge, and public awareness.

Despite the well-established associations between pain, sleep, and quality of life, there is significantly less literature on longitudinal data in the same area of research. Undertaking longitudinal research will be instrumental in understanding the causal relationship between pain, sleep, and quality of life. The common mechanisms between these aspects of health may be further elucidated if a particular intervention is implemented, such as targeting an improvement of sleep in a given population over a period of time. There are a number of different approaches or interventions that may improve sleep that may likely be complex or person-centred, tailored programmes outside of a clinical or study-related setting. Some of these approaches may include exercise, sleep hygiene manipulation,

medication or remedies, or sleep restriction therapy, as examples. Using objective measures of sleep such as polysomnography (PSG) or actigraphy should also be a part of future intervention-type studies, as there are a number of components of insomnia, quality of life, and sleep health that are perception based. By objectifying the measurements, there is a strong possibility data with a higher validity will be obtained, thereby improving the usefulness of the data for clinical or policy-related purposes. Despite objective measurement of sleep being significantly better than subjective measurement, there are limitations in this approach for studies such as this current one. Objective measurement tools for sleep are expensive and often require specialised settings in order to properly and practically use the. Additional drawbacks of objective measures such as PSG may include difficulty in targeting or assessing participants from distant locations due to the specific tools required, and potential decreases in ecological validity of sleep. Participants enrolling in studies requiring them to be connected to a PSG machine may have different or non- “normal” sleeping patterns due to the number of wires connected to them and a different sleep setup or routine than they may have been previously doing.

As discussed previously in this study, there is a significant scarcity in worldwide literature pertaining to the knowledge that healthcare practitioners have about sleep as a therapeutic target of public health. Future research in the area of identifying the knowledge, awareness, and understanding of healthcare practitioners have regarding sleep and its utilisation within healthcare practices is an important precursor to providing sleep as a therapeutic target. By identifying potential gaps in knowledge or understanding of sleep health in those that are in a position to educate or provide intervention to patients, future guidelines may be more comprehensively developed for the application of sleep as a general or individual target in the management of patients’ health.

Future research on public awareness of sleep as a modifiable determinant of health will also assist in the development of future public health guidelines. By investigating awareness in both a professional and public capacity, gaps in current public health guidelines or information dissemination strategies can be identified.

In a more generalised manner, progression from this research in New Zealand may also include a larger population of people, a more comparable population of males, and/or a case-control approach matching those with pain or sleep disturbances to those without. Population-based improvements are also significantly indicated in future studies. This is because the present study is limited in its generalisability due to being largely comprised of a sample of females with chronic pain. Each of these suggestions or improvements in future research would allow results to be more accurate to the wider New Zealand

populace, and be useful to policy advisors when referencing best practice for dealing with not only experiences of pain, but also sleep dysfunction and psychosocial health. Recent strategic planning from the New Zealand Ministry of Health indicates that a priority of healthcare within New Zealand is the prevention and management of long term conditions (New Zealand Ministry of Health, 2017). With literature in this thesis outlining sleep as a modifiable factor that contributes to most chronic disorders mentioned in the report by the New Zealand Ministry of Health, it is clear that improving sleep health will contribute to achieving this objective. The intimate links that pain, sleep, and mental health have in common, as outlined here and in the literature review, may help provide context to the complex and often difficult nature of treating a variety of health issues. Though QALYs were not utilised in the current study, future research into sleep as a therapeutic target may also choose to include QALYs as a preliminary indicator for the utility of targeted sleep intervention in order to potentially assist in the contextualisation of the treatment of pain and its outcomes.

Osteopaths are in a favourable position to be a part of this research, whether the mode of research is through applying treatment based on existing guidelines and monitoring progress, or through extending prospective research in this area. Being a profession that has strong roots in holistic practices, there is significant potential for osteopaths to be successful in integrating sleep health interventions into a patient's management plan. However, the extent of the knowledge and clinical aptitude of osteopaths is unknown and should be investigated further. Research around sleep being used as an intervention target among manual-based therapists is scarce. Studies such as the current research project, and Haley Dillon's (Dillon, 2017) are important to create a foundation for further investigations both globally and specific to New Zealand.

