Factors Associated with Poor Sleep Among a Sample of Community-Based New Zealand Older Adults

A thesis presented in partial fulfilment of the requirements for the degree of

Master of Arts

In

Psychology

School of Psychology

Massey University

New Zealand

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2023

Abstract

Background: Sleep is well documented as a vital element in healthy ageing. However, to date, research concerning the sleep of older New Zealanders has used single or short-form items, limiting the estimations of sleep problems and the factors associated with them. The Ageing Well through Eating, Sleeping, Socialising and Mobility (AWESSoM) programme includes comprehensive measurements of sleep. This study aimed to describe the sleep status of community-dwelling older adults in New Zealand (NZ), and explore the factors associated with problematic sleep defined by both poor sleep quality and increased risk of obstructive sleep apnoea (OSA).

Methods: A sample of 88 older adults (aged 63-93 years, 70.5% female) completed a survey as a component of the AWESSoM study. Problematic sleep was firstly defined as poor sleep quality using the Pittsburgh Sleep Quality Index (PSQI). Then increased risk for OSA was defined using the STOP-Bang questionnaire. Likelihood of being defined as a problem sleeper was explored with regards to demographic status, physical and mental health status (Short-Form Health Survey [SF-12]), cognitive functioning (Rowlands Universal Dementia Assessment Scale [RUDAS]) and activities of daily living (Nottingham Extended Activities of Daily Living [NEADL]) using chi-square and Mann-Whitney *U* tests followed by binary logistic regression.

Results: Over half of the sample (55.7%) were defined as having poor sleep quality and 51% were defined as having a moderate to high risk of OSA. Female gender (OR = 4.098, 95% CI [1.18, 14.08]) and reduced cognitive functioning (OR = 0.736, 95% CI [0.566, 0.957]) were independently related to belonging to the poor sleep quality group. Male gender (OR = 92.34, 95% CI [9.607, 887.719]), younger age (OR = 0.866, 95% CI [0.777, 0.996]),

and increased comorbid health conditions (OR = 1.503, 95% bCI [1.085, 2.083]) were independently associated with having medium-to-high risk of OSA.

Conclusion: This thesis contributes to the growing body of evidence that suggests poor sleep is prevalent within the older adult population and that the factors associated with sleep are multifactorial and vary with the type of sleep disturbance. Findings will contribute to informing future interventions that promote sleep health, enabling older adults to age well and stay independent for longer.

Keywords: Sleep health, poor sleep, older adults, New Zealand, quantitative

Acknowledgements

Firstly, I would like to thank my supervisor, Dr Rosemary Gibson, who was not only a source of incredible knowledge but was also an amazing support throughout the year. I simply could not have done this without you. You were always there to answer the smallest question and hold my hand during those tough statistical moments. Thank you so much.

I would also like to thank the AWESSoM team for allowing me access to the data and, of course, the people who participated in this survey.

I would also like to thank my friends and family, who most likely got sick of the rollercoaster of emotions that a thesis creates. Emma, my number one cheerleader, for hearing my woes, hearing my excitement and all the emotions in between. Thank you for being there and for always telling me I could do it. Thank you to my husband, Reno, who never quite understood what I was talking about. Your support in allowing me to focus on this full-time has not gone unnoticed.

It has been a journey.

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List of Abbreviations

AWESSoM	Ageing Well through Eating, Sleeping, Socialising and Mobility
BMI	Body Mass Index
LiLACS NZ	Life and Living in Advanced Age: A Cohort Study in New Zealand
NEADL	Nottingham Extended Activities Daily Living
NREM	Non-rapid eye movement
NZHS	New Zealand Health Survey
NZ	New Zealand
OSA	Obstructive Sleep Apnoea
PSQI	Pittsburgh Sleep Questionnaire Index
REM	Rapid eye movement
rMEQ	Reduced Morning Eveningness Questionnaire
RUDAS	Rowlands Universal Dementia Assessment Scale
SF-12	Short-Form Health Survey

Introduction

The number of older people in New Zealand (NZ) is steadily increasing, with Stats NZ (2022) reporting that 1 in 6 people were aged 65 years or older in 2022. It is predicted that by 2028, 1 in 5 people will be in this age group, and it is estimated that one-quarter of the population will be over 65 by the 2050s. Ageing has been associated with a decline in sleep health, and poor sleep is commonly reported among older adults (Miner & Kryger, 2017). This is important because sleep has also been identified as an important determinant of health and well-being and a key aspect of healthy ageing (Zhang et al., 2022). Existing literature suggests that older adults report more night-time awakenings, have difficulties with sleep onset, decreased sleep efficiency, and more reported daytime sleepiness (Cheung et al., 2022). Existing research suggests that the causes of poor sleep in older adults are multifactorial, including changes to sleep patterns, physiological changes to the circadian rhythm and sleep architecture, homeostatic sleep pressure, and other health and social issues (Carskadon & Dement, 2011; Mendelson, 1989; Wang et al., 2020). Poor sleep among older adults can cause a number of adverse outcomes that directly impact general functioning and activities of daily living and are often associated with poorer quality of life. Poor sleep is also linked with comorbid disease, service use, and earlier mortality (Cheung et al., 2022). It is increasingly recognised that the factors affecting sleep are multifactorial, at the individual as well as the broader socioecological level (Buysse, 2014). Previous research indicates that, among older New Zealanders, the prevalence of self-reported sleep problems is 30-40% and that sleep problems are associated with poor health outcomes (Gibson et al., 2020). However, to date, research on the sleep of older New Zealanders has been limited to single or short-form items, limiting the interpretation of these relationships and the ability to make informed recommendations for ageing well.

This study examined the factors associated with poor sleep in community-dwelling older adults in Aotearoa, New Zealand. The aims were: to describe the sleep health of community-based older New Zealanders, and to investigate the demographic and health-related factors associated with poor sleep, defined firstly by measures of poor sleep quality and secondly defined by a measure of sleep disordered breathing. This thesis contributes to the growing body of evidence suggesting that poor sleep is prevalent in the older adult population, with many health-related factors associated with it.

To achieve this, the present thesis considers a data set collected as a component of the Ageing Well through Eating, Sleeping, Socialising and Mobility (AWESSoM) research programme funded by Aotearoa New Zealand's National Science Challenge (2019-2024). Older New Zealanders' 'poor sleep' (as defined using standardised measures indicative of both poor sleep quality and sleep-disordered breathing) is described and then explored in relation to the demographics as well as health-related predictors.

Literature Review

This literature review provides a brief overview of what sleep is, how it is structured and regulated, and common theories concerning its function; how sleep and sleep health are defined; and critically evaluates the existing research on health factors and how they are associated with poor sleep in the older adult population.

Conceptualisation of Sleep from a Physiological Perspective

Sleep Architecture

There is a strong body of research indicating how sleep is structured. Sleep architecture refers to the basic structures of what is considered normal sleep, which alternate cyclically across the stages of an episode of sleep (Colton & Altevogt, 2006). Human sleep is typically described by two states, non-rapid eye movement (NREM) and rapid eye movement (REM), the stages within which cycle in 90-minute blocks throughout the night (Carskadon & Dement, 2011). NREM sleep is divided into stages 1, 2, 3 and 4, each with unique characteristics in variations of brain wave patterns, eye movements and low muscle tone (Colton & Altevogt, 2006). In NREM stages 1 and 2 are considered to be the lighter stages of sleep. These stages have the lowest threshold for arousal and sleep can be easily disrupted by external stimuli (Timofeev & Chauvette, 2019). Stages 3 and 4 are considered the deeper stages of sleep, where there is a higher threshold for external stimuli to disrupt sleep. Studies suggest that slow-wave sleep is a crucial part of memory, learning and other physiological processes (Hu et al., 2021). REM is noticeably different to other sleep stages as there is a decrease in muscle tone throughout the body, conjugate rapid eye movements appear (Miner & Kryger, 2017), and dreaming is more often experienced in this stage of sleep compared to others (Gooneratne & Vitiello, 2014).

Sleep Regulation

To understand sleep regulation, Borbely (1982) proposed a framework known as the two-process model. The model focuses on the two systems that drive sleep and wakefulness: the circadian timing system, the body's internal clock (process C); and the homeostatic sleep pressure system, the body's functional need for sleep (process S). The two processes consistently interact to regulate when and for how long individuals sleep, thus creating consolidated sleep during the night and wakefulness throughout the day (Hood & Amir, 2019).

Process C is the mechanism that regulates rhythms in behaviours and physiological processes over a 24-hour cycle (Weaver, 2016). At a molecular level, circadian rhythmicity is created by a group of core clock genes that can be found within cells throughout the body (Skeldon et al., 2016). Our biological clock is found in the hypothalamus, specifically in a group of nerve cells called the suprachiasmatic nucleus. This endogenous time-keeping system predicts daily changes in the environment and regulates both physiological and metabolic processes (Dunlap, 1999). It is primarily driven by night and day cycles and other external environmental cues and individual behaviours, which are referred to as zeitgebers (Taillard et al., 2021). The most important zeitgeber is the light/dark cycle, which has a major entraining influence on the circadian rhythm, and any misalignment between the internal clock and external zeitgebers can cause poor sleep (Weaver, 2016). The suprachiasmatic nucleus receives information about light from the optic nerves. When light is detected, the suprachiasmatic nucleus sends signals to raise the body’s core temperature, heart rate, blood pressure and to inhibit hormones like melatonin (Taillard et al., 2021). Therefore, process C has a significant impact on sleep onset (timing), the maintenance of sleep during the night, and overall sleep quality (Taillard et al., 2021).

Process S is a system that accumulates during the wakefulness period and is triggered when it intersects with process C, inducing sleep (Mishima, 2016). During sleep, process S begins to decrease, and when it intersects with process C, it triggers wakefulness (Mishima, 2016). Homeostatic sleep pressure is at its lowest in the morning and continues to build during the wakefulness period of the day, increasing the need to sleep. Although not much is known about the specific physiological location of the homeostatic sleep drive, it is assumed that process S has some control with regard to slow-wave activity during slow-wave sleep.

Conceptualisation of Sleep

Sleep is a crucial phenomenon that plays a significant role in supporting various bodily functions, including cognition and overall physical and mental well-being. Sleep patterns, experiences and problems evolve throughout a person's lifetime. In order to demonstrate how certain factors are associated with sleep-related changes, it is first important to understand what sleep is, how it is conceptualised, how it occurs, and, most importantly, how it changes during the ageing process.

Sleep and Sleep Health

The definition of sleep varies within the literature. Some research focuses on the physiological changes that occur within the body. For example, Tubbs et al. (2019) discuss sleep as changes in the brain wave activity, heart rate, breathing, body temperature and other physiological functions such as blood pressure, which all vary dependent on the stages of sleep. From a behavioural perspective, Carskadon and Dement (2011) describe sleep as a reversible state of perceptual disengagement from the environment, characterised by closed eyes, a resting posture, and reduced mobility. Historically, research has predominately focused on sleep pathology, such as sleep disorders, with a tendency to overlook the positive aspects of sleep. In contrast, considerations of more holistic ‘sleep health’ are becoming increasingly popular. Buysse (2014) defines sleep health as “a multidimensional pattern of

sleep-wakefulness, adapted to individual, social, and environmental demands, that promotes physical and mental wellbeing. Good sleep health is characterised by subjective satisfaction, appropriate timing, adequate duration, high efficiency, and sustained alertness during waking hours" (p.12). Unlike traditional medical models of sleep, Buysee acknowledges the complexities of sleep, placing emphasis on not only the physiological processes but also the environmental and behavioural aspects. The concept recognises individual differences and that multiple factors can impact sleep-wake patterns. More recently, Hale et al. (2020) described sleep health as an interactive socio-ecological framework, bringing together domains of individual, social and contextual influences on sleep health. These aspects are seen as modifiable to address disparities in sleep health.

Theories of Sleep

Because of the complexity of sleep, there are many theories concerning its function. Several key theories have aimed to identify the function of sleep: restoration theory, evolution theory, and information processing theory. Although there is much detail in the explanation of these theories, for the purpose of this thesis, a basic explanation is provided.

The restoration theory of sleep suggests that sleep is critical for the body to restore physiological functions that keep both the body and the mind healthy and functioning at its best. This theory suggests that the stages of sleep are important. NREM sleep has been linked to restoring the physiological components of the body, such as tissue repair, hormone production, and protein synthesis, an aspect of human growth (Tubbs et al., 2019), which occurs during sleep. Conversely, REM sleep has been associated more strongly with restoring mental functioning (Ezenwanne, 2011). Ezenwanne found that during periods of sleep, the rate of cell division increased, which suggested that sleep induces physiological restoration. Further supporting this theory, Xie et al. (2013) used two-photon imaging in mice and found that the brain activity associated with REM flushed out waste toxins during sleep. Their study

further suggested that poor sleep, often reported by individuals with neurodegenerative diseases such as Alzheimer's, could be linked to brain wastes not being cleared during sleep periods. These results suggest that this is a major reason why sleep is so crucial. However, more research is required involving human rather than rodent participants.

The evolutionary theory suggests that there are periods of inactivity and activity as a way to conserve energy (Ezenwanne, 2011). This theory is based on the belief that sleep is an adaptive behaviour, which developed as a way to protect against predators and natural hazards (Barton & Capellini, 2016). Being asleep reduces the potential of encountering a predator, reducing the risk of harm (Barton & Capellini, 2016). From this perspective, sleep is based on survival efforts. Wakefulness is based on maximising the ability to find food, and sleep is induced to minimise the risk of harm. The theory also argues that sleep is a way to conserve energy. However, some literature argues that saving energy could be achieved in periods of rest rather than sleep (Rial et al., 2007).

Lastly, information processing theory is based on the cognitive functioning needs of humans. This theory argues that sleep is crucial to enable humans to process information acquired during the day and also allows the brain to prepare for new information that will be gained the next day (Born & Wilhelm, 2012). Research suggests that sleep allows for memories or new information to be stored in long-term memory (Gamaldo et al., 2019). Support for this theory comes from research demonstrating that a lack of sleep can negatively impact memory recall (Born & Wilhelm, 2012). The theory also suggests that sleep enhances the brain's plasticity and increases cognitive functioning and higher performance of tasks. Studies further highlight how the quantity as well as the quality of sleep can impact learning, attention, focus and memory consolidation (Cluydts, 2003). For example, brain development is at its most rapid in newborns and young children, who sleep between 13 and 14 hours per day, in both deep slow wave sleep as well as REM. The functional impact of sleep on

emotional information processing has also been widely documented in the literature. Sleep also appears to be crucial to emotional regularity, with studies finding that sleep influences the way in which individuals react, and their ability to cope with emotional stress (Vandekerckhove & Wang, 2018). In a recent study, Cluydts (2003) found that poor sleep significantly enhanced negative emotional reactions, compared to positive reactions to positive stimuli being delayed. Current literature suggests that REM sleep plays a significant part in both emotional regulation and memory consolidation (Stickgold & Walker, 2007; van den Berg et al., 2019).

There is no single theory that explains the function of sleep, but rather a combination of ideas. The existing literature suggests that poor sleep plays a crucial role in negative mental and physical outcomes such as depression and cognitive impairment (Vitiello, 2009). Poor sleep has been associated with earlier mortality (Vitiello, 2009), which indicates the key role it plays in all aspects of human health. This highlights why further research on sleep is important due to its complexities and associations with adverse outcomes for individuals. Although well researched internationally, there is currently a lack of understanding of sleep in NZ older adults.

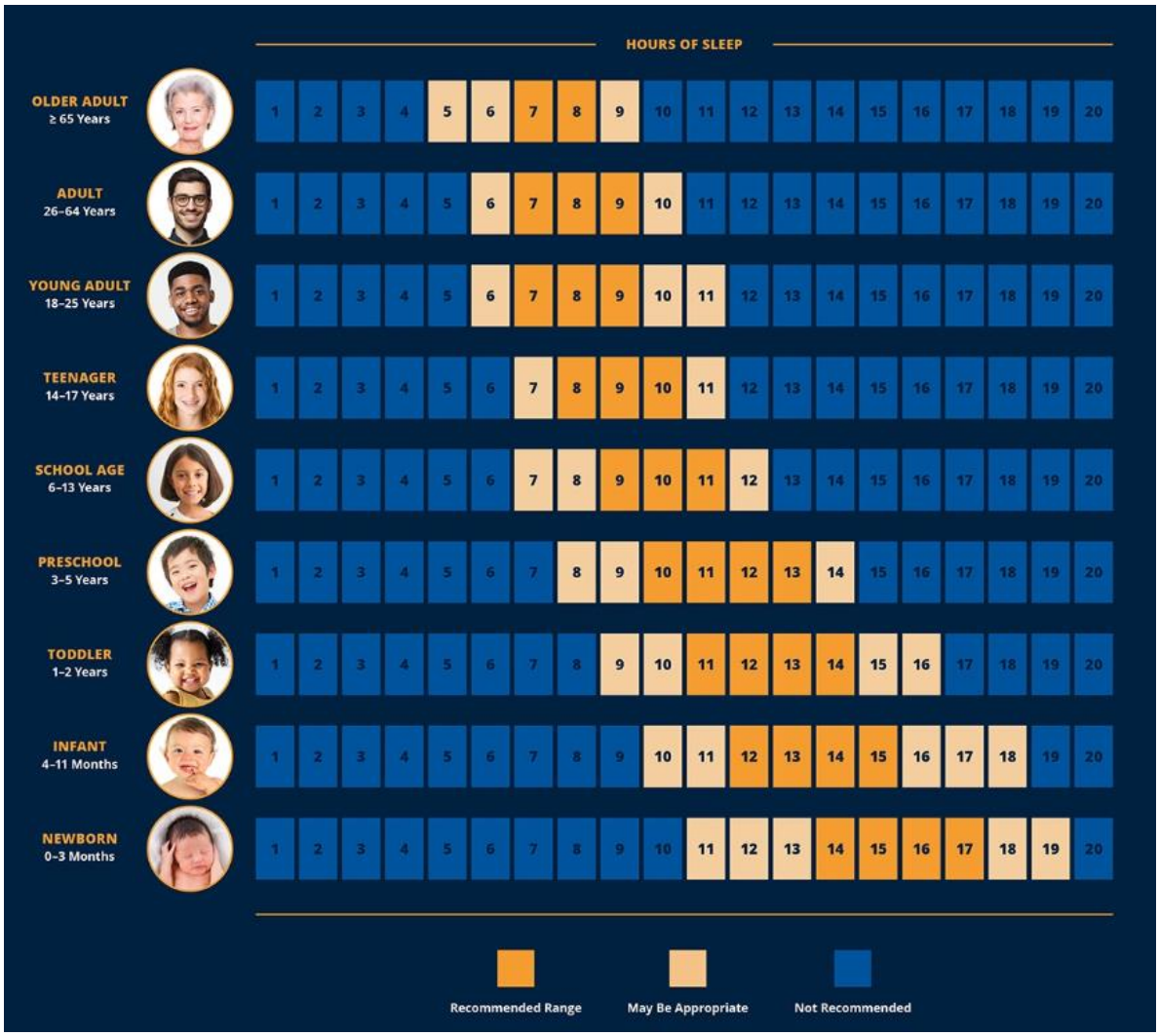
Sleep Requirement

The amount of sleep needed to feel rested, recovered, and alert is dependent on the individual. Each person has their own sleep requirement that is optimal for their health and wellbeing. However, there are guidelines set by the National Sleep Foundation that are dictated by age (See Figure 1). The National Sleep Health guidelines provide a baseline for what is considered best sleep practice; however, there are many factors to consider that may impact an individual's ability to sleep, including physiology, activity levels, and lifestyle factors. The National Sleep Foundation recommends 7 to 8 hours of sleep for adults aged 65 years and older. Evidence suggests that 6 to 9 hours of sleep provide older adults with better

cognitive function, mental and physical health and overall quality of life when compared to older adults with atypical sleep (shorter or longer) durations.

Figure 1

National Sleep Foundation sleep recommendation based on life stages



Note: National Sleep Guideline. From *'How much sleep do we really need?'*, by The Nation Sleep Foundation, 2023. (https://www.thensf.org/how-many-hours-of-sleep-do-you-really-need/)

Sleep and Ageing

There is a large body of evidence that shows older adults have a longer sleep onset, changes to sleep timing (earlier rise time and earlier bedtimes), shorter sleep durations, higher prevalence of sleep disruptions (frequent wake ups), reduced amounts of slow wave sleep and REM and increased lighter stages of sleep (1 and 2) (Ohayon et al., 2004). In Miner et al.'s (2017) meta-analysis, it was found that changes to sleep physiology were well-documented using polysomnography and that slow-wave sleep starts to decrease in middle-aged adults when compared to young adults and decreases further with advancing age. This reduction in slow-wave activity is extremely prominent in the older adult population. Borely (1982) argues that slow-wave activity is closely linked with the body's homeostatic drive to sleep. The longer an individual stays awake, the higher is the likelihood of increased slow-wave activity during the sleep period. Due to the decrease in sensitivity to the homeostatic drive in older adults, there is a decrease in the deep, more restful stage of sleep involving slow wave activity. These changes make older adults more vulnerable to sleep disruptions due to the lighter stage of sleep making individuals more sensitive to external cues, with a higher likelihood of arousals from external cues such as temperature or noises (Carskadon & Dement, 2011). A number of studies have associated both REM and slow wave sleep with the consolidation of memories (Cassidy-Eagle & Siebern, 2017; Gagnon et al., 2019; Gauthier et al., 2006; McKinnon et al., 2014). With the reduction in REM sleep in older adults, these changes could, therefore, contribute to cognitive impairment in the older adult population.

Age-related changes to sleep have been well documented throughout the literature. Older adults typically report difficulties in sleep onset, frequent night-time wakings, and earlier rise times (Ohayon et al., 2004). There are multiple factors that cause poor sleep to be prevalent among older adults. Firstly, changes to the circadian rhythm begin to occur in older age. There are several factors likely to contribute to changes in the circadian rhythm. Firstly,

the suprachiasmatic nucleus begins to shrink with ageing, which can create a weaker system that may not be as sensitive as it once was (Cooke & Ancoli-Israel, 2011). Supporting this theory, Hood and Amir (2019) found a reduction in the number of cells and a decrease in the volume of the suprachiasmatic nucleus in older humans and animals compared to their younger counterparts. Secondly, changes to the nocturnal secretion of endogenous melatonin also begin to deteriorate. Lastly, older adults may start to have desensitisation to exogenous cues that would normally play a role in the activation of the circadian rhythm. For example, light is a powerful zeitgeber, but older adults can sometimes have reduced regular access to daylight (due to physical limitations). Another impact of lack of light may come from physical health changes to the eye, such as progressive thickening and yellowing of the outer lens, which may affect the transmission of light to the suprachiasmatic nucleus (Kessel et al., 2010). As the circadian rhythm desensitises to zeitgebers, the homeostatic sleep pressure becomes weaker (Taillard et al., 2021). Older adults also typically report more awakenings at night and more sleepiness during the day compared to when they were younger. The timing of sleep is also more likely to shift to an earlier phase.

The timing of sleep is regulated by both homeostatic regulation and the circadian rhythm. Individuals have a natural time preference for daily sleep and waking, which is often referred to as a chronotype. This has been found to be influenced by genetics, environment, and social factors (Didikoglu et al., 2019; Fischer et al., 2017; Monk & Buysse, 2014). Older adults often report phase advance, where the drive to sleep begins earlier in the evening and wakefulness starts earlier in the morning compared to younger adults. One theory of why phase advance occurs relates to age-related changes resulting in the circadian rhythm becoming weaker, in addition to changes in physiology, such as body temperature and release of sleep-inducing hormones (Li & Gooneratne, 2019). For example, Duffy et al. (1998), using a constant routine protocol, found when comparing 44 older adults to 101 young men, adults

aged in their mid-60s and above reported initiating sleep and final awakening approximately 1 – 2 hours earlier than those in their 20s. Also supporting this theory, a study by Tranah et al. (2018) found that there was a difference in the time of release of hormones such as melatonin between younger and older adults, with older adults releasing these hormones one hour earlier. These changes have been suggested to lead to increased daytime sleepiness and daytime napping, potentially reducing the quality of night-time sleep. In a cycle of poor sleep, daytime sleepiness may be associated with nighttime poor sleep due to the abnormalities described above. An imbalance between process C and process S can alter an older adult's wakeful periods as the pressure system has lower thresholds for sleep (Taillard et al., 2021). Studies have shown that older adults who are morning types tend to have better sleep quality and stability in their bedtimes and waking times than evening types (Randler & Engelke, 2019).

This is not to suggest that there is not individual variance in individual's needs and tolerances for sleep. The Buysse theory of multifactorial influences on why older adults experience poor sleep is important to note here. Older adult sleep disturbances can be attributed to a range of factors, including changes to the circadian rhythm, comorbid medical conditions, medications, lifestyle factors (physical and mental health) and demographic factors.

Sleep Disorders

'Sleep disorders' is a collective term that refers to conditions that can affect different aspects of sleep. The etiology of primary sleep disorders involves a disturbance in the sleep/wake system, rather than being secondary to health comorbidities such as depression, or physical disease. There are several sleep disorders that are common among older adults and can contribute to older adults experiencing poor sleep, including insomnia, sleep-disordered breathing, and restless leg syndrome. Researchers have found that the prevalence of these

sleep disorders is much higher among older adults than in younger individuals (Crowley, 2011). There are different ways in which sleep disorders present; however, all seem to create aspects of poor sleep in older adults. For example, difficulty falling asleep, increased numbers of nighttime awakenings, and complaints regarding non-restful sleep. Sleep disorders have been well documented as creating poor sleep quality, shorter or longer sleep durations, and poor daytime functioning due to excessive daytime sleepiness (Suzuki et al., 2017). Given that poor sleep in later life can have significant implications for both quality of life and levels of daily functioning, it is crucial to understand poor sleep and how older adults may be able to sleep better. There is a considerable amount of literature that supports the theory that mental and physical illness, and other health-related factors such as smoking, alcohol consumption and prescription medications can also play a crucial role in sleep disorders in older adults (Vitiello et al., 2002).

Although older adults can experience multiple types of sleep disorders, for the purpose of this thesis sleep disordered breathing, specifically sleep apnoea, was the focus. Obstructive sleep apnoea (OSA) is a common sleep disorder that is characterised by repeated episodes of partial or complete upper airway obstruction during sleep, which leads to disrupted breathing and a temporary lack of airflow (Lavoie et al., 2018). Diagnosis of OSA is based on the number of breathing disruptions per hour. Having five or more apnoeas per hour is considered mild (5-15 disruptions per hour), while 16-30 is moderate, and 30 or more is severe (Gooneratne & Vitiello, 2014). Poor sleep caused by OSA in older adults has several adverse effects on sleep architecture and overall sleep health due to the microarousals (brief awakenings) (Martin et al., 1997). Disruptions in breathing lead to sleep fragmentation and frequent arousals during the night, reducing sleep efficiency. This can lead to excessive daytime sleepiness and impaired cognition, including decreased ability in executive functioning, impaired vigilance, working memory decline, and declines in both alertness and

attention (Phillips, 2017). This is often a direct contributor to challenges in day-to-day functioning and maintaining independence. Untreated sleep apnoea is associated with many different negative health outcomes, including increased mortality, and cognitive impairments (Lavoie 2018). It is also known to increase daytime sleepiness, which can impact safety in some situations, such as driving a vehicle (Lavoie, 2018). These OSA-induced problems can thus impact quality of life, cognitive function, mental and physical health and overall daytime performance (Lee et al., 2014; Reynolds & Adams, 2019; Suzuki et al., 2017; Young et al., 2002).

The prevalence of OSA and other sleep disorders due to respiratory events is increased due to age-related changes in respiratory muscle function, where there may be a loss of tissue elasticity contributing to the collapse of the airway, making older individuals more vulnerable to poor sleep (Gooneratne & Vitiello, 2014; Phillips, 2017). In a study by Lee et al. (2014), which used nocturnal polysomnography on 696 Korean adults aged 60 years old and over, it was found that up to 36.5% of older adults had OSA and the disorder was estimated to be 2 – 4 times more likely in older adults than younger adults. In older men, OSA rates are double those in older women (Lavoire, 2018). Clinical studies have found that sleep disorders are most likely to be diagnosed in midlife; however, evidence has shown that OSA prevalence also increases with age (Phillips, 2017).

New Zealand studies have suggested that there are high levels of undiagnosed sleep disorders such as OSA in the general NZ population (Mihaere et al., 2009). Diagnosis of OSA can be difficult in older adults due to clinical presentations and the underreporting of symptoms (Mihaere et al., 2009). There may also be difficulties due to older adults not always having a sleep partner to report symptoms that the individual may be experiencing. For example, snoring is a hallmark symptom of OSA, but often older adults no longer have a bed partner to confirm this (Gooneratne & Vitiello, 2014). In the NZ context, research has

found that Māori are at a higher risk of experiencing sleep disorders compared to non-Māori (Paine et al., 2005). Given the high prevalence of sleep disorders, (Buchan et al., 2023) believes this has put a strain on the NZ healthcare system, which warrants further research on OSA in older adults.

Factors Associated with Poor Sleeping in Older Adults

Gender/Sex Differences

Gender differences have been observed in sleep patterns among older adults, and in recent years, increasing attention has been given to understanding the difference between genders with regard to sleep health. Gender/sex will be defined in this thesis as the biological and physiological differences between women and men, with the understanding that there are key differences at a cellular level.

Guidozzi (2015) found in a meta-analysis that women spent more time in bed, and had longer sleep durations compared to men. However, women also reported experiencing more poor sleep than men. Women were more likely to report issues with sleep onset, staying asleep, earlier rise times and overall, less sufficient sleep than men. Similarly, Suh et al. (2020) found that normal age-related changes occur in adults aged 60 years and older. Suh used the PSQI, a subjective measure of sleep, which showed that women, aged 60 years and olde, begin to show decreased sleep duration, delayed mid-sleep time, and decreased sleep efficiency when compared to men.

One explanation of gender differences in sleep is the underlying hormonal differences between men and women. According to Jonasdottir et al. (2020), underlying mechanisms explain the sex-specific differential risk for poor sleep. Research investigating sex-specific differences in sleep has shown that poor sleep in older adult males is correlated with the decline in their sex hormone, testosterone (Wan Suh et al., 2020). Randler and Engelke (2019) obtained similar findings in women, showing that gender differences in sleep diminish

around menopause. Prior research has established that sleep-related changes are moderated by gender. For example, women report sleeping longer than men until age 50-60, which coincides with the average onset of menopause in women (Fischer et al., 2017). Menopause and its hormonal changes can have some symptoms that may trigger poor sleep, such as hot flashes, night sweats and insomnia symptoms (Jonasdottir et al., 2021).

There are conflicting findings on the impact of gender differences on the timing of circadian rhythms. For example, using home-based morning logs and wrist actimetry over 15 nights in samples of 50- to 70-year-old men and women, Reyner et al. (1995) found clear gender differences in the timing of the circadian rhythm, where women had a significant difference in melatonin amplitude, with lower core temperatures compared to men. The study showed that although sleep timing between genders was similar, the timing of the circadian rhythm was different. Women had earlier core body temperature changes and melatonin changes than men, which gave women a reported earlier need for sleep. These findings contribute to our knowledge of how sleep, from a physiological standpoint, changes during older adulthood.

Sleep disorders occur in both females and males; however, the prevalence of sleep disorders between genders differs (Guidozzi, 2015). Epidemiological data show that women report a higher prevalence of insomnia than men, which may be attributed to both behavioural and hormonal factors (Ohayon et al., 2004). Insomnia is defined as dissatisfaction of sleep. It is often associated with symptoms of difficulty initiating sleep, difficulties in maintaining sleep, frequent night time awakenings and early morning awakenings with an inability to return to sleep (Patel et al., 2018). Fischer et al. (2017) found that women reported two to three symptoms of insomnia more than men, who often report only one symptom of insomnia. Depression, worry or ruminative thoughts are mostly reported to be responsible for difficulties in falling asleep for women. Non-hormonal causes

(such as gender-targeted household responsibilities and mental health) were also found to be higher for women (Peng et al., 2021).

A meta-analysis by Zeng et al. (2020) showed that females had a significantly higher prevalence of reporting poor sleep. The meta-analysis examined recently published studies using the international insomnia diagnostic criteria, and found that gender differences were multifactorial, but women were more vulnerable to socioeconomic factors, such as low incomes and low education levels. Furthermore, females were more likely to experience mood disorders such as depression and anxiety. Wang et al. (2020) obtained similar findings using the PSQI to assess sleep quality, and through the use of structured interviews, found that women in general were more likely to be less educated, have lower incomes, have more chronic diseases and have higher rates of anxiety and depression than men. Another study used quantitative analysis to determine that women tended to have poorer self-reported sleep than men because women commonly experience heightened body awareness and a tendency to express more somatic symptoms or report more emotional stress than men (Wan Suh et al., 2020). One explanation is that men are less like to report poor sleep due to social or gender stereotypes; however, there is little evidence to substantiate this.

Gender differences are also apparent with regards to OSA. Men have been found to have a greater prevalence of OSA than women, with a ratio of about 3-4: 1 (Guidozzi, 2015). Misdiagnosis of sleep apnea has been mentioned in the literature, with some studies believing that it’s because women and men present differently. Women report symptoms such as chronic fatigue, insomnia, headaches, lack of energy and mood disturbances. In contrast, men are more likely to report snoring, pauses in breathing during the night and excessive daytime sleepiness (Guidozzi, 2015). Mallampalli and Carter (2014) expressed concern over these findings because males are overrepresented in clinical research on OSA while women are underdiagnosed and understudied.

Although there is clear international evidence of gender differences in sleep health, further study is warranted to understand whether similar gender differences also occur in the New Zealand population. Building on international research, Gibson et al. (2023) found mixed results in gender-related differences in sleep. The study used data collected by the NZ Health Survey (NZHS), which is a cross-sectional survey focusing on the health and well-being of New Zealanders. It was found that younger adults showed significant differences between genders, with women more likely to report dissatisfaction with their overall sleep. However, in work by Gibson et al. (2016) using data collected from Te Puāwaitanga o Ngā Tapuwae Kia Ora Tonu. Life and Living in Advanced Age: A Cohort Study in New Zealand (LiLACS NZ) study, there were contrasting findings, with gender not being a predictor of poor sleep in advanced age. The study was limited, however, due to a lack of validated measures of poor sleep.

Ethnic Differences

Internationally, ethnicity has been found to significantly affect sleep health, with poor sleep inequitably distributed across ethnicities. Buysse (2014) argues that sleep health, which consists of sufficient sleep duration, efficiency, timing, wakefulness, sleepiness and overall satisfaction, should occur daily in all individuals. However, studies have shown sleep health to vary by ethnicity (Johnson et al., 2019). A review by Johnson et al. (2019) conducted in the US demonstrated that minority ethnic groups are more likely to experience shorter sleep durations, less deep sleep, and inconsistent sleep timing compared to white populations. Similarly, George et al. (2020) found significant ethnic differences in self-reported sleep quality: African Americans reported the poorest sleep quality, followed by whites, Asians and Latinos. African Americans reported shorter sleep duration and more sleep disturbances.

Various factors contribute to why specific ethnicities report a higher prevalence of poor sleep. Grandner's (2019) social-ecological model of sleep describes how sleep plays a more significant role in several adverse health outcomes, and it is determined by individual-level factors, which are governed by societal-level factors. Grandner explains that social-level factors are embedded within societal levels; for example, individual behaviours and biology are embedded within a social environment that includes culture and socioeconomics, and thus are embedded in societal issues such as society and public policy. This illustrates that it is not ethnicity alone that is predictive of poor sleep but macro social level factors that vary between ethnicities. For example, individuals from minority ethnic groups may face environmental stressors such as unemployment, poor living conditions, and chronic stress (Petrov & Lichstein, 2016). Lower incomes and education levels may lead to jobs where there are unstable work hours, unpredictable work schedules, or night shifts, which ultimately affect the ability to maintain stable sleep patterns (Petrov & Lichstein, 2016). With ethnic minorities being more likely to experience these risk factors, the association between ethnicity and poor sleep is much more multifactorial and complex.

Local research has also found differences in sleep when grouped by ethnicity. Paine et al. (2005) conducted an epidemiologic study of insomnia using a sample of NZ adults aged between 20 and 59 years. The survey found that 27% of adults had a current sleep problem and indicated that of these, 25% had a chronic sleep problem. An analysis using logistic multiple regression indicated that ethnicity was not a significant predictor of chronic sleep issues. However, the study did find that the prevalence of insomnia symptoms among Māori was significantly higher than non-Māori. Being Māori was an independent risk factor for experiencing multiple nighttime wakings, waking early, and sleep problems after controlling for age, gender, employment status, socioeconomic status and night work. The study pointed out that although there were clear disparities for Māori in insomnia prevalence, it was still not

clearly understood. Building on this research, Gibson et al. (2016), using data from LiLACS NZ, found that 26.3% of Māori and 31.7% of non-Māori reported sleep problems, with both ethnicities reporting a median of three sleep symptoms. The study was able to describe the health status of Māori compared to non-Māori, with enough Māori participants to have equal explanatory power, meaning that findings had the same precision for Māori and non-Māori. Although sleep was not the primary focus of the research, there were general sleep questions included. Gibson et al. reported that the findings were in contrast to previous NZ research, where younger Māori were more likely to report poor sleep. A potential factor contributing to these results was that Māori were three times more likely to not answer sleep questions compared to non-Māori participants. However, the reasons for this were unknown. Similar findings have been reported in NZ: Paine and Gander (2016) using a national survey of 5100 Māori and 4000 non-Māori aged 20 to 59 years, found clear ethnic inequities in both short and long sleep durations even in fully adjusted models. However, the study found that those reporting poor sleep had lower socioeconomic status and negative health experiences, accounting for a large part of the ethnic disparity.

Alcohol

Research on alcohol and its effect on sleep has grown significantly, with previous literature suggesting alcohol consumption can have a negative impact on sleep. Alcohol is a substance that is absorbed into the bloodstream once it reaches the stomach and small intestine (Britton et al., 2020). The body's ability to break down alcohol is slow, which causes alcohol to continue circulating around the body. However, this process varies with factors such as a person's age (Pietilä et al., 2018). What is agreed upon is that alcohol is of concern to older adults because of age-related physiological changes and sensitivity to alcohol, and the impact it has on sleep.

Drinking alcohol in the evening before bed can cause an individual to miss the first two cycles of REM sleep, because alcohol is a sedative (He et al., 2019). Because of its sedation properties, sleep onset can be quick; however, it can create an imbalance in the four stages of sleep. Often slow wave sleep is decreased, with REM often being suppressed at the beginning of the night and rebounding later, which causes restlessness and less restful sleep (He et al., 2019). Alcohol has also been associated with daytime sleepiness as a result of sleep disturbances, which has ramifications for an individual's quality of life. Alcohol further disrupts circadian rhythms, impacts breathing-related sleep abnormalities and can trigger vivid dreams (He et al., 2019)

Canham et al. (2016) investigated the relationship between binge drinking (4 or more drinks per session) in adults 50 years and older. The findings were that older adults who binge drank on two or more days in a week had a 64% increase in experiencing poor sleep compared to non-binge drinkers. Britton et al. (2020) made similar findings, using a longitudinal study method (30 years) to investigate associations between alcohol use and sleep in adults aged between 35 and 55 years. Findings showed that men who consumed 21 units per week had a higher rate of sleep disturbances than older men who did not consume alcohol. Men who consumed more than 21 units (1 drink = 1 unit) of alcohol a week also reported feeling unrested and waking tired. Findings for women, however, were unclear. These findings suggest that alcohol can have negative effects on sleep quality, with increased sleep disruptions often leading to excessive daytime sleepiness the next day. There is a gap in NZ research focusing on the older adult population, alcohol consumption and sleep health. It is important to understand how often older adults are drinking since alcohol is well-known to play an important part in decreased sleep quality.