## Limitations

There were a number of limitations in this study, excluding the limitations in sex-related analysis mentioned above. Firstly, as a result of the cross-sectional nature of the survey, correlation between cause and effect could not be determined. Secondly, due to the survey being solely comprised of self-report questionnaires, there is a high likelihood of biases, whether they be conscious or unconscious, being introduced into answers. There are a number of reasons that participants may offer biased responses to a survey, ranging from not properly understanding what a measure is to social-desirability bias, where a participant may want their answer to look favourable to the eyes of a researcher, even if the responses are anonymous (Rosenman, Tennekoon, & Hill, 2011). Self-report

questionnaires such as the PSQI are limited due to their subjective nature. More objective measurements of sleep in the form of polysomnography or actigraphy could not feasibly be obtained in this study, but may be indicated for future studies.

Thirdly, there were only five respondents out of the 125 that completed the PSQI questionnaire that had PSQI global scores indicating they were ‘good’ sleepers (PSQI global score less than or equal to five). This made analysis between ‘good’ and ‘poor’ sleepers unlikely to be completely accurate due to the highly unbalanced sample sizes between the two sleep quality groups. This finding was parallel to groupings for sex (heavy predominance of women in the current study), and those in chronic pain (vast majority of those suffering from chronic pain in this study). Finally, a psychometric component of the physical disability questionnaire was missing, which was realised at the time of distribution of the composite questionnaire. This resulted in providing a measurement that was unable to be validated nor proven to be an effective measurement of physical disability.

## Conclusion

Despite the vast differences in sample size for sex, sleep quality, and pain duration, important conclusions were able to be drawn within this sample population. Generally, the results in this current study were consistent or similar to existing literature, particularly that of Haley Dillon’s research (Dillon, 2017). Higher pain intensity and chronic pain duration related closely to health-related quality of life. Physical health outcomes were particularly indicated in this association, with higher levels of pain intensity and longer pain duration relating to higher levels of physical disability as measured by the PCS score from the SF-12v1, rather than the Physical Disability Index. Higher pain intensity tended towards lower levels of sleep quality, and respondents with chronic pain were overwhelmingly considered to be ‘poor’ quality sleepers. Those that were considered to be ‘poor’ sleepers had lower levels of wellbeing, higher levels of disability affecting mental aspects of health, and had more interference of pain on their sleep. As a result, the outcomes discussed in this thesis have the ability to assist policy makers in New Zealand to prevent disease and promote wellbeing. This can be achieved through expanding knowledge on best practice approaches to treating pain, sleep disorders, and factors relating to quality of life.

There was some limitation in the ability to interpret and infer from the data obtained in

this study due to the large differences in sample size between sexes, sleep quality groups, and different pain durations. As a result, the findings in this study mainly provide insight into a population of female New Zealanders with poor sleep quality and moderate to high levels of pain intensity that has been present for more than three months. Through this lens, our results show strong evidence that poor sleep quality, higher levels of pain intensity, and longer pain duration are associated with a decrease in health-related quality of life and wellbeing status, primarily the physical component. As sleep quality decreases, pain intensity increases, and the duration of pain extends, lower levels of quality of life and wellbeing are experienced. Further research is needed primarily in the form of longitudinal research and utilising a case-control methodology, in order to more closely ascertain and elucidate the causational relationships between these aspects of health. Findings from this study and similar studies, using both New Zealand and international population samples, would be beneficial for patients and practitioners alike, providing better health outcomes by treating each pain or sleep condition more wholly. This could be achieved through supplementary education on sleep health and the clinical skills required to provide appropriate intervention on sleep. Pain is the most common complaint of those presenting to healthcare providers such as manual therapy practitioners including osteopaths, physiotherapists, chiropractors, and massage therapists. These professions have a great potential to improve outcomes in those with pain by employing a more holistic approach in their management of patients, such as providing extra support for mental health, or including sleep education or improvement in the management plans. Despite inherent limitations in the survey application and methodology of this study, the reciprocal nature between pain and sleep highlights the need to be more aware of managing sleep as a useful tool in the treatment of pain, particularly that of a chronic nature.