Medications

The use of prescriptions and over-the-counter medications increases in older adults (Qato et al., 2016). While medications provide therapeutic benefits, some can inadvertently cause issues with the sleep/wake cycle, leading to poor sleep. These can be broadly categorised as stimulating or producing drowsiness, both of which may influence sleep quality and quantity by altering sleep patterns, where drowsiness may occur during the day, while stimulants interfere with sleep at night (Barczi & Teodorescu, 2017). There are a number of medications or over-the-counter medications that can have a stimulating effect that has the potential to have a negative impact on a person's sleep/wake cycle. Common medications such as cold and flu medicines (pseudoephedrine, ephedrine), activating antidepressants such as desipramine, and most selective serotonin receptor inhibitors (SSRIs) can also influence sleep initiation and maintenance (Barczi & Teodorescu, 2017). Other medications can produce drowsiness and increase the prevalence of daytime sleepiness: anticonvulsants, morphine, and other opiate analgesics can significantly increase daytime sleepiness and decrease alertness, as well as creating disturbances in sleep efficiency and sleep architecture (Barczi & Teodorescu, 2017). Some beta-blockers have been shown to decrease melatonin secretion, which in turn can cause sleep fragmentation (Miner & Kryger, 2017).

Older adults commonly have a range of comorbidities that require multiple medications. Polypharmacy is well documented in research to contribute to an increased risk of poor sleep in older adults (Onen & Onen, 2018). Although there is no clear definition of polypharmacy in the literature, there is a large consensus that it is the use of five prescribed medications concurrently, whether these are over-the-counter, prescription, or traditional and complementary medications (World Health Organization, 2019). If combined inappropriately, polypharmacy can be dangerous, with severe adverse effects, such as

excessive daytime sleepiness, confusion, and falls (Barczi & Teodorescu, 2017). A study by Qato et al. (2016) using a sample of older adults (62 – 85 years) in the United States, found that 88% of the community-dwelling sample used at least one prescription medication, 38% used over-the-counter medications and 65% used dietary supplements. These percentages are common in the international literature (Barczi & Teodorescu, 2017).

There is some evidence in NZ populations that medication use and polypharmacy are associated with problematic sleep. In an earlier analysis in 2011/2012, data from medicine dispensaries were reviewed over a 9-month period, showing that 44% of enrolled patients over the age of 75 were using five or more medications (Bpacnz, 2012). More recent research suggests that the prevalence of polypharmacy in NZ older adults is increasing, with 75% of those engaging in polypharmacy being 60 years old or more in 2018 (Nind et al., 2021). These statistics are high, and based on international literature, it would be expected that a large proportion of those using polypharmacy would also experience poor sleep. However, a study by Gibson et al. (2023), using data collected from the NZHS, with a focus on adults aged 65 years and older, found that medications did not remain an independent predictor once all other factors were controlled for. Due to the high rates of polypharmacy among older NZ adults (Hikaka et al., 2021), it is important to determine how polypharmacy is impacting sleep. Investigating the association between poor sleep and polypharmacy could improve health policies and overall policies in prescribing medications to older adults.

Physical Health

There is variance within the literature as to what contributes to ‘physical health’. Most often, physical health is characterised by somatic comorbidities, such as chronic pain, weight, and chronic physical disease. Other definitions refer to physical health as physical activity, which involves the measurement of exercise. Physical health is also referred to as an

individual's ability to take part in the activities of daily living, such as being able to walk up stairs.

Generally, older adults are likely to experience a decline in physical health. A lack of restful sleep can heighten the likelihood of various ailments and health concerns, such as obesity, high blood pressure, heart disease, diabetes, and stroke (Garbarino et al., 2021). (Guo et al., 2023) using a cross-sectional online survey of 17,408 participants aged over 60 years, found that physical health was a predictor of poor sleep among older Chinese adults. The study used the Chinese validated version of the PSQI (Pittsburgh Sleep Questionnaire Index) as a measure of sleep and compared it to multiple factors of physical health. Firstly, the study asked for participants' general health status. Secondly, it recorded whether participants were currently experiencing chronic pain, and whether participants had two or more comorbidities. The study found that poor self-rated health status, chronic pain and physical comorbidities were associated with poor sleep among older Chinese adults. Similarly, Chen (2011) found that participants reporting moderate to severe pain, either widespread or multisite, showed significant associations with poor sleep. The study used a population-based cross-sectional study with 765 participants aged 70 years and older. Medical conditions that were associated with pain were osteoarthritis, disc disease, diabetes, and lung disease. However, pain was not associated with age. After controlling for other health-related factors, pain was a significant predictor of poor sleep, with a two-fold increase in the likelihood of experiencing poor sleep. Li and Gooneratne (2019) found that older adults reporting good health were far less likely to report poor sleep. However, the literature does point out that physical health is a factor associated with poor sleep because of the compounding variables that older adults often experience, such as being more vulnerable to chronic disease, physical disabilities and ongoing medical interventions (Kredlow et al., 2015).

An aspect of physical health is older adults' ability to partake in physical activities. A national US survey focusing on the general population of America showed that the prevalence of inactivity is increasing (Whitfield et al., 2021). In New Zealand, adults aged over 65 years are less likely to be doing 30 minutes of exercise on five or more days of the week than younger individuals, with under 50% achieving this goal (Ministry of Health, 2015). Clinical trials and systematic reviews have found that physical activity is associated with better sleep quality. For example, Huang et al. (2023) found longer sleep latency, greater wakefulness after sleep onset, poorer sleep efficiency, and poorer subjective sleep quality, were all associated with lower reported levels of physical activity. Huang used the PSQI and actigraphy of 116 participants with a mean age of 71.9 years that showed subjective higher sleep quality, shorter sleep duration and higher levels of sleep efficiency were all positively associated with greater physical activity. Furthermore, morning-type individuals were less likely to have adverse associations between poor subjective sleep quality and physical activity. It has also been found that attending to the dimensions of sleep health can also improve the level of physical activity, with less reported daytime sleepiness and fewer daytime naps (Huang et al., 2023). Other studies have observed that sleep quality is highly associated with higher reported levels of physical activity in older adults (Cunningham et al., 2020). Unfortunately, older adults who are underactive are less likely to age healthily and are more likely to have major chronic diseases, cognitive impairment, and major limitations of physical function (Best et al., 2019). In comparison, Best et al. (2019) found no association between sleep health and physical activity, which was not consistent with the latest literature. The study used an actigraphy watch to measure physical activity over 14 days in 152 community-dwelling adults aged 53 to 101 years old. Sleep quality was also measured by wrist-worn actigraphy as well as a consensus sleep diary, which asked the participant to describe aspects of sleep including number of awakenings, overall sleep quality and any

additional comments. Best et al. (2019) were able to determine, using wrist-worn actigraphy, that increasing physical activity increased the probability of improved sleep quality (i.e. efficiency, less wakening's, and improved duration and latency), with less emphasis on sleep impacting physical activity. They also found no associations between physical activity and other measures of sleep quality, fragmentation, efficiency or latency. The study is an important part of understanding with more confidence how physical activity is a factor that impacts sleep, because of its use of objective measures. Other studies have been largely based on subjective reports. Older adulthood is a period where there is a likelihood of a decline in levels of physical activity, loss of mobility and functional independence.

One aspect of physical health that has been found to affect sleep in the general population is body mass index (BMI). It is a key contributing factor to poor sleep, which studies have found to be a good indicator of the level of risk in both older and younger populations (Bliwise, 1993). Interestingly, Gooneratne and Vitiello (2014), found that obesity-related OSA was less likely in adults aged 70 years and over. The literature suggests that the treatment of sleep disorders like OSA can lead to dramatic improvements in symptoms in older adults, even within the context of comorbidities and mental health conditions (Lavoie et al. 2018).

There has been limited research in NZ on how physical activity is associated with poor sleep among older adults. In a study by Paine et al. 2016, using the New Zealand Health survey for persons aged 15 years and over, found that poor sleep was significantly associated with poorer rates of physical health (as measured via single-form questions from the SF-36 questionnaire) and adverse health outcomes such as heart disease. The study provided a first insight into physical health and its association with poor sleep in NZ, however, it has not been explored in the older population.

Mental Health

Research has consistently demonstrated that there is a strong bidirectional association between mental health and poor sleep across the lifespan (Scott et al., 2021). Mental health disorders, such as depression, constitute a well-known comorbidity that has adverse effects on sleep. For example, depression has been well recognised as significantly and independently increasing the likelihood of poor sleep in older adults (Barczi & Teodorescu, 2017). Recent research found that older adults experiencing depression had an increased time from wake to sleep onset, decreased sleep efficiency, a higher number of nighttime arousals, increased early-morning wakefulness, and less total sleep time than older adults without depression (Barczi & Teodorescu, 2017; Thase, 2006). Other notable changes were changes to both REM and slow wave sleep (Plante, 2021). In a review of the research, Thase (2006) found that the majority of people diagnosed with a depressive disorder also reported sleep disturbances. Similar findings were made in a systematic review by Smagula et al. (2016), which found that depressed mood was highly associated with poor sleep in 10 out of the 13 selected studies. The review focused on population-based research, specifically on older adults. However, only two studies used objective measures of poor sleep. Other methods used were well validated indexes for sleep quality (Buysse, 1989). Lee et al. (2019) found a significant association between anxiety and poor sleep quality, which suggested that anxiety symptoms in older adults may also contribute to sleep fragmentation and reduced time spent asleep. These findings are consistent with a recent study by Kennair et al., (2022), which explored anxiety and depression symptoms and insomnia in a sample of 1069 Norwegian adults aged 60 years and over. Measures for anxiety, depression and insomnia were well-validated tools and showed that there was a moderate association between anxiety, depression and insomnia. One limitation of this study, however, is that the sample had relatively low levels of reported symptoms of anxiety, depression and insomnia. For some older adults life

changes, such as retirement, can impact mental health (Arber et al., 2009) leaving them vulnerable to changes in sleep quality.

Recent evidence has suggested that poor sleep may precede depression, with research indicating that older adults with poor sleep have a higher risk of developing mood disturbances. For example, in one longitudinal study using 3824 adults aged 65 years and older, Jaussent et al. (2011) found that all participants were originally free of depressive symptoms at baseline and with follow-ups at 2 and 4 years. Follow ups found that poor sleep is not only a predisposing factor for depression but also an independent risk factor for developing depression. Furthermore, the study found that insomnia was significantly associated with the development of depression among older adults. Similar findings were made by Bao et al. (2017), who conducted a meta-analysis and systematic review of the prevalence of poor sleep and depression in community-dwelling older adults (60 years and older). The review found a high prevalence of sleep disturbances (30.5%) and depressive symptoms (18.1%) with high rates of co-occurrence (10.6%). The meta-analysis concluded that older adults with persistent sleep disturbances had a higher risk of poor sleep, such as onset, worsening and reoccurrence of depression, compared to older adults without self-reported sleep disturbances. The literature is conflicted in understanding the relationship between sleep and depression. However, the more recent studies suggest there is not a cause and effect relationship, but rather a complex bidirectional relationship.

Other studies have produced contradictory findings, such as no association being found between mood and poor sleep. For example, Gureje et al. (1999) noted that it is possible for mood to change over time and that the appearance of depression was not necessarily a risk factor for older adults developing poor sleep. While this study had a large sample size of older adults, it is noted that poor sleep may also worsen depression and some

physical illnesses, so it remains important to identify and treat sleep problems in order to prevent a cycle of risk relationships detrimental to overall health.

In an NZ study, Gibson et al. (2016) used the LiLACS NZ data, which consisted of 251 Māori and 398 non-Māori, between 79 and 90 years of age. Poor sleep was rated using a single item "Do you have trouble with your sleeping (on at least 3 nights per week), such it interferes with your activities the next day (eg, unrefreshed in the morning, fatigue, poor concentration, or irritability?)". Using multiple logistic regression, the study identified that poor sleep was related to poorer mental health. Furthermore, participants who reported current poor sleep had significantly lower mental health status compared to participants who reported good sleep. Participants who did report poor mental health status were most likely to have depression. In another NZ study, data from NZHS was analysed and indicated that lower SF-12 mental scores had a significant independent relationship with sleeping atypically (long or short sleep) in older adults. In a first of its kind, Cunningham et al. (2019) set out to describe the mental health of older adults in NZ using District Health Board data in a programme for integration of mental health data. They found that 81% (of those aged 65 – 74 years) and 86% (of those aged 85 years old and above) of participants using mental health services were European, and the majority were female (two thirds). While indicators of sleep and mental health have been included in studies concerning older NZ adults, sleep has not been a key focus and therefore findings have been limited to short-form or individual items. Further research using long-form measures is essential in understanding the association between poor sleep and mental health.

Cognition

There are both structural and functional changes in the brain that correlate with age, including neuronal loss, loss of synapses, and overall cognitive dysfunction (Murman, 2015). A strong bi-directional relationship exists between cognition and sleep, which is well-

researched in the international literature. The ageing process is well known to impact cognitive functioning. With age come pathological changes to brain regions that help to control the sleep/wake cycle (da Silva, 2015). Yu et al. (2017) found clear differences between older people with a mild cognitive impairment and a control group in several sleep-related areas, including sleep duration, sleep disturbances, sleep latency, sleep quality and daytime sleepiness. The mild cognitive impairment group had lower mean scores for all of the sleep health factors. These results have been replicated elsewhere. For example, Muangpaisan et al. (2008) found that older adults with mild cognitive impairment experienced more night-time sleep-disturbed behaviours, such as waking up and getting out of bed (45.5%) compared to older adults with normal cognitive functioning. Likewise, da Silva found that older adults in Laos with a diagnosis of Alzheimer's disease (a progressive neurodegenerative dementia) reported a higher prevalence of poor sleep, compared to non – cognitively impaired older adults. Da Silva maintained that the pathologic changes in cognitive functioning associated with Alzheimer's disease go on to impact sleep architecture, which can exacerbate cognitive decline. Due to the impact of sleep architecture, and the function of the sleep stages, this can have effects on cognitive processes such as memory. Taken together with previous findings, the weight of the evidence suggests that individuals with mild cognitive impairment have poorer sleep quality compared to cognitively healthy older adults. One thing to consider is the psychological impact of experiencing cognitive decline and how this may impact sleep health. However, the prevalence of older adults reporting poor sleep is noticeably high among those experiencing mild cognitive impairment and other dementias.

There is also a large body of literature focused on how sleep impacts cognition. Hughes et al. (2018) investigated the association between total sleep time and cognitive function by categorising participants into groups according to their reported amount of

nighttime sleep. The study found that participants with an average night-time sleep total of between 6.1 and 7 hours had the highest cognition scores overall. In another recent review, Dzierzewski et al. (2022) found that there were mixed results in the literature relating sleep and cognitive functioning. One finding is that longer sleep onset latency is associated with poorer verbal memory and executive functioning, and greater total wake time is associated with lower psychomotor speed and memory. The review also found that increased REM duration, sleep efficiency and maintenance efficiency were associated with higher cognitive processing speeds and executive functioning in older adults. The review highlights that although there is strong evidence that sleep is associated with cognitive functioning, there is also some conflicting evidence. The association between cognition and sleep is not straightforward, with a large number of normative age-related changes contributing to the decline of both sleep and cognition in older adult. Dziereswki pointed out that there was one study in which no associations were found between sleep duration and cognitive abilities. Similarly, Blackwell et al. (2006) used actigraphy to measure total sleep time, sleep efficiency, sleep latency, total nap times, and wake after sleep onset in 2932 women (mean age 83.5 years old). Cognitive function was measured using validated measures. The study found that women with sleep efficiency 70% or lower, higher sleep latency, higher waking after sleep onset, and who napped two or more hours per day, had a higher risk of cognitive impairment. The study found no significant relationship between total time asleep and cognitive impairment.

Although there is a large body of international research specifically looking at the relationship between sleep and cognition, studies are lacking in NZ. Sleep and cognitive functioning are highly associated with one another. However, the exact nature of how they interact is yet to be determined. There is an opportunity to improve understanding of the relationship between poor sleep and cognitive impairment, as measures of cognition have not

been well represented or investigated in previous studies on sleep and ageing (Gibson et al., 2020, 2023). Given the strong bi-directional association between cognition and sleep, it is important to create more effective interventions to manage and treat poor sleep to potentially slow the cognitive decline created by poor sleep in older adults. Early diagnosis of poor sleep or cognitive decline needs to be considered to help older adults age healthily.

Summary

With an ageing population, it is important to understand why older adults are experiencing poor sleep, as it is not considered a normal part of the ageing process. It is important to acknowledge that sleep health and poor sleep are multifactorial and can be complex to understand. Identifying how these factors are associated independently with poor sleep is needed to enable changes to health policy and remove barriers that prevent older adults ageing healthily and being able to continue to live independently. This study used a data set from the AWESSoM research programme (Lord et al., 2022) which was begun on 19 July 2021. The data set consists of older adults aged 60 plus (Māori and Pacific) and 75 plus (non-Māori). This survey was a first for NZ, with a focus on sleep in older adults, and used long-form, well-validated sleep measures. To date, there has been limited research conducted in NZ that has specifically focused on sleep in older adults. The present research aimed to gain insight into the various independent factors and their relationship to poor sleep, thus filling the research gap.

The aims for this thesis were as follows:

1. Describe the sleep health of community-based older New Zealanders
2. Investigate the demographic and health-related factors associated with poor sleep defined firstly by measures of ‘poor sleep’ quality and secondly by a measure of sleep disordered breathing

Based on previous research, it was hypothesised that:

1. More older adults would report being ‘poor sleepers’ than ‘good sleepers’, due to the use of more comprehensive measures that may capture higher rates of ‘poor sleep’ than previous research
2. Demographic factors would be associated with poor sleep quality: e.g., female, Māori, older age
3. Participants identified defined as having poor sleep quality would be more likely to have lower cognitive function, lower rates of mental and physical health, consume daily alcohol, have more comorbidities, and have less ability to perform activities of daily living.
4. Participants identified as being at moderate to high risk of obstructive sleep apnoea would also be more likely to have poor sleep quality.
5. Participants who were identified as being at moderate to high risk of obstructive sleep apnoea would be associated with lower rates of mental and physical health, consume daily alcohol, have more comorbidities, and have less ability to perform activities of daily living, compared to the group who had low risk of OSA.

Methods

This section discusses the use of quantitative research methods to describe sleep health and investigate factors associated with poor sleep in community-dwelling older NZ adults. Secondary data from the AWESSoM research programme was used to achieve the aim of the current thesis.

AWESSoM Research Programme

The AWESSoM research programme aimed to deliver five integrated studies across various ethnicities and ages within NZ to optimise wellbeing and reduce the functional decline and dependence that is often associated with ageing (Lord et al., 2022). The research programme was based on the reasoning that maintaining independence is crucial to older adults and anticipated that the data would provide ways to guide health strategies that might strengthen community-level support to whanāu to help older adults age well.

Questionnaire

The measures used in this thesis were applied in the AWESSoM study because they had been validated in previous research and were considered to be appropriate and practical for older adults. Demographic details gathered by the AWESSoM study were analysed to understand the nature of the sample of older adults, along with specific data on the samples' physical and mental health, polypharmacy, cognitive functioning, ability to cope with activities of daily living, sleep quality, and sleep health. The measures were used to gain insight into the sleep health of older adults and factors that might predict or be associated with poor sleep. Each of these measures are described below. For a detailed overview of the complete AWESSoM survey see Appendix A.

Recruitment of Participants

Participants were drawn from an existing dataset, which was part of the AWESSoM programme in Aotearoa/New Zealand (NZ) (Lord et al., 2022).The data were part of a wider study that aimed to deliver five integrated studies across varying ethnicities and ages to understand how to optimise well-being in older adults and begin to understand the functional decline and dependence associated with age.