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# APPENDICES

## Appendix A: Ethics Approval

**From:** [fraser.roberts](mailto:fraser.roberts)  
**To:** [Sylvia Hach](mailto:Sylvia.Hach@unitec.ac.nz); [Shamim Shaikh](mailto:Shamim.Shaikh@unitec.ac.nz)  
**Subject:** Fwd: Ethics Application 2017-1075 Roberts  
**Date:** Tuesday, 24 October 2017 12:07:48 PM

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----- Forwarded message -----

**From:** Nigel Adams <[nadams@unitec.ac.nz](mailto:nadams@unitec.ac.nz)>  
**Date:** Fri, Oct 20, 2017 at 2:51 PM  
**Subject:** Ethics Application 2017-1075 Roberts  
**To:** Fraser Roberts <[fraser.roberts123@gmail.com](mailto:fraser.roberts123@gmail.com)>  
**Cc:** Asher Lewis <[alewis@unitec.ac.nz](mailto:alewis@unitec.ac.nz)>, Unitec Research Ethics Committee <[ethics@unitec.ac.nz](mailto:ethics@unitec.ac.nz)>

Dear Fraser

**Ethics application number: 2017-1075**

Thank you for completing and submitting the amendments requested. As Primary Reader of your application and under delegated authority from the Unitec Research Ethics Committee (UREC) I now authorise you to begin your research.

Please note, if you have not yet done so at the time of receiving this advice; please email one copy of your final amended ethics application and any additional documents to the UREC secretary at: [ethics@unitec.ac.nz](mailto:ethics@unitec.ac.nz).

You will receive a formal letter of approval from UREC in due course.

The dates that must be referred to on the Information Sheet AND Consent Forms given to all participants and appear on your documents are as follows:

Start date: 01 November 2017

Finish date: 31 December 2018

Please note, you must inform UREC, in advance of any ethically-relevant modification in the project as this may require additional approval.

Best wishes for your project.

Signed,

(Name of PR)

Nigel Adams



## Appendix B: Facebook and LinkedIn post



**Pain and Sleep Research NZ**

8 February 2018 · 🌐



Hi all,

I am an Osteopathy student studying in Auckland doing my Master's research project on the relationship between pain, sleep, and daily functioning (emotional, psychological, physical etc.) The results of this questionnaire will be used to inform various healthcare modalities about the usefulness of sleep as a therapeutic target when treating musculoskeletal pain.

The survey should take about 15 minutes to complete, and by completing it you are in the draw to win a 75\$ Westfield voucher. Please let me know if you have any questions

<https://www.surveymonkey.com/r/pain-sleep>



SURVEYMONKEY.COM


**Effects of sleep on pain, quality of life, and physical function Survey**

Web survey powered by SurveyMonkey.com.

Create your own online survey now with SurveyMonkey's expert certified FREE...



Appendix C: Poster



**IN PAIN?**

**CAN'T SLEEP?**

**WE CARE!**

**BE IN TO WIN \$75!**

Consider filling out a ~15 minute survey about musculoskeletal pain, sleep, and daily functioning (physical, emotional, psychological etc.). To participate, you must be 18+ and have been to a health professional in the past 3 months  
Complete the survey at [www.surveymonkey.com/r/pain-sleep](http://www.surveymonkey.com/r/pain-sleep)

By participating in this research, you will be contributing to a growing body of research helping educate healthcare professionals on how to best treat patients with pain and/or sleeping problems. Any participation is highly appreciated and very useful.

UREC REGISTRATION NUMBER - 2017-1075

This study has been approved by the UNITEC Research Ethics Committee from (01/11/2017) to (31/12/2018). If you have any complaints or reservations about the ethical conduct of this research, you may contact the Committee through the UREC Secretary (ph: 09 815-4321 ext 8551). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

<a href="http://www.surveymonkey.com/r/pain-sleep">www.surveymonkey.com/r/pain-sleep</a>   Fraser - 021 079 4825 <a href="http://www.surveymonkey.com/r/pain-sleep">www.surveymonkey.com/r/pain-sleep</a>   Fraser - 021 079 4825	<a href="http://www.surveymonkey.com/r/pain-sleep">www.surveymonkey.com/r/pain-sleep</a>   Fraser - 021 079 4825	<a href="http://www.surveymonkey.com/r/pain-sleep">www.surveymonkey.com/r/pain-sleep</a>   Fraser - 021 079 4825	<a href="http://www.surveymonkey.com/r/pain-sleep">www.surveymonkey.com/r/pain-sleep</a>   Fraser - 021 079 4825	<a href="http://www.surveymonkey.com/r/pain-sleep">www.surveymonkey.com/r/pain-sleep</a>   Fraser - 021 079 4825	<a href="http://www.surveymonkey.com/r/pain-sleep">www.surveymonkey.com/r/pain-sleep</a>   Fraser - 021 079 4825	<a href="http://www.surveymonkey.com/r/pain-sleep">www.surveymonkey.com/r/pain-sleep</a>   Fraser - 021 079 4825	<a href="http://www.surveymonkey.com/r/pain-sleep">www.surveymonkey.com/r/pain-sleep</a>   Fraser - 021 079 4825	<a href="http://www.surveymonkey.com/r/pain-sleep">www.surveymonkey.com/r/pain-sleep</a>   Fraser - 021 079 4825	<a href="http://www.surveymonkey.com/r/pain-sleep">www.surveymonkey.com/r/pain-sleep</a>   Fraser - 021 079 4825
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## Appendix D: Patient Information Sheet

You are invited to participate in a research project conducted as a part of the Masters of Osteopathy program at the Unitec Institute of Technology, Auckland, New Zealand.

Project: The associations between pain, sleep, health-related quality of life, and disability in people presenting with musculoskeletal pain to osteopathic clinics in New Zealand.

Who are the researchers?

My name is Fraser Roberts and I am currently completing my Master of Osteopathy degree at Unitec, New Zealand.

My supervisors are Drs Shamim Shaikh and Sylvia Hach, who are biomedical and/or health researchers and lecturers within the Healthcare Pathway at Unitec New Zealand.

The aim of this research:

We are interested in investigating the relationship between sleep and musculoskeletal pain, and the effect they have on physical functions and mental wellbeing. This functioning will be measured using health-related quality of life and disability measures. To do this, those that have been to an osteopath in the last three months prior to participating in this study will be invited to complete a one-off questionnaire. There are no right or wrong answers to any of the questions within the questionnaire.

This area of research is important to help improve the osteopathic profession's understanding of potential and appropriate ways to investigate, treat and manage pain. This may also contribute to improve outcomes for patients.

What it will mean for you:

If you choose to participate, you will be asked questions about sleep, pain and symptoms you may be experiencing, and your quality of life. The entirety of the questionnaire should take 15 minutes or less to complete. Your responses to the questions will be anonymous and no details that personally identify you will be collected unless you decide to enter the draw to win a \$75 Westfield voucher, in which case we will only require a phone number or email address (anonymous or unidentifiable email address), collected at the end of the survey.

Completing and returning this questionnaire is interpreted as implied consent. If you do not wish to participate in this study, please quit the webpage.

Who may participate?

- Anyone over 18 years old
- Anyone who can read and write English
- Those who live in New Zealand
- Those that have visited a health professional in the last three months

What we do with the data and results and how we protect your privacy:

Information and results from the questionnaire will be used in the development of my master's thesis. We intend to make the results from this thesis available to scientific and professional communities through publishing in a scientific journal and/or presenting findings at a conference or an osteopathic educational institute. The only people who will have access to your responses will be you, my supervisors, and myself as the primary researcher.

Thank you for considering participating in my research project. This study has been approved by Unitec's Ethics Committee (2017-1075)

Research Start date: 01 November 2017

Finish date: 31 December 2018

Please contact us if you have any questions or concerns

## Appendix E: Composite questionnaire

By completing this form you consent for the information provided to be used for research

No identifying information will be collected\*

\*If you would like to go into the draw to win a \$75 voucher, you will be asked to provide contact details in the form of a contact number or email address.

Please contact the researcher Fraser Roberts on 021 079 4825 or email [fraser.roberts123@gmail.com](mailto:fraser.roberts123@gmail.com) if you require further clarification

After reading each question, tick or select the answer that best describes your situation. The order of the answers varies between the questions, so take a moment to read each question carefully. We know that sometimes answers may not describe you exactly, so please pick the answer that *most closely describes you*.