Inclusion/exclusion criteria

The inclusion criteria were that the participants were community-dwelling, at least 60 years old for Māori and Pacific and at least 75 years old for non-Māori. Participants had to be in the early stages of functional decline as indicated by self-identified functional deficits on a life-curve app trajectory. Participants were excluded from the study if they were not able to give consent or resided in assisted or palliative care.

Procedure

The survey opened on 19 July 2021 and used two key sites to recruit participants (Tauranga and Howick, Auckland) via the Easthealth Primary Health Organisation. Other recruitment strategies included planned workshops in health centres, local and national advertisements, medical practices, national organisational support, and social media.

Interviews were conducted face-to-face, and surveys were completed. Participants responded directly or family members were able to respond on their behalf. The AWESSoM survey was 39 pages long and contained 11 sections (See Appendix A). Out of the 90 participants, 88 (97%) answered all the questions in the survey. Two participants withdrew from the survey before BMI and neck circumference could be collected. These participants were therefore excluded from the data, because BMI and neck circumference formed part of the STOP-Bang measure.

Due to COVID-19, there were issues with gaining access to ‘at risk’ older adults. During the period of data collection, the Auckland region went through periods of social restrictions in response to the COVID-19 pandemic. Older adults in NZ were advised to stay in their ‘bubble’ to ensure their health. Older adults who were at risk of functional decline were vulnerable to COVID-19, which created a barrier to recruiting participants for the survey. Inclusion criteria were broadened due to at-risk older adults being more likely to be socially distancing at the time of data collection.

Sleep-Related Measures

Sleep was measured in three ways: sleep quality, sleep disordered breathing, and chronotype

Sleep Quality

The subjective measure used to assess the samples' sleep health was the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1988). This is a self-rated questionnaire specifically aimed to measure sleep quality and disturbances over a 1-month period. The PSQI measure has been described as the most well-used subjective measure of sleep and is considered the ‘gold standard’ for self-perceived sleep quality compared to other sleep measures, such as the insomnia severity index (Fabbri et al., 2021). The PSQI has internal consistency and a reliability coefficient (Cronbach alpha) of 0.83. It has been used in older adult populations has high validity and reliability (Smyth, 2008).

The PSQI consists of 19 self-rated questions, which together assess sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunctions (Buysse et al., 1989). The questionnaire consists of the following questions:

1. When have you usually gone to bed?
2. 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 numbers of hours you spend in bed)

The following questions are asked “During the past month, how often have you had trouble sleeping because you…” using ordinal measures of: “Not during the past month = 0”, “less than once a week = 1”, “Once or twice a week = 2”, Three or more times a week = 3”.

5. 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)
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?
9. During the past month, how would you rate your sleep quality overall?

The 19 self-reported questions are scored and grouped into seven components, each with an equal weighting between 0 and 3. The seven scores are then calculated as a global score, which is rated 0 – 21. Lower scores indicate higher sleep quality than higher scores, with a cut-off score of >5 indicating that a participant is a 'poor sleeper'. There are five additional questions for a bed partner, which were not included in the global score for the purpose of the present study.

A component of the measure 'How do you rate your sleep quality overall?' was used separately to determine how participants perceived their sleep. These were rated as 'very bad', 'fairly bad', 'fairly good', and 'very good'. This measure was analysed to assess the difference between self-reported sleep quality and perceived sleep quality.

STOP-Bang Questionnaire

The STOP-Bang questionnaire is a tool commonly used to screen patients for OSA. It consists of eight items that assess an individual's risk of OSA.

Items included the following:

1. Do you snore loudly?
2. Do you often feel tired, fatigued, or sleepy during the daytime?
3. Has anyone observed you stop breathing during sleep?
4. Do you have (or are you being treated for) high blood pressure?

STOP-Bang is scored using yes/no (Answers 1/0). Scores range from 0 – 8, with higher scores representing a likelihood of OSA. As part of this measure, participants' Body Mass Index (BMI) was determined using the formula weight (kgs) over height squared (m^2). BMI was then categorised as overweight (BMI 25.0 – 29.9), normal (BMI 18.5 – 24.9) or underweight (BMI <18.5). Neck circumference was also recorded in centimetres (cm). A cut-

off score of >3 indicates a high sensitivity for detecting OSA: 93% and 100% for moderate and severe OSA respectively (Chung et al., 2012).

Reduced Morning-Eveningness Questionnaire

The reduced morning-eveningness (rMEQ) questionnaire was designed to identify whether a participant has a morning or evening preference, also termed chronotype. The rMEQ is a self-report questionnaire developed by Adan and Almirall (1991) following criticisms of the original MEQ scale (Horne & Ostberg), which was believed to be too long.

The measure uses five items from the original 19-item MEQ measure:

1. Considering only your own rhythm, at what time would you get up if you were entirely free to plan your day?
2. After the first half hour after having woken in the morning, how tired do you feel? (after your final wake up).
3. At what time of the day do you think that you reach your 'feeling best' peak? (approximately)
4. One hears about 'morning types' and 'evening types'. Which one of these types do you consider yourself to be?

The total scores of the 5-item rMEQ range from 2 to 26. A higher score indicates a preferred Morningness chronotype, while a lower score indicates an Eveningness chronotype. The cut off scores for this measure were Eveningness: < 12; neither: 12 -17; Morningness: >17. The measure has been validated in many countries (Danielsson et al., 2019), with an internal consistency of $\alpha = 0.68$.

Demographic and Health-Related Measures

Demographics

Age was calculated in years at the time of the survey being completed. To be eligible to complete the survey, participants had to be aged at least 75 years (non-Māori), with a lower threshold of 60 years for Māori and Pacifica participants. Age was analysed as a continuous variable at univariate and regression levels.

Ethnicity was determined by asking participants to indicate, "What ethnic group(s) do you belong to?". Participants could respond with one or multiple ethnicities. Participants were asked to confirm their gender, as "male", "female", or "other". A non-response was coded as "refused".

General Health

Smoking, alcohol consumption, number of medications, and number of comorbid health issues were taken from the "medical and health" section of the AWESSoM survey. Smoking was answered as either a "yes" or "no" to currently smoking. Alcohol consumption was answered by "0=never", "1=less than monthly", "2=monthly", "3=weekly", "4=daily or almost daily". Medications were collected as a table of recorded medications. Participants were given a list of medical conditions and asked if they had any significant medical history or major health problem that a doctor had confirmed. Smoking was recorded as "yes" or "no".

Short-Form Health Survey (SF-12)

The SF-12 survey is a 12-item questionnaire designed to assess overall health from a participant's perspective (Ware et al., 1996). The SF-12 is a published shortened version of the Short-Form 36 (SF-36; Ware, Kosiniski, & Keller, 1996) that provides reliable information with the use of only 12 items to reconstruct a Mental Component Summary (MCS) and a Physical Component Summary (PCS) (Ford et al., 2000; Frieling et al., 2013;

Sanderson & Andrews, 2002; Ware et al., 1996). The SF-12 is considered a reliable and valid substitute measure for the SF-36, particularly when the MCS and PCS scores are of interest (Frieling et al., 2013). Twelve items from the SF-36 were selected to best represent MCS and PCS, with two each from the physical functioning, role-physical, role-emotional and mental health subscales and one each from the bodily pain, general health, vitality and social functioning subscales (Sanderson & Andrews, 2002). The measure uses a Likert scale to rate each item. However, the way in which the SF-12 is scored is not straightforward. Each component (physical and mental) is calculated separately. Each component then has a raw total score. Both the mental and physical component are then given a standardised score, which is then compared to a mean and standard deviation. In the US population the mean score is 50 and the standard deviation is 10 (Frieling et al., 2013). The higher the score, the higher the level of health and functioning.

The questionnaire has been found to be a reliable and valid measure that can be used with confidence to measure health status outcomes for older adults (Resnick & Parker, 2001). Internal consistency of the revised SF-12 has been determined using Cronbach alpha coefficients of 0.72 – 0.89, with test-retest reliability (r=0.73–0.86) (Resnick & Parker, 2001).

Nottingham Extended Activities of Daily Living (NEADL)

The Nottingham Extended Activities of Daily Living (NEADL) questionnaire focuses on assessing an individual's self-reported functional ability and has been found to be a reliable measure of functional status (Nouri, 1987). The measure has high re-test reliability and validity (Green & Young, 2001).

The NEADL has 22 items that focus on four domains of function: mobility (6 items), domestic (5 items), kitchen (5 items), and leisure (6 items). Responses are evaluated as; “No (not performed) 0 points”; “with help (1 point)”; “on my own but with difficulty (2 points)”;

"On my own easily (3 points)". Each subsection total is calculated, with overall combined subsection totals ranging between 0 and 66 points. Higher scores indicate high levels of independence and function (Sahin et al., 2008).

The Rowlands Universal Dementia Assessment Scale

The Rowlands Universal Dementia Assessment Scale (RUDAS) is a scale used to assess cognitive performance and is a reliable method of detecting dementia (Storey et al., 2004). The scale was developed as a simple method of detecting cognitive impairment, which is valid across cultures and easily administered in a short time frame by healthcare professionals (Storey et al., 2004)

The RUDAS covers six aspects: memory, visuospatial orientation, praxis, visuo-constructional drawing, judgement, and language. Instructions are read to the participants. For example, item 6, "I am going to time you for one minute. In that one minute, I would like you to tell me the names of as many different animals as you can….". The scale has a score interval of 0 – 30 points. The ability of RUDAS to detect cognitive impairment at a cut-off score of < 22 showed sensitivity of 78.4% and specificity of 85.1%. The measure also showed to have high reported rates of inter-rater (0.99) and test re-test (0.98) reliabilities (Storey et al., 2004). The RUDAS is also shorter than other cognitive screening measures, such as the Montreal Cognitive Assessment.

Ethics

Approval for the AWESSoM study was obtained from the Central Health and Disability Committee (Ref: ACTRN12621001679875). Participation in the survey was voluntary, and participants remained anonymous. Application to obtain the data was made to the AWESSoM research group (led by Professor Ngaire Kerse) with a research proposal. Once the formal request was made, the data were released without identifiable material to protect participant privacy. Data were stored in a password-protected file.

Data Analysis

Data were analysed using SPSS 29.00 software (IBM Corp, 2022). Kolmogorov-Smirnov normality tests were run on variables (see Appendix B for results table). Continuous variables were described using mean, median, standard deviation and range, while categorical variables were described using frequency percentages.

To answer the main research question, the present study dichotomised both of the key sleep scales (i.e. sleep quality using the PSQI and risk of OSA using the STOP-Bang) to understand what factors were associated with these different forms of sleep assessments. The rMEQ was measured as a factor to describe the chronotypography of the sample, however, was not used to define 'poor sleep' alone.

Sleep quality category was determined by the total PSQI (0=21) calculated for each participant and was categorised using the PSQI's cut-off score of >5 (Buysse, 2014). Participants' sleep quality was dichotomised and categorised as either "good sleep" (<5) or "poor sleep" (>5) to allow for categorical analysis.

Risk for OSA was dichotomised from the STOP-Bang measure and categorised as either "low risk of OSA" or "moderate to high risk of OSA' to allow for categorical analysis. This was determined by the total score for each participant. This was determined by a low risk > 3, and moderate to high risk < 3.

Ethnicity was categorised as "Māori" and "Non-Māori" due to the low percentage of participants who identified outside of these ethnic groups. Therefore, ethnicity was coded simply as a dichotomous variable.

Smoking was removed from the descriptive statistics and not included in the univariate or regression models because all participants recorded themselves as "non-smokers".

Alcohol consumption was categorised into two groups: “daily alcohol use” and “not daily alcohol use”. Medications were recorded as continuous variables for the purpose of descriptive statistics, but polypharmacy was used as a categorical variable (yes, ≥ 5 medications, or no polypharmacy) for the univariate and regression models. Comorbidities were used as a continuous variable.

Relationships to both poor sleep quality and sleep disordered breathing were explored using Chi-Square analysis and Mann-Whittney *U* tests. Followed by logistic regression models to ascertain independent relationships with poor sleep.

Results

Descriptive Statistics

The original data set (Lord et al., 2022) had 90 participants, subsequently reduced to 88 due to two participants missing data for BMI and neck circumference, which was needed to calculate the STOP-Bang measure. The 88 participants had a mean age of 80.2 years (SD= 6.6, Range= 63-93), 70.5% were female and 29.5% were male. The majority of the sample were not Māori (87.5%), with a small percentage of 12.5% reporting as Māori. Due to low statistical power, ethnicity was not further analysed. Descriptions of the sample and the key variables can be found in Table 1.

In regard to general health, the majority of the sample did not drink alcohol daily (76.1%). More than half of the sample recorded day napping (53.4%), took five or more prescribed medications daily (62.5%, range 0-16), all but one participant scored as 'at risk' of a possible mild cognitive impairment on the RUDAS screening, with 98.9% reporting no mild cognitive impairment. NEADL scores ranged from 6 to 22 (a score of $\geq$ 22 indicating impairment). SF12 scores varied, the mental component ranging from 16.32 to 67.85 and the physical component ranging from 15.20 to 46.80. The entire sample did not smoke (100%) therefore this factor was not included in further analysis.

A large proportion of the questionnaire variables were not normally distributed, so the assumptions were not met for the use of parametric tests. Non-parametric tests were deemed more appropriate for conducting statistical analyses. Non-parametric tests factor in deviations from normality and do not rely on a normally distributed population (Nahm, 2016). Therefore, the use of non-parametric tests, such as the chi-square, Mann-Whitney *U*, and binary logistic regression, was justified to ensure the validity of the analyses. The descriptive statistics and test of normality can be found in Table 1.

Table 1

Descriptive statistics of continuous variables (n=88)

	Mean	SD	Median	IQR	Skewness	Kurtosis
Age (years)	*80.24*	*6.60*	*80.50*	*9*	*-0.524*	*0.299*
Total health comorbidities (count)	*4.28*	*2.43*	*4.00*	*4*	*0.245*	*-0.712*
Number of prescriptions (count)	*5.75*	*4.01*	*5.00*	*6*	*0.566*	*-0.153*
NEADL total	*19.61*	*2.53*	*20.00*	*2*	*-2.56*	*9.64*
SF12 physical	*31.68*	*6.39*	*32.06*	*9.58*	*-0.175*	*-0.155*
SF12 mental	*53.90*	*11.65*	*57.33*	*14.47*	*-1.163*	*0.881*
RUDAS total	*27.00*	*2.21*	*27.00*	*3*	*-0.345*	*-0.724*
PSQI global score	*6.42*	*3.29*	*6.00*	*6*	*0.480*	*-0.416*
Bedtime	*20:38*	*5:10*	*22:00*	*1:30*	*-3.651*	*12.242*
Rise time	*7:19*	*00:58*	*7:22*	*1:15*	*0.137*	*1.678*
Sleep duration	*7.15*	*1.32*	*7.00*	*2*	*0.187*	*1.966*
Sleep efficiency	*77.31*	*15.69*	*78.26*	*21.78*	*-0.217*	*1.863*
BMI	*28.86*	*5.45*	*27.66*	*8.57*	*0.603*	*-0.572*

NEADL: Nottingham Extended Activities of Daily Living, SF-12: Short-Form Health Survey RUDAS: Rowlands Universal Dementia Assessment Scale, PSQI: Pittsburgh Sleep Quality Index, BMI: Body Mass Index

Indicators of Poor Sleep Quality

In this sample of older adults, participants recorded a mean bedtime of 20:38 (median = 22:00). Rise times were recorded a mean time of 7:19 (median = 7:22). However, participants reported an average sleep efficiency of 77%. Almost half of the participants reported being a "moderate to definitely" morning chronotype (48.9%). Almost a third (31.8%) of the participants considered their overall sleep quality "very good", and 54.5% considered their sleep quality "fairly good" overall, compared to 12.5% who considered their quality of sleep to be "fairly bad". The median global PSQI score was 6.00 (range 3 – 12), and 55.7% were identified as "poor sleepers" (defined by a PSQI score of >5, here described as the "poor sleepers" group").

Univariate analyses between "good" and "poor" sleepers (defined by PSQI) revealed that there were no significant differences between groups with regard to categorical variables (using Chi-Square analysis, see Table 2). Mann-Whitney *U* tests indicated significant differences in RUDAS scores between "poor" and "good" sleepers (see Table 3).

Table 2

Comparisons of good vs poor sleepers (defined by PSQI) with regard to Categorical Variables (Chi-Square Analysis)

	Good Sleep	*Poor Sleep*	*X2*	*P (two-tailed)*
Female	41.9%	58.1%	.483	.487
Male	50.0%	50.0%		
Not Daily alcohol	49.3%	50.7%	2.771	.096
Daily Alcohol	28.6%	71.4%		
No day Naps	46.3%	53.7%	.127	.721
Day Naps	42.6%	57.4%		
No Polypharmacy	48.5%	51.5%	.371	.542
Polypharmacy	41.8%	58.2%		
Low Risk OSA	44.2%	55.8%	.001	.981
Mod-High Risk OSA	44.4%	55.6%		
Chronotype not Morning	40.0%	60.0%	.696	.404
Chronotype Morning	48.8%	51.2%		

A Mann-Whitney *U* test indicated that the RUDAS scores of the poor sleepers (*Mean Rank* = 39.16, *n* = 49) were significantly lower than those of the good sleepers (*Mean Rank* = 51.21, *n* =39), *U* = 694.00, *z* = -2.227, *p* = .026, two-tailed. This effect can be described by Cohen's (1988) conventions as 'medium' (r = .03).

Table 3

General health measures scores comparing Good Sleep and Poor Sleep (Mann-Whitney U Test)

	Good sleep Median	Poor sleep Median	*U*	*P*(two-tailed)
Age	80	81	918.00	.752
Comorbidities	4	4	881.50	.531
NEADL	21	20	881.50	.526
SF12 Physical	31.94	32.18	913.00	.721
SF12 Mental	57.34	57.33	833.00	.303
RUDAS	28	26	694.00	.026

NEADL: Nottingham Extended Activities of Daily Living, SF-12: Short-Form Health Survey RUDAS: Rowlands Universal Dementia Assessment Scale

Sleep duration and sleep efficiency were also indicated by the Mann-Whitey *U* test as statistically significant. However, because they were part of the PSQI measure, no further analysis was carried out on these variables.

Binomial logistic regression was used to examine which factors were independently associated with being in the poor sleep quality group. The model showed RUDAS to be statistically significant, $X2$ (1, N=88) = -.307, p = .022. This showed that, with each point increase on RUDAS, participants were 0.73 times less likely to report poor sleep (OR = 0.736, 95% CI, 0.57 – 0.96). The model also showed females to be a significant predictor of poor sleep (OR = 4.098, 95% CI, 1.18 – 14.08).

The model explained between 14.5% (Cox & Snell R square) and 19.4% (Nagelkerke R square) of the variance in the dependent variable and correctly classified 69.5% of cases.

Table 4

Binary logistic analysis exploring factors independently related to being in the PSQI "poor sleep"

				95% CI	
	B	Sig.	OR	Lower	Upper
Gender (females)	-1.409	.026	0.244	1.18	14.08
Age	-0.036	.341	0.965	0.895	1.039
Daily Alcohol	1.158	.068	3.185	.917	11.060
Comorbidities	-0.013	.916	0.988	0.782	1.248
Polypharmacy (yes)	0.454	.471	1.574	0.459	5.402
NEADL	-0.074	.553	0.929	0.727	1.186
SF12 Physical	-0.032	.539	1.032	0.933	1.143
SF12 Mental	-0.017	.538	0.984	0.933	1.037
RUDAS	-0.307	.022	0.736	0.566	0.957

NEADL: Nottingham Extended Activities of Daily Living, SF-12: Short-Form Health Survey RUDAS: Rowlands Universal Dementia Assessment Scale

Indicators of Obstructive Sleep Apnoea

Using the STOP-Bang, it was found that that 51.1% were deemed of moderate to high risk of OSA. The variables of interest were dichotomised for the chi-square analysis, which can be seen in Table 5. These showed that there was a significant relationship between gender and being in the moderate-high risk group of OSA X^2 (1, N=88) = 20.576, p= <.001 when compared to the low-risk group for OSA. Males were more likely to be at moderate to high risk for OSA (88.5%) than females (35.5%).