**Q1. Date of Birth:** \_\_\_\_\_ **Gender:**  Male  Female

**Q2. Which ethnic group do you belong to? (Mark the space or spaces which apply to you)**

- NZ European  Maori  Samoan  Cook Island Maori  Tongan
- Niuean  Chinese  Indian
- Other (such as Dutch, Japanese, Tokelauan). Please state:

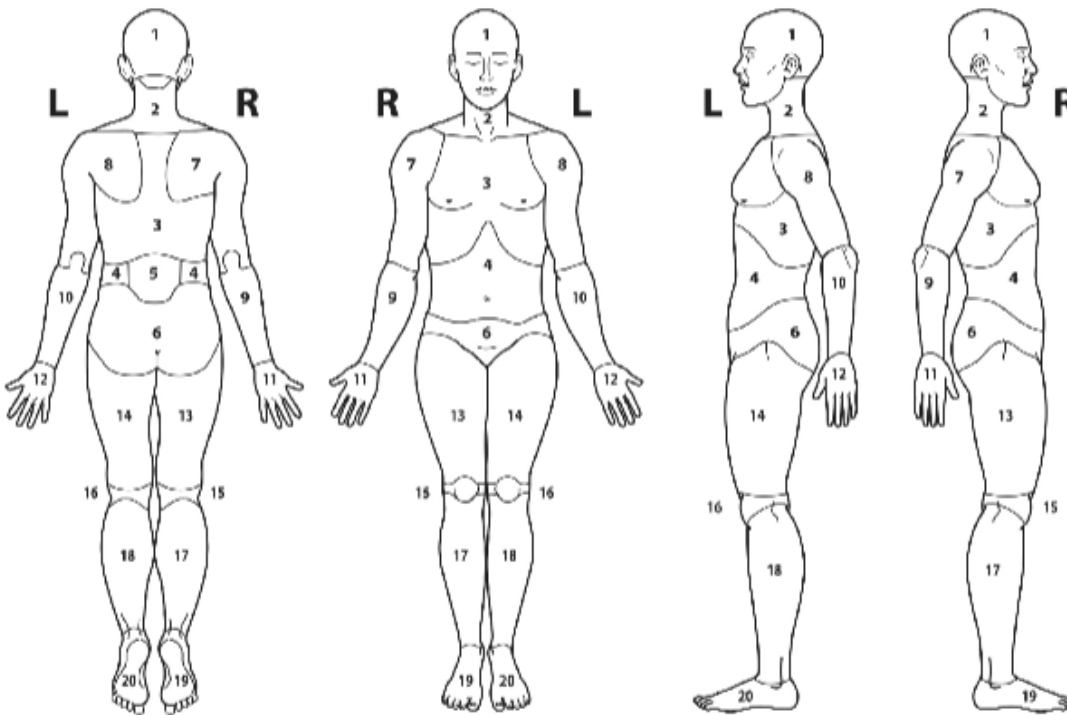
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**Q3. What is your employment status?**

- Employed  Unemployed  Retired  Never employed
- Student (not currently working)  Student (employed part-time or casual)

Q4. Have you been to an osteopath in the past three months?  Yes  No

Q5. Year you first came to an osteopathic clinic? (best estimate) \_\_\_\_\_



Q6. Shade the area of your main complaint

Q7. How long have you had your current pain problem?

- Less than 6 weeks       Between 6 weeks – 3 months       Greater than 3 months  
 Not applicable

Q8. Generally, how severe has the pain been throughout

0 ————— 100  
VAS (mm)

**this time?**

[Not at all]

[The worst pain imaginable]

**Q9. Throughout the time you have had this problem, has the severity of the pain (how much it affects your daily life)...**

Improved     Stayed the same     Got worse

Q10. Is your treatment an ACC claim?

Yes     No

Q11. Please indicate for each of the five statements which is closest to how you have been feeling over the last two weeks. Notice that higher numbers mean better well-being.

Example: If you have felt cheerful and in good spirits more than half of the time during the last two weeks, please tick or select the box with the number 3.

		All of the time	Most of the time	More than half of the time	Less than half of the time	Some of the time	At no time
1	I have felt cheerful and in good spirits	5	4	3	2	1	0
2	I have felt calm and relaxed	5	4	3	2	1	0
3	I have felt active and vigorous	5	4	3	2	1	0
4	I woke up feeling fresh and rested	5	4	3	2	1	0
5	My daily life has been filled with things that interest me	5	4	3	2	1	0

Q12. Answer every question by placing a check mark on the line in front of the appropriate answer. If you are unsure about how to answer a question, please give the best answer you can and make a written comment beside your answer.