There was also a significant relationship between day napping and being at moderate to high risk of OSA X^2 (1, N=88) = 4.507, p= .034. In total, 61.7% of older adults who day napped were at moderate to high risk of OSA compared to 39% of those who did not nap.

Finally, there was a statistically significant relationship between polypharmacy (prescribed ≥5 medications) and moderate to high risk of OSA X^2 (1, N=88) = 4.61, p= .032. Participants who used >5 prescriptions were more likely than those who used less than 5 prescriptions to be at moderate to high risk of OSA (60% vs 36.4% respectively).

Table 5

Comparisons of good vs poor sleepers (defined by STOP-Bang) with regard to categorical variables (Chi-Square Analysis)

	Low Risk	*Moderate/High Risk*	X^2	*P (two-tailed)*
Female	64.5%	35.5%	20.576	<.001
Male	11.5%	88.5%		
Not Daily alcohol	47.8%	52.2%	.137	.712
Daily Alcohol	52.4%	47.6%		
No day Naps	61.0%	39.0%	4.507	.034
Day Naps	38.3%	61.7%		
No Polypharmacy	63.6%	36.4%	4.611	.032
Polypharmacy	40.0%	60.0%		

Table 6 outlines continuous variables split by low risk of OSA and moderate to high risk of OSA. A Mann-Whitney *U* test indicated that the number of health comorbidities was significantly higher in the moderate to high-risk of OSA group (*Mean Rank* = 50.72, *n* = 45) compared to those in the low-risk of OSA group (*Mean Rank* = 37.99, *n* = 43), *U* = 687.50, *z* = -2.35, *p* = .019, two-tailed. This effect can be described as medium (*r* = .25).

Total prescriptions were also significant. The Mann-Whitney *U* test showed that the number of prescriptions in the moderate to high-risk group (*Mean Rank* = 50.02, *n* = 45) was

significantly higher than those in the low-risk OSA group (*Mean Rank* = 38.72, *n* = 43), *U*= 719.00, *z* = -2.086, *p* = 0.37, two–tailed. This effect can be described as medium (*r* = .22). No other variables were considered statistically significant, as illustrated in Table 6.

Table 6

Demographic, General Health, Mental Health, and Sleep Health variable scores comparing Low risk of OSA group and Moderate to high-risk of OSA group (Mann-Whitney U Test)

	Low risk OSA	Mod/high risk OSA		
	Median	Median	U	P(two-tailed)
Age	82	80	777.50	.112
Comorbidities (count)	3	5	687.50	.019
NEADL (count)	21	20	800.50	.155
SF12 physical (count)	33.15	31.90	798.50	.158
SF12 mental (count)	59.04	55.68	884.50	.488
RUDAS (count)	28	27	792.00	.138
PSQI global score (count)	6	6	949.50	.880

NEADL: Nottingham Extended Activities of Daily Living, SF-12: Short-Form Health Survey RUDAS: Rowlands Universal Dementia Assessment Scale, PSQI: Pittsburgh Sleep Quality Index, BMI: Body Mass Index

Binary logistic regression was used to analyse the relationship between demographics, general and mental health and being categorised as having a moderate to high risk of OSA compared to a low risk (Table 7).

Holding all other predictor variables constant, the odds of a participant being at moderate to high risk of OSA increased by 92.34 (95% CI [9.67, 887.19]) for males compared to females.

Age was also significant, for every year's increase in age, participants were found to be 0.86 times less likely to be at moderate to high risk of OSA (95% CI [0.777, 0.965]).

It was also found that, when controlling for other variables in the analysis, total health comorbidities were significant , with each health comorbidity increasing a participant's odds by 1.503 of being at moderate to high risk of OSA (95% CI [1.085, 2.083]).

Table 7

Binary logistic analysis exploring factors independently related to being at moderate to high risk of OSA

				95% CI	
	B	Sig.	*OR*	Lower	Upper
Gender (Male)	4.526	<.001	92.349	9.607	887.719
Age (63–93)	-0.144	.009	0.866	0.777	0.965
Daily Alcohol (yes)	-1.125	.140	0.325	0.073	1.447
Health comorbidities (0-10)	0.408	.014	1.503	1.085	2.083
Polypharmacy (yes)	0.053	.944	1.055	0.238	1.672
NEADL (6-22)	0.026	.881	0.974	0.693	1.370
SF12 Physical (15.20-46.80)	-0.093	.164	0.911	0.799	1.039
SF12 Mental (16.32-67.85)	-0.010	.764	0.990	0.926	1.058
RUAS (22-30)	-0.223	.167	1.250	0.905	1.726

NEADL: Nottingham Extended Activities of Daily Living, SF-12: Short-Form Health Survey RUDAS: Rowlands Universal Dementia Assessment Scale, PSQI: Pittsburgh Sleep Quality Index, BMI: Body Mass Index

Discussion

The primary aim of this thesis was to describe the sleep health of community-based older New Zealand adults. A further aim was to investigate the demographic and health-related factors associated with poor sleep, defined firstly by a measure of poor sleep quality and secondly defined by a measure of sleep disordered breathing. The following section will discuss the key findings of this study and highlight some key considerations and recommendations.

Sleep Health of older New Zealanders

The first objective of this thesis was to explore the sleep health of community-dwelling older New Zealand adults. Based on previous literature both internationally and within NZ (Garland et al., 2017; Gibson et al., 2020, 2023; Guo et al., 2023; Lo & Lee, 2012; Wang et al., 2020), it was hypothesised that older adults would be more likely to experience 'poor sleep' than 'good sleep', due to the current study utilising more comprehensive measures of sleep compared to previous studies. Here, 55.7% of the sample were defined as 'poor sleepers'. This is similar to previous research by Gordon et al. (2022) in a population of American adults between 65 and 79 years of age. It was found that one-fourth of the older adults sampled got less than the recommended 7 hours of sleep (averaging < 6 hours of sleep), over 40% reported fair or poor sleep quality, and 13% suffered from insomnia. Within NZ, research found that the prevalence of poor sleep among older adults was similar to the younger adults (Gibson et al., 2020; Paine et al., 2019). NZ studies have largely only used single items to indicate poor sleep, which indicate that NZ older adults have similar rates of poor sleeping compared to younger adults. The current study, using more comprehensive measures of sleep, provided results that are more in line with international research. This aligns with theories that focus on the physiological and psychosocial changes that older adults tend to experience, which contribute to poor sleep (Mander et al., 2013). Psychosocial

changes may create changes to sleep attitudes, where older adults are going through social transitions, such as retirement, or changes to their beliefs around what is “poor sleep” and whether they have changes in their attitude indicating that they do not need as much sleep as they did when younger. Changes to sleep architecture have been well-researched in the older adult population and findings suggest that older adults spend less time in the restorative stages of sleep such as REM and SWS, and more time in lighter stages of sleep (Ohayon et al., 2004). Lighter stages of sleep increase the likelihood of arousals by factors such as temperature, noise and other environmental stimuli (Cooke & Ancoli-Israel, 2011). Physical health changes to the eye, deterioration of the suprachiasmatic nucleus, as well as reduced ability to receive regular light exposure and other such time cues can also increase the likelihood of negative impacts on sleep (Kessel et al., 2010). Previous NZ research has been limited to short-form measures to describe the sleep health of older adults. The current study, however, used long-form measures of sleep, giving a better indication of sleep health in NZ. Further research using long-form measures to assess the prevalence of poor sleep in the older adult population in NZ is paramount to correctly address screening and interventions for poor sleep, because of the importance of sleep in overall well-being and good health.

The results were not consistent with current literature that argues poor sleep and OSA commonly occur together (Sweetman et al., 2017). In recent research by Sweetman et al. (2017) it was found that 30 – 40% of participants who experienced insomnia also met the diagnostic criteria for OSA as measured by polysomnography. Furthermore, their study found that 30 to 50% of participants seen for OSA were also experiencing significant insomnia. One theory as to why OSA is commonly associated with poor sleep is that individuals repeatedly stop and start breathing while they sleep (Kalcina et al., 2017). This creates sleep disruptions during the night, as well as excessive daytime sleepiness (Martin et al., 1997). One interpretation of why the current study did not have similar results to the current literature is

that new information now indicates that the STOP-Bang measure is not relevant for older adults. Martins et al. (2020) found that old age correlates with an increased risk of OSA due to neuromuscular mechanisms rather than sex or body mass index. The STOP-Bang measure was found not to be accurate in predicting OSA when compared to its use in younger populations. The reasons for the lack of accuracy in older populations include (1) the fact that older adults more frequently have normal BMIs compared to younger adults; (2) being older than 50 years, which Martins et al. argue, makes this question irrelevant and adds an increase in score; (3) neck circumference also becomes irrelevant because the measure is collinear with both sex and BMI; and (4) sex difference as a risk factor for OSA diminishes in older adults. The difference between the current studies' findings and the current literature may be explained by Martin's argument that the STOP-Bang is not a good measure for OSA in the older population. However, in a study by (Oshita et al. (2020), the STOP-Bang was found to be a reliable measure for the prediction of OSA. Their study consisted of 107 participants between the ages of 35 and 84 years, with a median age of 67. Further research is warranted, specifically focusing on whether the STOP-Bang is a reliable measure in older adult populations. It can be assumed, based on previous literature, that older adults are likely to experience poor sleep if they also have OSA.

Poor Sleep and Demographics

The study aimed to identify which demographics were associated with poor sleep in older adults. On the basis of the previous literature, it was hypothesised that females would report higher rates of poor sleep compared to males, while males would be more likely to be at risk of OSA. It was also hypothesised that older participants and Māori participants would experience more poor sleep compared to good sleep.

The findings of this study showed that older adults believed their sleep to either be ‘good’ or ‘fairly good’ when results clearly indicated otherwise (55.7% were categorised as

‘poor sleepers’). This agrees with a previous NZ study that indicated older adults have a shift in their attitudes about sleep (Crestani et al., 2022). This qualitative research helps understand such results, with their finding that that older adults felt that sleep disruptions were a normal part of the ageing process and were happy as long as their regular daytime functioning was satisfactory. These findings may indicate that further psychometric testing is warranted, specifically with regard to the reliability of single item or full measures in terms of the way different populations across a lifespan interpret and answer these questions. Potentially, future work may be needed to develop a sleep measure specific to older adults.

The present study found that women were 4.09 times more likely to be in the poor sleep quality group compared to males. Conversely, males were 92.34 times more likely to be in the moderate to high risk of OSA group compared to females. The results from the current study confirmed the hypothesis that women were more likely to be defined as poor sleep quality than men when controlling for other health-related measures. The findings agree with the theory proposed by Jonasdottir et al. (2020) and Zhang et al. (2022) that sleep health varies with gender because of underlying biological mechanisms. The current study also agrees with the theory proposed by Reyner et al. (1995), which states that gender differences in sleep may be attributed to behavioural and mood differences, where women are more likely to report subjective poor sleep and have a higher prevalence of mood disorders. A review by Rani et al. (2022), found that there were significant gender differences between older adults in the prevalence of poor sleep across all six countries analysed. Poor sleep was higher among women than men. The study found that gender differences remained significant even when adjusting for variables such as demographic, socioeconomic and health-related measures in India, China, Russia and South Africa. The study explored covariates across the countries, with India having the highest rates of poor sleep among females. The authors indicated that their results may have been due to India having lower incomes, poorer living

conditions, or poorer mental health for females when compared to the remaining five countries. The review, however, had limitations as the sleep questionnaire was limited to one question. Due to the review spanning six different cultures, it also may have been interpreted differently between cultures, producing different results. Although this review had similar findings to the current study, analysing covariates such as living conditions and incomes was outside the scope of the current thesis. Tange (2017) also had similar findings in an independent study that showed significant differences between genders in sleep quality. Other earlier studies, however, concluded there were no gender differences in self-reported poor sleep (Buysse et al., 1991).

When analysed at a univariate and regression level, males were found to be significantly more likely to be categorised as moderate to high risk of OSA. This result is expected due to the STOP-Bang measure assigning males a higher risk of developing OSA. However, recent research has indicated that there are unique risk factors for sleep disorder breathing among the older population which is irrespective of gender (such as, neurodegenerative decline, menopause (Barewal, 2019)). Therefore, it may not be as accurate to weight the scoring of measures for sleep disordered breathing using male gender in an older compared to younger population. As mentioned by Martins et al. (2020) gold standard measures like polysomnography would be better in understanding gender differences relating to OSA in the older adult population. Further research in this area would be beneficial to understand the accuracy of predictions relating to gender, older adults and OSA in NZ. The current study's findings have provided an insight into how older adults are sleeping in NZ. More research into why the current study has similar results relating to gender differences for poor sleep would be beneficial to understanding why females in NZ also report poor subjective sleep.

Based on literature theorising that age impacts physiological functioning related to sleep (Liu-Ambrose & Falck, 2019), it was hypothesised that age would be associated with and a significant predictor of poor sleep. It was found that age was not significantly related to the PSQI 'poor sleep' group and was negatively related to being in the STOP-Bang poor sleep group. The current findings did not align with previous research on the topic. Paine et al. (2005) found that age, when analysed through logistic regression, was a significant predictor of the reporting of chronic sleep problems. However, the study focused on 20- to 59-year-olds, which is not comparable to the current study's inclusion criteria for older adults. In contrast, Crestani et al., (2022), using qualitative research methods, indicated that changes in the perception of and requirements for sleep changed with ageing. The study found that increasing age did not show higher rates of poor sleep but found changes in the perception of sleep. It is noted that changes in attitude to sleep may also indicate that the way in which older adults are reporting poor sleep when given the PSQI could lead to an underreporting of sleep issues.

The current study found a negative association between age and OSA, so younger older adults were more likely to be deemed of moderate to high risk of OSA. This was not hypothesised, nor did it align with previous research. Evidence from current studies argues that older adults are vulnerable to OSA due to age-related changes in respiratory functioning, which can create issues in the airway (Gooneratne & Vitiello, 2014; Phillips, 2017). Lee et al. (2014) found that older adults were 2 – 4 times more likely to have OSA compared to younger adults, although, as previously mentioned, it is questionable whether the use of STOP-Bang is effective in measuring OSA. Lee et al. (2014) did use STOP-Bang initially and then applied polysomnography. The result argues that age is a factor, in contrast to other research suggesting age is not a factor (Martins et al., 2020). Taken together, the findings of the current study indicate the need for further research on how older age impacts OSA and

the prevalence of poor sleep. Gold standard measures of polysomnography may further explain which theory has merit. The current study was unable to bridge the gap in NZ research in exploring age and poor sleep. Further research exploring the association between increasing age and poor sleep is warranted, with a larger sample of older adults.

Poor Sleep and Health-Related Measures

The study also aimed to investigate the relationship between poor sleep and health-related measures, and whether any health-related measures were predictors in older adults experiencing poor sleep.

It was hypothesised that mental health and cognitive functioning would be associated with measures of poor sleep. In the present study, there was a significant relationship between lower RUDAS scores and poor sleep. This indicated that with each point reduction in their RUDAS score (indicative of poorer cognitive functioning), participants were 1.4 times more likely to be categorised as poor sleepers using the PSQI. The current study's findings agree with the review by Wennberg et al. (2017), which found evidence supporting a theory that physiological changes in the brain cause cognitive impairment, which becomes a contributing factor to poor sleep. The study also argued that poor sleep may contribute to the development of cognitive impairments such as Alzheimer's disease, and that co-occurrence of both poor sleep and cognitive impairment would predict a more rapid decline in cognitive abilities for the individual in the future. Lobo et al. (2008) found that self-reported poor sleep at a baseline measure significantly predicted the prevalence of cognitive impairment two years later with a secondary measure. Beaulieu-Bonneau and Hudon (2009) found that within the 18 studies that were reviewed, poor sleep was highly prevalent among individuals with mild cognitive impairment (14%-59%), making it one of the core non-cognitive symptoms of mild cognitive impairments. There is evidence to suggest that OSA plays a role in the development of cognitive impairments such as Alzheimer's disease (Barletta et al., 2019). In a review of

current research, Barletta et al. (2019) found that daytime sleepiness and sleep fragmentation were major contributors to the development of cognitive impairment in OSA. One explanation of this theory is that hypoxemia, caused by OSA, as well as sleep fragmentation, affects memory, executive functioning and attention mainly by causing neuronal injuries within the prefrontal cortex and hippocampus (Nair et al., 2011), thus affecting cognitive functioning. Based on the existing literature, the current study would have expected OSA and cognitive impairment to be related. However, symptoms of OSA were not related to cognitive impairment. The current literature points to a bi-directional relationship between poor sleep and cognitive impairment. The current data provides further evidence that poor sleep quality and cognitive impairment are associated, and cognition impairment can be a strong predictor of experiencing poor sleep (Dzierzewski et al., 2022; Kondo et al., 2021). Further research is needed in this area to help older adults stay independent and experience healthy well-being for longer.

No additional measures of mental health were found to be related to problem sleep defined by either sleep quality or OSA measures. The present study found the older adults to have an above-average mean score of 53.90, indicating that the sample overall believed they had good mental health. This is contrary to previous research indicating a strong association between the measure of general mental health and sleep status (Benca & Peterson, 2008; Plante, 2021). One potential explanation could be that the SF-12 used to measure the sample's mental health is not valid for this subpopulation group. However, the measure has been well-validated in older adults (Su & Wang, 2019). Factors such as sample characteristics may have influenced the relationship, as community-dwelling older adults are less likely to have poor mental health compared to older adults residing in care homes. A review by De Medeiros et al. (2020) found that older adults who resided in care homes were less likely to engage in social behaviours and had poorer rates of mental health compared to community-dwelling

older adults. The review believed that the absence of socialisation was a key factor in poorer mental health outcomes for older adults in care homes compared to community-dwelling older adults. (Gough et al., 2021) also found that community-dwelling adults are likely to be more social and have higher rates of community participation. In an NZ study, Gibson et al. (2020) found that poor sleepers reported poorer scores for mental health, such as depression and lower scores for feelings of coping and control when compared to individuals with good sleep. These findings may explain why there was no relationship between mental health and poor sleep in the current study, because the participants were community-dwelling older adults. This study used a sample of healthy older adults, which may be reflective of recruitment bias; i.e., those who were more unwell were less likely to volunteer for the research. Further research is needed with a more diverse range of older adults, including those with various mental health needs.

Physical Health and Poor Sleep

The current study did not find a statistically significant relationship between physical health and poor sleep. Based on previous literature, it was hypothesised that participants identified as experiencing 'poor sleep' would be more likely to have lower rates of physical health. The present study found the older adults had an above-average mean score of 31.68, indicating that the sample overall believed they were in good physical health. These findings did not support the hypothesis or align with previous research. In a study by Lo and Lee (2012) participants who perceived their health as 'poor' were more likely to have a shorter duration of sleep per night; an indication that subjective measures of health impact sleep quality in older adults. The study did not focus on overall sleep quality, so is not a direct comparison to the current study. However, a shorter duration of sleep is an indication of 'poor' sleep because it does not meet the National Sleep Foundation's guidelines that recommend 7- 9 hours of consecutive night time sleep. Other studies suggest that the

relationship between physical health and poor sleep is bi-directional (Zhang et al., 2022) and that poor sleep experienced by older adults may start to affect the immune system, decrease physical health and lead to physical impairments (Zhang et al., 2022). This theory may be why the current study had non-significant findings for physical health and poor sleep. Although this study did not have findings in line with other studies, further research is needed because of the high prevalence of poor sleep in older adults. Findings from other studies show that there is a strong association between physical health and sleep health. Although not shown in this study, findings suggest this sample may have been overly healthy for the participants' age and not a representative sample of the older adult population in NZ. It is imperative to understand how physical health is associated with and what effect it has on older adults' sleep health. This information would help health professionals to identify potential risks for poor sleep and give options for early intervention treatments in this population. Understanding how physical activity affects sleep health is important, as it is a cost-effective and promising non-pharmacological intervention for the treatment of poor sleep. Adding research in a New Zealand context can improve the health system and have a significant impact on ageing healthily for NZ older adults.

Health Comorbidities and Poor Sleep

The results of the present study did not support the hypothesis that having comorbid health conditions (mental and physical) would be associated with indicators of poor sleep. These results are inconsistent with the claim in previous literature that suggests there is a relationship between co-morbidities and poor sleep (Barczi & Teodorescu, 2017; Pinto et al., 2016). In a review by McCarthy (2021), comorbidities such as depression, heart failure, chronic respiratory disorders, pain disorders, dementia, medications and polypharmacy were found to increase the likelihood of experiencing poor sleep quality throughout a lifespan. The review argued that sleep disturbances were highly likely to occur in older adults who reported

depression, but also found sleep disturbances were a risk factor for the development of depression. McCarthy also found that heart failure impacts sleep health, with individuals often experiencing increased sleep latency, nighttime wakings and early morning awakenings. However, a likely reason mentioned is the mental impact of a physical health issue. Respiratory disorders were also linked to poor sleep due to observed lower oxygen saturation levels. Pain disorders were also significant in the prediction of poor sleep, McCarthy found that other studies reported similar findings of a bi-directional relationship between pain and poor sleep. Pain was associated with more nighttime arousals, and poor sleep was associated with a subsequent increase in pain. Dementia was also found to have a bi-directional relationship with poor sleep, with problems in short and long sleep durations, insomnia, OSA and overall sleep quality. Poor sleep was also commonly associated with an increased risk of preclinical dementias. Lastly, the review found that participants who reported co-morbidities were also using prescribed medications. Medications such as antihypertensives, antidepressants, corticosteroids and decongestants were all found to negatively impact sleep. Overall, the review found that poor sleep was common in older adults experiencing co-morbidities. Interestingly, in the present study, medications (defined by quantity and polypharmacy) were not associated with poor sleep quality. A limitation of Mccarthy's review was that there was no consistent measure of sleep in the studies reviewed. At the time of writing this thesis, no literature was found contrasting McCarthy's review. The current study's findings may be explained by the low number of sample participants or the sample being overly healthy and not a true representation of the older adult population. In terms of future research, it would be useful to extend the current findings by recruiting more participants for the sample, with a more diverse range of comorbidities. There is a need for future research because of the growing older adult population, and as previous studies have

noted, as adults age, the number of health comorbidities they experience typically increases (Onen & Onen, 2018) .

Polypharmacy appeared to be significant in the moderate to high risk of OSA group at a univariate level; however, it was no longer significant when all other factors were controlled for in a regression analyses. This finding is in contrast to research by Jullian-Desayes et al. (2017), which claims that polypharmacy is associated with a higher risk of OSA. Their study found that opioids, benzodiazepines, baclofen, testosterone and other drugs that induce weight gain were suspected to increase the risk or worsen OSA. In contrast, there are medications that have been found to not impact OSA, such as antihypertensive drugs, anaesthetic agents, melatonin-related drugs, and weight loss-inducing drugs. Similar findings from Matos et al. (2020) found that concurrent medications, especially opioids and benzodiazepines, can create OSA due to their effect on patients' upper airways. As previously mentioned, older persons often experience age-related changes to their airways. This makes the older adult population vulnerable to medications that may further decrease their ability to breathe. These findings suggest that there are physiological effects of polypharmacy that may increase older adults' vulnerability to being at moderate to high risk of OSA.

Alcohol and Poor Sleep

On the basis of the previous literature, it was hypothesised that alcohol use would be associated with poor sleep. However, the present study did not support this. This is inconsistent with the current literature. There are some existing explanations as to why alcohol can be disruptive to sleep in older adults. Because of the physiological age-related changes in older adults, alcohol is seen as a disruptor to a sleep/wake system that is already sensitive to sleep disturbances. For example, older adults already experience less restful, lighter stages of sleep, and alcohol is known to reduce SWS and promote more REM sleep

(Britton et al., 2020). This imbalance can have unintentional negative impacts on older adults' sleep quality. Britton (2020), using a cross-sectional analysis, found that older men who drank were more likely to experience poor sleep compared to older men who did not consume alcohol. Men who did drink had a higher prevalence of not waking rested and having multiple sleep disturbances. Britton's study, however, did not find an association between older women's sleep and alcohol consumption. However, a limitation of this study was that the older adults were community-dwelling, and the alcohol measure was subjective, which may have created a risk of reporting bias. There is no indication in the data for the current study as to what amount was being consumed. The amount of alcohol may have more of an impact on sleep quality than the frequency of drinking. Alcohol consumption has been linked to exacerbating OSA symptoms by increasing snoring, reducing sleep quality, lowering oxygen levels in the blood, and creating a higher frequency of sleep apnoea episodes (Canham & Mauro, 2016). Alcohol can exacerbate OSA via increased muscle relaxation, which leads to airway obstruction during sleep. Furthermore, older adults can be more vulnerable to alcohol effects, which may make symptoms worse (Canham & Mauro, 2016). However, the present study did not support this. Future research exploring in more detail the amount of alcohol consumed, alongside the use of polysomnography, is needed to extend the current knowledge in NZ.

Activities of Daily Living and Poor Sleep

It was hypothesised that older adults with lower levels of functioning abilities (ADLs) would also experience poor sleep. The results of this study, however, did not support this hypothesis. The present results are not consistent with Lee et al. (2022) who found a significant association between ADLs and poor sleep in a population of older Chinese adults. Lee et al. (2022) examined the associations between ADLs and instrumental ADLs with changes in sleep among older Chinese adults. The study used longitudinal data and analysed

sleep quality and sleep duration in relation to ADLs. Findings showed that older adults who had ADL limitations had a greater risk of experiencing poor sleep, as well as not achieving recommended sleep durations. Similar findings were made by Arias-Fernández et al. (2021), who suggested that poor sleep quality was associated with functional limitations in older adults. The study found that the poorer the self-reported sleep quality, the greater the functional restrictions were for older adults. One explanation for the current study's findings not being consistent with current literature is the use of different ADL measures. Arias-Fernández used the FRAIL scale (Rockwood et al., 2005), a well-validated scale that is frequently used in clinical settings. Recently, the FRAIL scale has been updated; however, there is no psychometric research on the updated version. This makes it difficult to compare to the current study's use of the NEADL. However, the use of different measures between studies and the current one could be an explanation of why there is a variance in ADLs' association with poor sleep. Furthermore, the participants in the current study were functional, which was not expected. This could impact the findings due to variance in health-related measures of functional status. Given that the current study's findings differ from previous research, further investigation is warranted. There is a lack of evidence from NZ in this area. With the increasing older population and the impact of functional decline on the health system, it would be helpful to understand the relationship between sleep and ADLs to better predict and treat to ensure healthy ageing.

Another interesting finding of the current study is that day naps were statistically significant at a univariate level, but no longer significant once other factors were controlled for. One interpretation of this finding is that daytime sleepiness is an indication that those at moderate to high risk of OSA are experiencing poor sleep. Martin et al. (1997) showed OSA to have adverse effects on sleep architecture and overall sleep health due to brief awakenings that create fragmented sleep. These nighttime arousals can lead to excessive daytime

sleepiness (Phillips, 2017). The results and previous literature further support the initial hypothesis that OSA would be associated with poor sleep. In terms of future research, using polysomnography to assess whether daytime sleepiness is an indicator of poor nighttime sleep would be beneficial in understanding the relationship between daytime sleepiness and OSA.

Lastly, comorbidities were found to be independently related to the OSA problem groups. With each additional health condition, the likelihood of being in the moderate to high-risk of OSA group increased by 1.5 (95% CI, 1.08 – 2.08). These results supported the hypothesis that increased comorbidities would be associated with factors indicative of moderate to high risk of OSA. In past research, the main risk factors identified have been physical factors (such as obesity), age, gender, being post-menopausal, craniofacial issues, alcohol misuse, smoking and previous family history of OSA (Pinto et al., 2016). Having one or more of these factors would explain why an individual may be more at risk of OSA. Taken together, the findings indicate that the unhealthier the individual, the more likely they are to experience OSA. Much more work remains to be done before a full understanding of the factors associated with OSA in older adults is established. Further research may be helpful to understand the true prevalence of OSA in older adults in NZ and to what extent it impacts sleep health. There is also a lack of representation of the full range of ethnicities living in NZ. Expanding the participant pool would be beneficial for future research.

Research Strengths

What makes the current study important is that, to the authors' knowledge, this is the first to consider older adults' sleep using well-validated long-form measures such as the PSQI. There is a large body of international literature that focuses on older adults’ sleep; however, there is limited research specific to NZ older adults. What has been done in NZ has been limited: for example, in a study by Gibson et al. (2023) where data was taken from the

NZHS, only sleep durations were used to assess sleep across the nation. The study did not use a validated measure to assess overall sleep health. Furthermore, the NZHS and the LiLACS NZ study only used single or reduced items to measure sleep. This study therefore contributes to the body of evidence that focuses on associations, relationships and/or predictors linking poor sleep and health-related variables.

Limitations and Recommendations

Several factors limited the present study. Firstly, the study used cross-sectional, self-report data. Self-report measures are often seen to be sensitive to recall bias (Althubaiti, 2016). Self-reporting bias can create issues for a number of reasons, including social desirability, recall period, sampling approach, and selective recall (Althubaiti, 2016). These biases may have implications for the results, which may not provide an accurate representation of the older adult population. To address this limitation in future research, measures such as polysomnography would give a more accurate insight into sleep health.

Secondly, the data was collected during the COVID-19 pandemic, which resulted in healthy older adults participating rather than the original ‘at risk’ older adults the study was initially targeted to (Lord et al., 2022). The COVID-19 lockdown and the following months had a significant impact on older adults, who were advised to stay at home because they were considered as being at high risk from COVID-19 infections (those over 70 or older adults with existing medical conditions). This may have altered who wanted to participate in the AWESSoM study, which may have impacted the generalisability of the findings. As a result, the study worked to the strength of having ‘healthy’ older adults as a sample, which showed that over half of the sample still experienced ‘poor sleep’.

The demographic of the sample was also a limitation due to an underrepresentation of Māori participants. This created issues of generalisability to the NZ population. The sample was predominately ‘non-Māori’. Participants were also recruited from areas of higher

socioeconomic status (Tauranga and East Auckland). Previous research has shown that there are sleep quality disparities in Māori and Pacifica, and that low socioeconomic status results in higher rates of poor sleep, compared to sleep quality in Pakeha and those with higher socioeconomic status (Paine et al., 2005). Future research might benefit from recruiting participants from different areas of NZ to enable better generalisability to the entire NZ population.

Lastly, recent research indicates the STOP-Bang measure may be less reliable for use in the older adult population compared to middle-aged adults. For example, Martins et al. (2020) points out that BMI, age, neck circumference, and gender may be less relevant for the older adult population. The study indicated that a modified STOP-Bang, such as the STOPb28, and the use of objective measures such as polysomnography could be more suitable measures for the older population. In a study by Godoy (2022), STOP-Bang had a sensitivity of 71%, accuracy of 62% and specificity of 41%. Although sensitivity is important in screening tests, the probability of having OSA is more important, which is where the specificity results fall short.

Implications

The findings reported in this thesis further expand on the current knowledge of how community-dwelling older adults sleep in NZ. Previous studies have used short-form measures to understand older adult sleep, and this is the first to look at older adults' sleep using long-form measures. The study found that older adults had poor sleep, defined as either poor sleep quality or moderate to high risk of OSA. Even more interesting is that the predictors for these different categories of poor sleep differ. Women were more likely to report poor sleep quality, while males were more likely to report moderate to high risk of OSA. Cognitive function was a predictor for sleep quality and health comorbidities were a predictor for OSA. Therefore, the presence of poor sleep most likely varies as do the factors

that affect it. These findings have some potential practical intervention implications. For example, factors associated with poor sleep may be screened for earlier on before they become a problem, or cause issues with the sleep health of older adults in NZ. As the population of older adults in NZ is expected to grow, the pressures from this population on the health system will also grow. This study was able to bridge a gap in NZ research and help enhance the credibility of previous findings with the use of validated long-form measures.

This study gives an insight into how community-dwelling older adults are sleeping in NZ. Understanding the factors associated with poor sleep can provide guidance in designing effective intervention strategies to ensure sleep health. The findings could inform health interventions to ensure that older adults are ageing well and stay independent for longer. Ensuring access to information for the older adult population about ways in which they can support their sleep through places such as Age Concern, local general practitioners, and social gathering areas such as bowling clubs would be beneficial. It is also important to increase public awareness that poor sleep is not just a factor of ageing, and that there are strategies available to ensure a better night's sleep, which will help people to age healthily, such as increased physical activity to reduce daytime sleepiness and increase overall sleep quality (Huang et al., 2023). Given that multiple factors are associated with sleep health, this would be an essential intervention. There is still much to learn about the sleep health of older adults, and future research is recommended to establish a more comprehensive understanding of sleep health in NZ. Future studies could look to use a larger sample so that the results are more generalisable to the general older adult population, including diverse geographical and socioeconomic situations.

Following the current study’s findings, further research on cognitive function and poor sleep is needed. Expanding the participants to both community-dwelling and residential-

care older adults will give a better insight into the relationship between poor sleep and cognitive impairment. Previous literature has suggested a strong bi-directional relationship between poor sleep and cognition (Costa et al., 2023; Dzierzewski et al., 2022; Gildner et al., 2019; Kondo et al., 2021; Meng et al., 2023). Further investigations would help to determine the importance of ensuring sleep health and of being aware of cognitive impairments early on. Given the increasing age of the NZ population, issues related to both poor sleep and cognitive impairments will also increase. This will put pressure on the NZ health system, which may have a negative effect on accessibility for older adults to GPs and to early healthcare interventions. There is still a gap in current NZ research, and this study's findings can guide future research by acknowledging the relationship between poor sleep and cognitive impairment and the need for increased knowledge of the potential bi-directional relationship that previous international literature has found.

The findings of this study also indicate that older adults believed their sleep to either be 'good' or 'fairly good' when the results clearly indicated otherwise (55.7% were categorised as 'poor sleepers'). This suggests that there may be a large number of older adults in the community who are sleeping 'poorly' but are underreporting their experience. Public health drives could address the importance of sleep in older adults, with an emphasis on general practitioners doing general screening. For example, with basic screening of sleep health, doctors may be able to intervene early and provide psychoeducation on sleep health. This could potentially decrease the number of adverse health consequences linked to poor sleep in older adults. Further research on the risks of older adults experiencing poor sleep is needed. This could be done using mixed methods involving gold standard polysomnography and qualitative interview methods.

Conclusion

The present study found that more than half of older adults were likely to be defined as poor sleepers defined by both subjective sleep quality and indicators of sleep disordered breathing. The sample showed that women were more likely to experience poor sleep quality compared to men, perhaps due to biological differences between genders or as a reflection of women having higher rates of depression or other emotional dysregulation. However, men were more likely to be categorised as being at moderate to high risk of OSA. Further investigations into sex-specific differences of sleep health, such as polysomnography sleep measures, as well as specific health-related measures focusing on depression, anxiety and other mood disorders, might give a better insight into whether mood disorders do impact older adults' sleep, and produce gender differences in sleep health.

Cognition and sleep have been well established in the existing literature, but the nature of the bi-directional relationship has remained inconclusive. The present study found significant associations between cognitive impairment and poor sleep and a significant predictive relationship to experiencing poor sleep. The regression analysis indicated that lower RUDAS scores were a predictor of also experiencing poor sleep quality but not a predictor for moderate to high risk of OSA. This suggests that cognitive impairment has a negative impact on sleep health. This finding highlights the importance of early intervention of potential mild cognitive impairment to ensure an individual can increase the positive aspects of their sleep health to stay independent and healthy for longer. Further investigations are very much needed, specifically within a NZ context. Although there is extensive international literature on the relationship, there are limited amounts relating to NZ. Research is needed to determine the relationship between mild to severe cognitive impairment and poor sleep in older adults. In practical terms, this may

help in the creation of health interventions to promote cognitive functioning, as well as sleep health, to help older NZ adults age more healthily and remain independent for longer.

An unexpected finding was that the majority of the sample reported their sleep quality as good or fairly good. These results were not reflective of the finding that over half the sample experienced poor sleep quality. Perhaps these results are reflective of the changing attitudes towards sleep with increasing age. These findings also suggest that the participants may have underreported poor sleep, and that the percentage of the sample experiencing poor sleep would in fact be larger. The sample was generally regarded as having ‘good health’, which may contribute to why the participants rated their sleep health as fairly good or good. Further investigations focusing on mixed methods, including polysomnography (the gold standard of sleep monitoring) and qualitative exploration of what the individual classifies as ‘good sleep’. The outcome may give a better indication of older NZ adults' sleep and give a better understanding of where health interventions for sleep need to begin.

Other health-related measures were not associated with poor sleep, which was not in line with the hypotheses. This unpredicted result may have been due to the sample being community-dwelling and in good health for their age. During COVID-19 and following the pandemic, recruitment of older adults was difficult. Health campaigns in NZ told older adults to limit social interactions as their age might make them vulnerable. This resulted in limited availability of a wide range of older adults, with a relatively healthy trend in the sample. The current study is thus limited in its findings, and the interpretation that other health-related factors are not associated with or act as individual predictors of poor sleep needs to be revisited. Further research including care-assisted older adults or a

larger sample size may show a different outcome and be more generalisable to the wider population.

Findings from the present study showed that males, individuals who daytime napped, had higher numbers of total health comorbidities, and were taking higher numbers of prescription medications were more likely to be classified as being at medium to high risk of OSA. Being male was the only individual predictor of being at medium to high risk of OSA. This result, however, stems from the STOP-Bang measure that gives individuals a point for being male alone, so the level of prediction may be incorrect. Further investigations into reliable and valid measures for screening for OSA in the older adult population are crucial. The STOP-Bang measure may be showing more false positives than correct results, as has been highlighted in recent studies (Martins et al., 2020).

In summary, this study offered a first insight into how community-dwelling older adults in NZ are sleeping, using long-form validated measures of subjective sleep assessment. The results indicate that older adults are more vulnerable to poor sleep, not just because of biological age or age-related changes, but also because of a number of factors that can be altered. These findings may help to increase our knowledge of older adults' sleep and help promote health interventions to ensure older adults are ageing healthily and living independently for longer.

References

Althubaiti, A. (2016). Information bias in health research: Definition, pitfalls, and adjustment methods. *Journal of Multidisciplinary Healthcare*, *9*, 211–217. https://doi.org/10.2147/JMDH.S104807

Arber, S., Bote, M., & Meadows, R. (2009). Gender and socio-economic patterning of self-reported sleep problems in Britain. *Social Science and Medicine*, *68*(2), 281–289. https://doi.org/10.1016/j.socscimed.2008.10.016

Arias-Fernández, L., Smith-Plaza, A. M., Barrera-Castillo, M., Prado-Suárez, J., Lopez-Garcia, E., Rodríguez-Artalejo, F., & Lana, A. (2021). Sleep patterns and physical function in older adults attending primary health care. *Family Practice*, *38*(2), 146–152. https://doi.org/10.1093/fampra/cmaa085

Bao, Y. P., Han, Y., Ma, J., Wang, R. J., Shi, L., Wang, T. Y., He, J., Yue, J. L., Shi, J., Tang, X. D., & Lu, L. (2017). Cooccurrence and bidirectional prediction of sleep disturbances and depression in older adults: Meta-analysis and systematic review. *Neuroscience and Biobehavioral Reviews*, *75*, 257–273. https://doi.org/10.1016/j.neubiorev.2017.01.032

Barczi, S., & Teodorescu, M. (2017). Psychiatric and medical comorbidities and effects of medications in older adults. In M. Kryger, T. Roth, & W. Dement (Eds.), *Principles and practice of sleep medicine* (6th edition, pp. 1484–1495). Elsevier.