1. In general, would you say your health is:

\_\_\_\_\_ Excellent

\_\_\_\_\_ Very Good

\_\_\_\_\_ Good

\_\_\_\_\_ Fair

\_\_\_\_\_ Poor

Additional comments below (optional):

The following two questions are about activities you might do during a typical day. Does YOUR HEALTH NOW LIMIT YOU in these activities? If so, how much?

2. MODERATE ACTIVITIES, such as moving a table, pushing a vacuum cleaner, bowling, or playing

golf:

\_\_\_\_\_ Yes, Limited A Lot

\_\_\_\_\_ Yes, Limited A Little

\_\_\_\_\_ No, Not Limited At All

3. Climbing SEVERAL flights of stairs:

\_\_\_\_\_ Yes, Limited A Lot

\_\_\_\_\_ Yes, Limited A Little

\_\_\_\_\_ No, Not Limited At All

During the PAST 4 WEEKS have you had any of the following problems with your work or other regular activities AS A RESULT OF YOUR PHYSICAL HEALTH?

4. ACCOMPLISHED LESS than you would like:

\_\_\_\_\_ Yes

\_\_\_\_\_ No

5. Were limited in the KIND of work or other activities:

\_\_\_\_\_ Yes

\_\_\_\_\_ No

During the PAST 4 WEEKS, were you limited in the kind of work you do or other regular activities AS A RESULT OF ANY EMOTIONAL PROBLEMS (such as feeling depressed or anxious)?

6. ACCOMPLISHED LESS than you would like:

\_\_\_\_\_ Yes

\_\_\_\_\_ No

7. Didn't do work or other activities as CAREFULLY as usual:

\_\_\_\_\_ Yes

\_\_\_\_\_ No

8. During the PAST 4 WEEKS, how much did PAIN interfere with your normal work (including both work outside the home and housework)?

\_\_\_\_\_ Not At All

\_\_\_\_\_ A Little Bit

\_\_\_\_\_ Moderately

\_\_\_\_\_ Quite A Bit

\_\_\_\_\_ Extremely

The next three questions are about how you feel and how things have been DURING THE PAST 4 WEEKS. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the PAST 4 WEEKS –

9. Have you felt calm and peaceful?

\_\_\_\_\_ All of the Time

\_\_\_\_\_ Most of the Time

\_\_\_\_\_ A Good Bit of the Time

\_\_\_\_\_ Some of the Time

\_\_\_\_\_ A Little of the Time

\_\_\_\_\_ None of the Time

10. Did you have a lot of energy?

\_\_\_\_\_ All of the Time

\_\_\_\_\_ Most of the Time

\_\_\_\_\_ A Good Bit of the Time

\_\_\_\_\_ Some of the Time

\_\_\_\_\_ A Little of the Time

\_\_\_\_\_ None of the Time

11. Have you felt downhearted and blue?

\_\_\_\_\_ All of the Time

\_\_\_\_\_ Most of the Time

\_\_\_\_\_ A Good Bit of the Time

\_\_\_\_\_ Some of the Time

\_\_\_\_\_ A Little of the Time

\_\_\_\_\_ None of the Time

12. During the PAST 4 WEEKS, how much of the time has your PHYSICAL HEALTH OR EMOTIONAL PROBLEMS interfered with your social activities (like visiting with friends, relatives, etc.)?

\_\_\_\_\_ All of the Time

\_\_\_\_\_ Most of the Time

\_\_\_\_\_ A Good Bit of the Time

\_\_\_\_\_ Some of the Time

\_\_\_\_\_ A Little of the Time

\_\_\_\_\_ None of the Time

Q13. In the past week, on how many days have you done a total of 30 min or more of physical activity, which was enough to raise your breathing rate? (This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that may be part of your job)

\_\_\_\_\_ 1 day

\_\_\_\_\_ 2 days

\_\_\_\_\_ 3 days

\_\_\_\_\_ 4 days

\_\_\_\_\_ 5 days

\_\_\_\_\_ 6 days

\_\_\_\_\_ 7 days

Q14. The Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions. During the past month,