Barewal R. M. (2019) Obstructive sleep apnea: The role of gender prevalence, symptoms, and treatment success. *Dental Clinics of North America, 63*(2), 297-308

Barletta, P., Abreu, A. R., Ramos, A. R., Dib, S. I., Torre, C., & Chediak, A. D. (2019). Role of obstructive sleep apnea in cognitive impairment. *International Journal of Head and Neck Surgery*, *10*(3), 57–61. https://doi.org/10.5005/jp-journals-10001-1373

Barton, R. A., & Capellini, I. (2016). Sleep, evolution and brains. *Brain, Behavior and Evolution*, *87*(2), 65–68. https://doi.org/10.1159/000443716

Beaulieu-Bonneau, S., & Hudon, C. (2009). Sleep disturbances in older adults with mild cognitive impairment. *International Psychogeriatrics*, *21*(4), 654–666. https://doi.org/10.1017/S1041610209009120

Benca, R. M., & Peterson, M. J. (2008). Insomnia and depression. *Sleep Medicine*, *9*(1), 3–9.

Best, J. R., Falck, R. S., Landry, G. J., & Liu-Ambrose, T. (2019). Analysis of dynamic, bidirectional associations in older adult physical activity and sleep quality. *Journal of Sleep Research*, *28*(4). https://doi.org/10.1111/jsr.12769

Blackwell, T., Yaffe, K., Ancoli-Israel, S., Schneider, J., Cauley, J., Hillier, T., Fink, H., & Stone, K. (2006). Poor sleep is associated with impaired cognitive function in older women: the study of osteoporotic fractures. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *61*(4), 405–410.

Bliwise, D. (1993). Sleep in normal aging and dementia. *Sleep*, *16*(1), 40–81.

Borbely, A. (1982). A two process model of sleep regulation. *Human Neurobiology*, *1*(3), 195–204.

Born, J., & Wilhelm, I. (2012). System consolidation of memory during sleep. In *Psychological Research* (Vol. 76, Issue 2, pp. 192–203). https://doi.org/10.1007/s00426-011-0335-6

Bpacnz. (2012). *Polypharmacy in people over the age of 75 years*. Bpac NZ

Britton, A., Fat, L. N., & Neligan, A. (2020). The association between alcohol consumption and sleep disorders among older people in the general population. *Scientific Reports, 10*(1). https://doi.org/10.1038/s41598-020-62227-0

Buchan, C., Powell, S., Grivell, N., O'Brien, D., & Gordon, C. J. (2023). The sleeping giant - Nurses' professional principal practice in managing sleep health and sleep disorders in Australia and New Zealand: A cross-sectional study. *Collegian*, *30*(4), 557–564. https://doi.org/10.1016/j.colegn.2023.03.004

Buysse, D. J. (2014). Sleep health: can we define It? does it matter? *Sleep*, *37*(1), 9–17. https://doi.org/10.5665/sleep.3298

Canham, S. L., & Mauro, P. M. (2016). Self-medication with alcohol: Aging issues. In *Alcohol and Aging* (pp. 201–214). Springer.

Carskadon, M., & Dement, W. (2011). Normal human sleep: An overview. In M. Kryger, T. Roth, & W. Dement (Eds.), *Principles and Practice of Sleep Medicine* (6th ed., pp. 15–24). Elsevier.

Cassidy-Eagle, E. L., & Siebern, A. (2017). Sleep and mild cognitive impairment. *Sleep Science and Practice*, *1*(1). https://doi.org/10.1186/s41606-017-0016-5

Cheung, G., To, E., Rivera-Rodriguez, C., Ma'u, E., Chan, A. H. Y., Ryan, B., & Cullum, S. (2022). Dementia prevalence estimation among the main ethnic groups in New Zealand: a population-based descriptive study of routinely collected health data. *BMJ Open*, *12*(9). https://doi.org/10.1136/bmjopen-2022-062304

Cluydts, R. (2003). Comparing the effects of sleep loss after experimental sleep deprivation and in clinical patients. *Sleep Medicine Reviews*, *7*(4), 293–295.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Colton, H. R., & Altevogt, B. M. (2006). Sleep disorders and sleep deprivation: An unmet public health problem. In *Institute of Medicine (US) Committee on Sleep Medicine and Research* (Vol. 2).

Cooke, J. R., & Ancoli-Israel, S. (2011). Normal and abnormal sleep in the elderly. In *Handbook of Clinical Neurology* (Vol. 98, Issue C). https://doi.org/10.1016/B978-0-444-52006-7.00041-1

Costa, A. N., Curtis, A. F., Musich, M., Guandique, A. A., & McCrae, C. S. (2023). Self-reported cognition in older adults with insomnia: Associations with sleep and domain specific cognition. *Journal of Sleep Research*, *32*(1). https://doi.org/10.1111/jsr.13751

Crestani, F., Williams, G., Breheny, M., Tupara, H., Cunningham, C., Gander, P., & Gibson, R. (2022). Sleep health in later life: Interviews exploring experiences, attitudes and

behaviours of older people. *Ageing and Society*, 1–23. https://doi.org/10.1017/S0144686X22000447

Crowley, K. (2011). Sleep and sleep disorders in older adults. *Neuropsychology Review*, *21*, 41–53.

Cunningham, c, O' Sullivan, Caserotti, P., & Tully, M. A. (2020). Consequences of physical inactivity in older adults: A systematic review of reviews and meta-analyses. *Scandinavian Journal of Medicine and Science in Sports*, *30*(5), 816–827. https://doi.org/10.1111/sms.13616

Cunningham, R., Peterson, D., & Sims, A. (2019). Specialist mental health care for older adults in New Zealand-an exploration of service models and routine data. *NZMJ*, *132*, 1489. www.nzma.org.nz/journal

da Silva, R. A. P. C. (2015). Sleep disturbances and mild cognitive impairment: A review. *Sleep Science*, *8*(1), 36–41. https://doi.org/10.1016/j.slsci.2015.02.001

Danielsson, K., Sakarya, A., & Jansson-Fröjmark, M. (2019). The reduced Morningness–Eveningness Questionnaire: Psychometric properties and related factors in a young Swedish population. *Chronobiology International*, *36*(4), 530–540. https://doi.org/10.1080/07420528.2018.1564322

De Medeiros, M. M. D., Carletti, T. M., Magno, M. B., Maia, L. C., Cavalcanti, Y. W., & Rodrigues-Garcia, R. C. M. (2020). Does the institutionalization influence elderly's quality of life? A systematic review and meta-analysis. *BMC Geriatrics*, *20*(1). https://doi.org/10.1186/s12877-020-1452-0

Didikoglu, A., Maharani, A., Payton, A., Pendleton, N., & Canal, M. M. (2019). Longitudinal change of sleep timing: association between chronotype and longevity in older adults. *Chronobiology International*, *36*(9), 1285–1300. https://doi.org/10.1080/07420528.2019.1641111

Dunlap, J. C. (1999). Molecular Bases for Circadian Clocks Review review word for the late 80s and early 90s would have. In *Cell* (Vol. 96).

Dzierzewski, J. M., Perez, E., Ravyts, S. G., & Dautovich, N. (2022). Sleep and Cognition: A Narrative Review Focused on Older Adults. In *Sleep Medicine Clinics* (Vol. 17, Issue 2, pp. 205–222). W.B. Saunders. https://doi.org/10.1016/j.jsmc.2022.02.001

Ezenwanne, E. (2011). Current Concepts in the Neurophysiologic Basis of Sleep; a Review. *Annals of Medical and Health Sciences Research*, *1*(2), 173–179.

Fabbri, M., Beracci, A., Martoni, M., Meneo, D., Tonetti, L., & Natale, V. (2021). Measuring subjective sleep quality: A review. *International Journal of Environmental Research and Public Health*, *18*(3), 1–57. https://doi.org/10.3390/ijerph18031082

Fischer, D., Lombardi, D. A., Marucci-Wellman, H., & Roenneberg, T. (2017). Chronotypes in the US – Influence of age and sex. *PLoS ONE*, *12*(6). https://doi.org/10.1371/journal.pone.0178782

Ford, M. E., Havstad, S. L., Hill, D. D., & Kart, C. S. (2000). *Assessing the Reliability of Four Standard Health Measures in a Sample of Older, Urban Adults*.

Frieling, M. A., Davis, W. R., & Chiang, G. (2013). The SF-36v2 and SF-12v2 health surveys in New Zealand: Norms, scoring coefficients and cross-country comparisons. *Australian and New Zealand Journal of Public Health*, *37*(1), 24–31. https://doi.org/10.1111/1753-6405.12006

Gagnon, J. F., Lafrenière, A., Rauchs, G., Petit, D., & Carrier, J. (2019). Sleep in Normal Aging, Alzheimer's Disease, and Mild Cognitive Impairment. In *Handbook of Behavioral Neuroscience* (Vol. 30, pp. 677–692). Elsevier B.V. https://doi.org/10.1016/B978-0-12-813743-7.00045-1

Gamaldo, A. A., Wright, R. S., Aiken-Morgan, A. T., Allaire, J. C., Thorpe, R. J., & Whitfield, K. E. (2019). The Association between Subjective Memory Complaints and Sleep within Older African American Adults. *Journals of Gerontology - Series B Psychological Sciences and Social Sciences*, *74*(2), 202–211. https://doi.org/10.1093/geronb/gbx069

Garbarino, S., Lanteri, P., Bragazzi, N. L., Magnavita, N., & Scoditti, E. (2021). Role of sleep deprivation in immune-related disease risk and outcomes. In *Communications Biology* (Vol. 4, Issue 1). Nature Research. https://doi.org/10.1038/s42003-021-02825-4

Garland, S. N., Scurrey, S. R. M., & Ploughman, M. (2017). Factors Associated with Poor Sleep in Older Adults with Multiple Sclerosis. *International Journal of Behavioral Medicine*, *24*(6), 937–945. https://doi.org/10.1007/s12529-017-9653-4

Gauthier, S., Reisberg, B., Zaudig, M., Peterson, R., Ritchie, K., Broich, K., Belleville, S., Brodaty, H., Bennett, D., Chertkow, H., Cummings, J., de Leon, M., Feldman, H., Ganguli, M., Hampel. H, Scheltens, P., Tierney, M., Whitehouse, P., & Winblad, B. (2006). Mild cognitive impairment. *Lancet*, *361*(9518), 1262–1270.

George, K. M., Peterson, R. L., Gilsanz, P., Mungas, D. M., Glymour, M. M., Mayeda, E. R., & Whitmer, R. A. (2020). Racial/Ethnic differences in sleep quality among older adults. *Ethnicity and Disease, 30(*3), 469-478. https://doi.org/10.2307/48668060

Gibson, R., Akter, T., Jones, C., & Towers, A. (2023). Characteristics of Atypical Sleep Durations Among Older Compared to Younger Adults: Evidence from the New Zealand Health Survey. *The Journals of Gerontology: Series A*. https://doi.org/10.1093/gerona/glad042

Gibson, R., Gander, P., Kepa, M., Moyes, S., & Kerse, N. (2020). Self-reported sleep problems and their relationship to life and living of Māori and non-Māori in advanced age. *Sleep Health*, *6*(4), 522–528. https://doi.org/10.1016/j.sleh.2019.11.002

Gibson, R., Gander, P., Paine, S.-J., Dyall, L., Moyes, S., & Kerse, N. (2016). Sleep of Māori and non-Māori of Advanced Age. *NZMJ*, *10*, 1436. www.nzma.org.nz/journal

Gildner, T. E., Salinas-Rodríguez, A., Manrique-Espinoza, B., Moreno-Tamayo, K., & Kowal, P. (2019). Does poor sleep impair cognition during aging? Longitudinal associations between changes in sleep duration and cognitive performance among older

Mexican adults. *Archives of Gerontology and Geriatrics*, *83*, 161–168. https://doi.org/10.1016/j.archger.2019.04.014

Gooneratne, N. S., & Vitiello, M. V. (2014). Sleep in Older Adults. Normative Changes, Sleep Disorders, and Treatment Options. *Clinics in Geriatric Medicine*, *30*(3), 591–627. https://doi.org/10.1016/j.cger.2014.04.007

Gordon, N. P., Yao, J. H., Brickner, L. A., & Lo, J. C. (2022). Prevalence of sleep-related problems and risks in a community-dwelling older adult population: a cross-sectional survey-based study. *BMC Public Health*, *22*(1). https://doi.org/10.1186/s12889-022-14443-8

Gough, C., Lewis, L. K., Barr, C., Maeder, A., & George, S. (2021). Community participation of community dwelling older adults: a cross-sectional study. *BMC Public Health*, *21*(1). https://doi.org/10.1186/s12889-021-10592-4

Grandner, M. A. (2019). Social-ecological model of sleep health. In *Sleep and Health* (pp. 45–53). Elsevier. https://doi.org/10.1016/B978-0-12-815373-4.00005-8

Guidozzi, F. (2015). Gender differences in sleep in older men and women. *Climacteric*, *18*(5), 715–721. https://doi.org/10.3109/13697137.2015.1042451

Guo, H., Zhou, J., Chen, H., & Cao, X. (2023). Prevalence and associated factors of poor sleep quality among Chinese retirees: A multicenter cross-sectional study. *Journal of Affective Disorders*, *320*, 42–47. https://doi.org/10.1016/j.jad.2022.09.130

Gureje, O., Oladeji, B., Abiona, T., Makanjuola, V., & Esan, O. (1999). The natural history of insomnia in the Ibadan study of ageing. *Sleep*, *34*, 965–973.

Hale, L., Troxel, W., & Buysse, D. J. (2020). Sleep Health: An Opportunity for Public Health to Address Health Equity. *Annu. Rev. Public Health*, *41*, 81–99. https://doi.org/10.1146/annurev-publhealth

He, S., Taylor, B. V., Thakur, N. P., & Chakravorty, S. (2019). Sleep and alcohol use. In *Sleep and Health* (pp. 269–281). Elsevier. https://doi.org/10.1016/B978-0-12-815373-4.00021-6

Hikaka J, Jones R, Hughes C, Connolly MJ, Martini N. Ethnic Variations in the Quality Use of Medicines in Older Adults: Māori and Non-Māori in Aotearoa New Zealand. *Drugs and Aging*. 2021; 38:205-17

Hood, S., & Amir, S. (2019). Sleep and Aging: Circadian Influences. In *Handbook of Sleep Research* (Vol. 30, pp. 651–664). Elsevier B.V. https://doi.org/10.1016/B978-0-12-813743-7.00043-8

Hu, M., Shu, X., Feng, H., & Xiao, L. (2021). Sleep, inflammation and cognitive function in middle-aged and older adults: A population-based study. *Journal of Affective Disorders*, *284*, 120–125.

Huang, J., Li, M., McPhillips, M. V., Lukkahatai, N., & Li, J. (2023). Association of sleep and physical activity among older adults and the moderation of chronotype.

International Journal of Aging and Human Development, *97*(1), 35–51. https://doi.org/10.1177/00914150221128974

Hughes, J. M., Song, Y., Fung, C. H., Dzierzewski, J. M., Mitchell, M. N., Jouldjian, S., Josephson, K. R., Alessi, C. A., & Martin, J. L. (2018). Measuring Sleep in Vulnerable Older Adults: A Comparison of Subjective and Objective Sleep Measures. *Clinical Gerontologist*, *41*(2), 145–157. https://doi.org/10.1080/07317115.2017.1408734

IBM Corp. (2022). *SPSS Statistics for Windows, Version 29*. IBM Corp.

Jaussent, I., Bouyer, J., Ancelin, M. L., Akbaraly, T., Pérès, K., Ritchie, K., Besset, A., & Dauvilliers, Y. (2011). Insomnia and daytime sleepiness are risk factors for depressive symptoms in the elderly. *Sleep*, *34*(8), 1103–1110. https://doi.org/10.5665/SLEEP.1170

Jonasdottir, S. S., Minor, K., & Lehmann, S. (2021). Gender differences in nighttime sleep patterns and variability across the adult lifespan: A global-scale wearables study. *Sleep*, *44*(2). https://doi.org/10.1093/sleep/zsaa169

Jullian-Desayes, I., Revol, B., Chareyre, E., Camus, P., Villier, C., Borel, J. C., Pepin, J. L., & Joyeux-Faure, M. (2017). Impact of concomitant medications on obstructive sleep apnoea. In *British Journal of Clinical Pharmacology* (Vol. 83, Issue 4, pp. 688–708). Blackwell Publishing Ltd. https://doi.org/10.1111/bcp.13153

Kennair, L. E. O., Hagen, R., Hjemdal, O., Havnen, A., Ryum, T., & Solem, S. (2022). Depression, anxiety, insomnia, and quality of life in a representative community sample of older adults living at home. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.811082

Kessel, L., Lundeman, J., Herbst, K., Anderson, T., & Larsen, M. (2010). Age-related changes in the transmission properties of the human lens and their relevance to circadian entertainment. *Journal of Cataract and Refractive Surgery*, *36*(2), 308–312.

Kondo, R., Miyano, I., Lee, S., Shimada, H., & Kitaoka, H. (2021). Association between self-reported night sleep duration and cognitive function among older adults with intact global cognition. *International Journal of Geriatric Psychiatry*, *36*(5), 766–774. https://doi.org/10.1002/gps.5476

Kredlow, M. A., Capozzoli, M. C., Hearon, B. A., Calkins, A. W., & Otto, M. W. (2015). The effects of physical activity on sleep: a meta-analytic review. *Journal of Behavioral Medicine*, *38*(3), 427–449. https://doi.org/10.1007/s10865-015-9617-6

Lavoie, C. J., Zeidler, M. R., & Martin, J. L. (2018). Sleep and aging. *Sleep Science and Practice*, *2*(1), 3. https://doi.org/10.1186/s41606-018-0021-3

Lee, S. D., Kang, S. H., Ju, G., Han, J. W., Kim, T. H., Lee, C. S., Kim, T., & Yoon, I. Y. (2014). The prevalence of and risk factors for sleep-disordered breathing in an elderly Korean population. *Respiration*, *87*(5), 372378.

Lee, Y., Kong, D., Lee, Y., Lin, C., Liu, C., & Chang, Y. (2022). Functional disabilities and changes in sleep quality and duration among older adults: results from a longitudinal study in China, 2005–2014. *European Geriatric Medicine*, *13*(4), 967–975.

Li, J., & Gooneratne, N. S. (2019). Sleep and health in older adults. In *Sleep and Health* (pp. 31–43). Elsevier. https://doi.org/10.1016/B978-0-12-815373-4.00004-6

Liu-Ambrose, T., & Falck, R. S. (2019). Sleep, Physical Activity, and Cognitive Health in Older Adults. In *Handbook of Behavioral Neuroscience* (Vol. 30, pp. 665–676). Elsevier B.V. https://doi.org/10.1016/B978-0-12-813743-7.00044-X

Lo, C. M. H., & Lee, P. H. (2012). Prevalence and impacts of poor sleep on quality of life and associated factors of good sleepers in a sample of older Chinese adults. *Health and Quality of Life Outcomes*, *10*. https://doi.org/10.1186/1477-7525-10-72

Lobo, A., LoPez-Anton, R., De-La-Camara, C., Quintanilla, M., Campayo, A., & Saz, P. (2008). Non-cognitive psychopathological symptoms associated with incident mild cognitive impairment and dementia, Alzheimer's type. *Neurotoxicity Research*, *14*, 263–272.