1. When have you usually gone to bed? \_\_\_\_\_
2. On average, how long (in minutes) has it taken you to fall asleep each night?  
\_\_\_\_\_
3. When have you usually gotten up in the morning? \_\_\_\_\_
4. How many hours of actual sleep do you get at night? (This may be different than the number of hours you spend in bed) \_\_\_\_\_

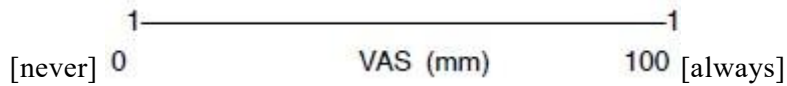
5. During the past month, how often have you had trouble sleeping because you...	Not during the past month (0)	Less than once a week (1)	Once or twice a week (2)	Three or more times week (3)
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the night or early morning				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				

h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe, including how often you have had trouble sleeping because of this reason(s):				
6. During the past month, how often have you taken medicine (prescribed or “over the counter”) to help you sleep?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?				
	Very good (0)	Fairly good (1)	Fairly bad (2)	Very bad (3)
9. During the past month, how would you rate your sleep quality overall?				

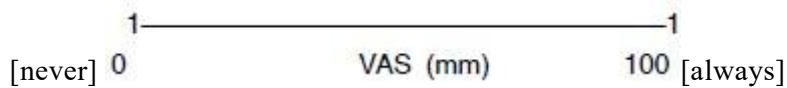
Q15. The Pain and Sleep Questionnaire

Please place a line perpendicular to the VAS line at the point that best represents your answer.

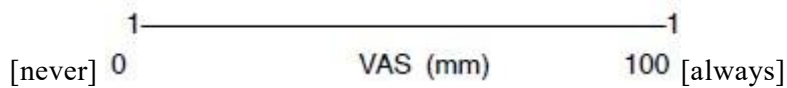
1) How often do you have trouble falling asleep?



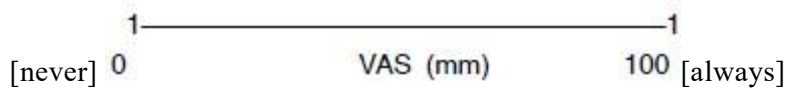
2) How often do you need pain medication to fall asleep?



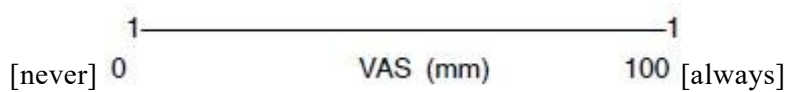
3) How often do you need sleeping medication to fall asleep?



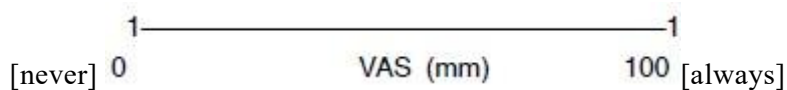
4) How often are you awakened by pain during the night?



5) How often are you awakened by pain in the morning?



6) How often is your partner is awakened?



Q 16. Physical Disability Index

In the past 30 days, how much difficulty did you have in:						
S6	<u>Concentrating</u> on doing something for <u>ten minutes</u> ?	None	Mild	Moderate	Severe	Extreme or cannot do
S7	<u>Walking a long distance</u> such as a <u>kilometre</u> [or equivalent]?	None	Mild	Moderate	Severe	Extreme or cannot do
S8	<u>Washing your whole body</u> ?	None	Mild	Moderate	Severe	Extreme or cannot do
S9	Getting <u>dressed</u> ?	None	Mild	Moderate	Severe	Extreme or cannot do
S10	<u>Dealing</u> with people <u>you do not know</u> ?	None	Mild	Moderate	Severe	Extreme or cannot do
S11	<u>Maintaining a friendship</u> ?	None	Mild	Moderate	Severe	Extreme or cannot do
S12	Your day-to-day <u>work</u> ?	None	Mild	Moderate	Severe	Extreme or cannot do

H1	Overall, in the past 30 days, <u>how many days</u> were these difficulties present?	<b>Record number of days</b> ____
H2	In the past 30 days, for how many days were you <u>totally unable</u> to carry out your usual activities or work because of any health condition?	<b>Record number of days</b> ____
H3	In the past 30 days, not counting the days that you were totally unable, for how many days did you <u>cut back</u> or <u>reduce</u> your usual activities or work because of any health condition?	<b>Record number of days</b> ____

## Appendix F: Composite correlation table

	Pain Severity	Pain duration	PCS	MCS	PSQI	PSQ-3	PDI	WHO-5
Pain Severity		$r_s(131) = .130$ $p = .138$	$r_s(135) = -.329$ $p = .000$	$r_s(125) = .380$ $p = .000$	$r_s(135) = -.022$ $p = .800$	*DNC	*DNC	*DNC
Pain duration	$r_s(131) = .130$ $p = .138$		*DNC	*DNC	C	*DNC	*DNC	*DNC
PCS	$r_s(135) = -.329$ $p = .000$	*DNC		*DNC	$r_s(124) = -.497$ $p = .000$	$r_s(121) = -.569$ $p = .000$	$r_s(117) = -.595$ $p = .000$	*DNC
MCS	$r_s(125) = .380$ $p = .000$	*DNC	*DNC		$r_s(124) = -.410$ $p = .000$	$r_s(121) = -.233$ $p = .010$	$r_s(117) = -.522$ $p = .000$	*DNC
PSQI	$r_s(135) = -.022$ $p = .800$	*DNC	$r_s(124) = -.497$ $p = .000$	$r_s(124) = -.410$ $p = .000$		$r_s(122) = .714$ $p = .000$	$r_s(118) = .596$ $p = .000$	$r_s(125) = -.542$ $p = .000$
PSQ-3	DNC	DNC	$r_s(121) = -.569$ $p = .000$	$r_s(121) = -.233$ $p = .010$	$r_s(122) = .714$ $p = .000$		*DNC	*DNC
PDI	*DNC	*DNC	$r_s(117) = -.595$ $p = .000$	$r_s(117) = -.522$ $p = .000$	$r_s(118) = .596$ $p = .000$	*DNC		*DNC
WHO-5	*DNC	*DNC	*DNC	*DNC	$r_s(125) = -.542$ $p = .000$	*DNC	*DNC	

\*DNC – Did Not Complete or was not performed

**Declaration**

**Name of candidate:** Fraser Roberts

This thesis entitled: The associations between pain, sleep, health-related quality of life, and disability in people presenting to healthcare clinics in New Zealand is submitted in partial fulfilment for the requirements for the Unitec Master’s degree of Osteopathy

**Principal Supervisor: Dr Shamim Shaikh**


**Associate Supervisor: Dr Sylvia Hach**

Candidate’s declaration

I confirm that:

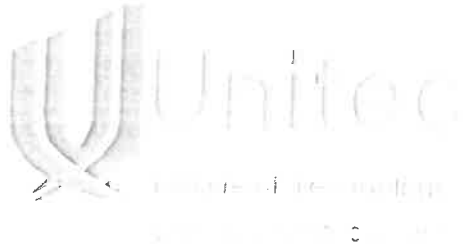
- This Thesis represents my own work
- The contribution of supervisors and others to this work was consistent with the Unitec Regulations and Policies.
- Research for this work has been conducted in accordance with the Unitec Research Ethics Committee Policy and Procedures and has fulfilled any requirements set for this project by the Unitec Research Ethics Committee.

Research Ethics Committee Approval Number: **2017-1075**

Candidate Signature: .....  ..... Date: ... **22/03/19** .....

Student number: 1432017

**Note to examiner/s:** This thesis is structured in a traditional style with the following sections mentioned in the order they are presented in this document; abstract, introduction, outline of research aim and objectives, literature review, methodology, results, discussion, bibliography and appendix.



Full name of author: Fraser Roberts

ORCID number (Optional): .....

Full title of thesis/dissertation/research project ('the work'):

The associations between sleep, pain, health-related quality of life, and disability in people presenting to healthcare clinics in New Zealand

Practice Pathway: Community Studies

Degree: Master of Osteopathy

Year of presentation: 2019

Principal Supervisor: Shamim Shaikh

Associate Supervisor: Sylvia Hach

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