Lord, S., Teh, R., Gibson, R., Smith, M., Wrapson, W., Thomson, M., Rolleston, A., Neville, S., McBain, L., Del Din, S., Taylor, L., Kayes, N., Kingston, A., Abey-Nesbit, R., Kerse, N., Allore, H., Campbell, K., Clare, S., Davey, J., … Tautolo, D. (2022). Optimising function and well-being in older adults: protocol for an integrated research programme in Aotearoa/New Zealand. *BMC Geriatrics*, *22*(1). https://doi.org/10.1186/s12877-022-02845-7

Kalcina, L., Valic, M., Pecotic, R., Pavlinac Dodig, I., & Dogas, Z. (2017). Good and poor sleepers among OSA patients: sleep quality and overnight polysomnography findings. *Neurological Sciences*, *38*(7), 1299–1306. https://doi.org/10.1007/s10072-017-2978-6

Mallampalli, M. P., & Carter, C. L. (2014). Exploring sex and gender differences in sleep health: A society for women's health research report. *Journal of Women's Health*, *23*(7), 553–562. https://doi.org/10.1089/jwh.2014.4816

Mander, B. A., Rao, V., Lu, B., Saletin, J. M., Lindquist, J. R., Ancoli-Israel, S., Jagust, W., & Walker, M. P. (2013). Prefrontal atrophy, disrupted NREM slow waves and impaired hippocampal-dependent memory in aging. *Nature Neuroscience*, *16*(3), 357–364. https://doi.org/10.1038/nn.3324

Martin, S. E., Engleman, H. M., Kingshot, R. N., & Douglas, N. J. (1997). Microarousals in patients with sleep apnoea/hypopnoea syndrome. *Journal of Sleep Research*, *6*(4), 276–280.

Matos, A., Bankes, D. L., Bain, K. T., Ballinghoff, T., & Turgeon, J. (2020). Opioids, Polypharmacy, and Drug Interactions: A Technological Paradigm Shift Is Needed to Ameliorate the Ongoing Opioid Epidemic. *Pharmacy*, *8*(3), 154. https://doi.org/10.3390/pharmacy8030154

McCarthy, C. E. (2021). Sleep disturbance, sleep disorders and co-morbidities in the care of the older person. *Medical Sciences* , *9*(2), 1–23. https://doi.org/10.3390/medsci9020031

McKinnon, A., Terpening, Z., Hickie, I. B., Batchelor, J., Grunstein, R., Lewis, S. J. G., & Naismith, S. L. (2014). Prevalence and predictors of poor sleep quality in mild cognitive impairment. *Journal of Geriatric Psychiatry and Neurology*, *27*(3), 204–211. https://doi.org/10.1177/0891988714527516

Mendelson, W. (1989). *Human Sleep: Research and clinical care*. Plenum Publishing Corporation.

Meng, W., Gao, T., Zhong, Y., & Ge, L. (2023). Association Between Sleep and Cognition of Older Adults in Rural Areas: A Cross-Sectional Study. *Inquiry (United States)*, *60*. https://doi.org/10.1177/00469580231171820

Miner, B., & Kryger, M. H. (2017). Sleep in the Aging Population. *Sleep Medicine Clinics*, *12*(1), 31–38. https://doi.org/10.1016/j.jsmc.2016.10.008

Mishima, K. (2016). Circadian regulation of sleep. In M. Gumz (Ed.), *Circadian Clocks: Role in Health and Disease. Physiology in Health and Disease* (pp. 103–115). Springer.

Monk, T. H., & Buysse, D. J. (2014). Chronotype, bed timing and total sleep time in seniors. *Chronobiology International*, *31*(5), 655–659. https://doi.org/10.3109/07420528.2014.885981

Muangpaisan, W., Intalapaporn, S., & Assantachi, P. (2008). Neuropsychiatric symptoms in the community-based patients with mild cognitive impairment and the influence of demographic factors. *International Journal of Geriatric Psychiatry*, *23*(7), 699–703.

Murman, D. L. (2015). The impact of age on cognition. *Seminars in Hearing*, *36*(3), 111–121.

Nahm, F. S. (2016). Nonparametric statistical tests for the continuous data: The basic concept and the practical use. *Korean Journal of Anesthesiology*, *69*(1), 8–14. https://doi.org/10.4097/kjae.2016.69.1.8

Nair, D., Zhang, S., Ramesh, V., Hakim, F., Kaushal, N., Wang, Y., & Gozal, D. (2011). Sleep fragmentation induces cognitive deficits via nicotinamide adenine dinucleotide phosphate oxidase-dependent pathways in mouse. *American Journal of Respiratory and Critical Care Medicine*, *184*(11), 1305–1312.

Nind, J., Smith, A., Devananda, M., & Auvray, B. (2021). A whole of population retrospective observational study on the rates of polypharmacy in New Zealand 2014 to 2018 Polypharmacy in New Zealand: What is the current status? *Health Science Reports*, *4*(2). https://doi.org/10.1002/hsr2.263

Nouri, F. (1987). An extended activities of daily living scale for stroke patients. *Clinical Rehabilitation*, *1*, 301–305.

Ohayon, M., Carskadon, M., Guilleminault, C., & Vitello, M. (2004). Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: Developing normative sleep values across the human lifespan. *Sleep*, *27*(7), 1255–1273.

Onen, S. H., & Onen, F. (2018). Chronic medical conditions and sleep in the older adult. *Sleep Medicine Clinics*, *13*(1), 71–79. https://doi.org/10.1016/j.jsmc.2017.09.007

Oshita, H., Ito, N., Senoo, M., Funaishi, K., Mitama, Y., & Okusaki, K. (2020). The STOP-Bang test Is useful for predicting the severity of obstructive sleep apnea. *JMA Journal*, *3*(4). https://doi.org/10.31662/jmaj.2020-0002

Paine, S. J., Harris, R., Cormack, D., & Stanley, J. (2019). Self-reported sleep complaints are associated with adverse health outcomes: cross-sectional analysis of the 2002/03 New Zealand Health Survey. *Ethnicity and Health*, *24*(1), 44–56. https://doi.org/10.1080/13557858.2017.1315368

Paine, S.-J., Gander, P. H., Harris, R. B., Reid, P., Ropu, T., Hauora, R., & Pomare, E. (2005). Prevalence and consequences of insomnia in New Zealand: disparities between Maori and non-Maori. *Australian and New Zealand Journal of Public Health*, *29*(1), 22–29.

Patel, D., Steinberg, J., & Patel, P. (2018). Insomnia in the elderly: A review. *Journal of Clinical Sleep Medicine*, *14*(6), 1017–1024.

Peng, Y. T., Hsu, Y. H., Chou, M. Y., Chu, C. S., Su, C. S., Liang, C. K., Wang, Y. C., Yang, T., Chen, L. K., & Lin, Y. Te. (2021). Factors associated with insomnia in older adult outpatients vary by gender: a cross-sectional study. *BMC Geriatrics*, *21*(1). https://doi.org/10.1186/s12877-021-02643-7

Petrov, M. E., & Lichstein, K. L. (2016). Differences in sleep between black and white adults: An update and future directions. In *Sleep Medicine* (Vol. 18, pp. 74–81). Elsevier. https://doi.org/10.1016/j.sleep.2015.01.011

Phillips, B. (2017). Obstructive sleep apnea in older adults. In M. Kryger, T. Roth, & W. Dement (Eds.), *Principles and Practice of sleep medicine* (sixth, pp. 1496–1502). Elsevier.

Pietilä, J., Helander, E., Korhonen, I., Myllyäki, T., Kujala, U., & Lindholm, H. (2018). Acute Effect of Alcohol Intake on Cardiovascular Autonomic Regulation During the First Hours of Sleep in a Large Real-World Sample of Finnish Employees: Observational Study. *JMIR Mental Health*, *5*(1).

Pinto, J. A., Ribeiro, D. K., Da Silva Cavallini, A. F., Duarte, C., & Freitas, G. S. (2016). Comorbidities associated with obstructive sleep apnea: A retrospective study. *International Archives of Otorhinolaryngology*, *20*(2), 145–150. https://doi.org/10.1055/s-0036-1579546

Plante, D. T. (2021). The Evolving Nexus of Sleep and Depression. In *The American Journal of Psychiatry* (Vol. 178, Issue 10, pp. 896–902). NLM (Medline). https://doi.org/10.1176/appi.ajp.2021.21080821

Qato, D., Wilder, J., Schumm, L., Gillet, V., & Alexander, G. (2016). Changes in prescription and over-the-counter medication and dietary supplement use among adults in the united states, 2005 vs 2011. *JAMA Internal Medicine*, *176*(4), 473–482.

Randler, C., & Engelke, J. (2019). Gender differences in chronotype diminish with age: A meta-analysis based on morningness/chronotype questionnaires. *Chronobiology International*, *36*(7), 888–905. https://doi.org/10.1080/07420528.2019.1585867

Resnick, B., & Parker, R. (2001). Simplified scoring and psychometrics of the revised 12-item short-form health survey. *Outcomes Management for Nursing Practice*, *5*(4), 161–166.

Reyner, L. A., Horne, J. A., & Reyner, A. (1995). Gender and age related differences in sleep determined by home-recorded sleep logs and actimetry from 400 adults. *Sleep*, *18*, 391–399.

Reynolds, A. C., & Adams, R. J. (2019). Treatment of sleep disturbance in older adults. In *Journal of Pharmacy Practice and Research* (Vol. 49, Issue 3, pp. 296–304). Wiley-Blackwell. https://doi.org/10.1002/jppr.1565

Rial, R., Nicolau, M., Gamundi, A., Akaarir, M., Aparicio, S., Garau, C., Tejada, S., Roca, C., Gene, L., Moranta, D., & Esteban, S. (2007). The trivial function of sleep. *Sleep Medicine Reviews*, *11*(4), 311–325.

Rockwood, K., Song, X., MacKnight, C., Bergman, H., Hogan, D. B., McDowell, I., & Mitnitski, A. (2005). A global clinical measure of fitness and frailty in elderly people. *CMAJ: Canadian Medical Association Journal*, *173*(5), 489–495.

Sahin, F., Yilmaz, F., Ozmaden, A., Kotevoglu, N., Sahin, T., & Kuran, B. (2008). Reliability and validity of the Turkish version of the Nottingham Extended Activities of Daily Living Scale Aging Clinical and Experimental Research. In *Aging Clin Exp Res* (Vol. 20, Issue 5).

Sanderson, K., & Andrews, G. (2002). The SF-12 in the Australian population: Cross-validation of item selection. *Australian and New Zealand Journal of Public Health*, *26*(4), 343–345. https://doi.org/10.1111/j.1467-842X.2002.tb00182.x

Scott, A. J., Webb, T. L., Martyn-St James, M., Rowse, G., & Weich, S. (2021). Improving sleep quality leads to better mental health: A meta-analysis of randomised controlled trials. *Sleep Medicine Reviews*, *60*. https://doi.org/10.1016/j.smrv.2021.101556

Skeldon, A. C., Derks, G., & Dijk, D. J. (2016). Modelling changes in sleep timing and duration across the lifespan: Changes in circadian rhythmicity or sleep homeostasis? *Sleep Medicine Reviews*, *28*, 96–107. https://doi.org/10.1016/j.smrv.2015.05.011

Smagula, S., Stone, K., Fabio, A., & Cauley, J. (2016). Risk factors for sleep disturbances in older adults: Evidence from prospective studies. *Sleep Medicine Reviews*, *25*, 21–30.

Smyth, C. (2008). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Journal of Psychiatric Research*, *31*(9), 406–418. www.hartfordign.organd/orwww.ConsultGeriRN.org.

Stickgold, R., & Walker, M. P. (2007). Sleep-dependent memory consolidation and reconsolidation. *Sleep Medicine*, *8*(4), 331–343. https://doi.org/10.1016/j.sleep.2007.03.011

Storey, J. E., Rowland, J. T. J., Conforti, D. A., & Dickson, H. G. (2004). The Rowland Universal Dementia Assessment Scale (RUDAS): A multicultural cognitive assessment scale. *International Psychogeriatrics*, *16*(1), 13–31. https://doi.org/10.1017/S1041610204000043

Su, S.-W., & Wang, D. (2019). The Reliability and Validity of Short Form-12 Health Survey Version 2 for Chinese Older Adults. In *Iran J Public Health* (Vol. 48, Issue 6). http://ijph.tums.ac.ir

Suzuki, K., Miyamoto, M., & Hirata, K. (2017). Sleep disorders in the elderly: Diagnosis and management. In *Journal of General and Family Medicine* (Vol. 18, Issue 2, pp. 61–71). Wiley-Blackwell. https://doi.org/10.1002/jgf2.27

Sweetman, A., Lack, L., Catcheside, P., Antic, N., Chai-Coetzer, C., Smith, S., Douglas, J., & McEvoy, R. (2017). Developing a successful treatment for co-morbid insomnia and sleep apnoea. *Sleep Medicine Reviews*, *33*, 28–38.

Taillard, J., Gronfier, C., Bioulac, S., Philip, P., & Sagaspe, P. (2021). Sleep in normal aging, homeostatic and circadian regulation and vulnerability to sleep deprivation. In *Brain Sciences* (Vol. 11, Issue 8). MDPI. https://doi.org/10.3390/brainsci11081003

Thase, M. (2006). Depression and sleep: pathophysiology and treatment. *Dialogues in Clinical Neuroscience*, *8*(2), 217–226.

Timofeev, I., & Chauvette, S. (2019). Neuronal Activity During the Sleep-Wake Cycle. In *Handbook of Behavioral Neuroscience* (Vol. 30, pp. 3–17). Elsevier B.V. https://doi.org/10.1016/B978-0-12-813743-7.00001-3

Tranah, G. J., Yaffe, K., Nievergelt, C. M., Parimi, N., Glymour, M. M., Ensrud, K. E., Cauley, J. A., Ancoli-Israel, S., Mariani, S., Redline, S., & Stone, K. L. (2018). APOEє4 and slow wave sleep in older adults. *PLoS ONE*, *13*(1). https://doi.org/10.1371/journal.pone.0191281

Tubbs, A. S., Dollish, H. K., Fernandez, F., & Grandner, M. A. (2019). The basics of sleep physiology and behavior. In *Sleep and Health* (pp. 3–10). Elsevier. https://doi.org/10.1016/B978-0-12-815373-4.00001-0

van den Berg, N. H., Benoit, A., Toor, B., & Fogel, S. (2019). Sleep Stages and Neural Oscillations: A Window into Sleep's Role in Memory Consolidation and Cognitive Abilities. In *Handbook of Behavioral Neuroscience* (Vol. 30, pp. 455–470). Elsevier B.V. https://doi.org/10.1016/B978-0-12-813743-7.00030-X

Vandekerckhove, M., & Wang, Y. L. (2018). Emotion, emotion regulation and sleep: An intimate relationship. *AIMS Neuroscience*, *5*(1), 1–17. https://doi.org/10.3934/Neuroscience.2018.1.1

Vitiello, M. V. (2009). Recent advances in understanding sleep and sleep disturbances in older adults growing older does not mean sleeping poorly. *Association of Pychological Science*, *18*(6), 316–324.

Vitiello, M. V., Moe, K. E., & Prinz, P. N. (2002). Sleep complaints cosegregate with illness in older adults: Clinical research informed by and informing epidemiological studies of sleep. *Journal of Psychosomatic Research*, *53*(1), 555–559. https://doi.org/10.1016/S0022-3999(02)00435-X

Wan Suh, S., Won Han, J., Hyun Han, J., Bin Bae, J., Moon, W., Sung Kim, H., Jong Oh, D., Phil Kwak, K., Jo Kim, B., Gyeom Kim, S., Lan Kim, J., Hui Kim, T., Ryu, S.-H., Woo Moon, S., Hyuk Park, J., Byun, S., Seo, J., Chul Youn, J., Young Lee, D., … Woong Kim, K. (2020). Sex differences in subjective age-associated changes in sleep: a prospective elderly cohort study. *Aging*, *12*(21), 1–17.

Wang, P., Song, L., Wang, K., Han, X., Cong, L., Wang, Y., Zhang, L., Yan, Z., Tang, S., & Du, Y. (2020). Prevalence and associated factors of poor sleep quality among Chinese older adults living in a rural area: a population-based study. *Aging Clinical and Experimental Research*, *32*(1), 125–131. https://doi.org/10.1007/s40520-019-01171-0

Ware, J. E., Kosinski, M., & Keller, S. D. (1996). A 12-Item Short-Form Health Survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care*, *34*(3), 220–233.

Weaver, D. (2016). Introduction to circadian rhythms and mechanisms of circadian oscillations. In M. Gumz (Ed.), *Circadian Clocks: Role in health and disease* (pp. 1–56). Springer.

Wennberg, A. M. V., Wu, M. N., Rosenberg, P. B., & Spira, A. P. (2017). Sleep disturbance, cognitive decline, and dementia: A review. *Seminars in Neurology*, *37*(4), 395–406. https://doi.org/10.1055/s-0037-1604351

World Health Organization. (2019). *Medication safety in polypharmacy*.

Xie, L., Kang, H., Xu, Q., Chen, M., Liao, Y., Thiyagarajan, M., O'Donnell, J., Christensen, D., Nicholson, C., Iliff, J., Takano, T., Deane, R., & Nedergaard, M. (2013). Sleep drives metabolite clearance from the adult brain. *Science*, *342*(6156), 373–377.

Young, T., Peppard, P. E., & Gottlieb, D. (2002). Epidemiology of obstructive sleep apnea: A population health perspective. *Am J Respiratory Critical Care Med*, *165*(9), 1217–1239.

Yu, J., Mahendran, R., Rawtaer, I., Kua, E. H., & Feng, L. (2017). Poor sleep quality is observed in mild cognitive impairment and is largely unrelated to depression and anxiety. *Aging and Mental Health*, *21*(8), 823–828. https://doi.org/10.1080/13607863.2016.1161007

Zeng, L. N., Zong, Q. Q., Yang, Y., Zhang, L., Xiang, Y. F., Ng, C. H., Chen, L. G., & Xiang, Y. T. (2020). Gender difference in the prevalence of insomnia: A meta-analysis of observational studies. *Frontiers in Psychiatry*, *11*. https://doi.org/10.3389/fpsyt.2020.577429

Zhang, C., Dong, F., Zheng, X., Xue, Y., Xiao, S., Shi, L., Xue, B., Zhang, J., & Ou, W. (2022). The impact of sleep quality on subjective wellbeing among older adults with multimorbidity: A moderated mediation model. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.813775

Appendix A

AWESSoM
BASELINE

Study ID No:.....
Date: .....

AGEING WELL THROUGH EATING, SLEEPING, SOCIALISING AND MOBILITY (AWESSOM)

QUESTIONNAIRE BASELINE

AWESSoM
BASELINE

Study ID No:.....
Date: .....

Contents

AWESSoM Data Collection Version 12 Baseline: 09/11/21

Interviewers, fill in as much as possible PARTICIPANT'S PERSONAL INFORMATION and DEMOGRAPHIC questions prior to face-to-face interview. Double check details with the participant. Fill in using CAPITAL LETTERS

Interviewer's initials: _____

Date of Interview: _____ (dd/mm/yyyy)

Start Time: _____

Interviewer to complete – Who is responding to this questionnaire?

☐ [1] Participant ☐ [2] Family member/other

Method by which data has been collated (please tick):

	Face to Face	Telephone	Zoom
Questionnaire			
Short Physical Performance Battery			

Study site (centre ID)
☐☐ 01 Tauranga; 02 Howick

Participant ID (study number)
☐☐☐☐

AWESSoM: BASELINE

Study No ID: .....
Date: .....

A. PARTICIPANT'S PERSONAL INFORMATION AND DEMOGRAPHIC QUESTIONS

A1. **NHI Number** ☐☐☐☐☐☐☐

A2. **Name** .....

A3. **Address** .....

.....

..... **A4. Telephone**.....

A5. **Email** (if available).....

A6. **Alternative Contact Information:** Could we please have the name and address of someone we could contact if we couldn't get hold of you? If none, record N/A in each box.
Name .....

A7. **Address** .....

.....

..... **A8. Telephone**.....

A9. **Email** (if available).....

A10. What is this person's **relationship** to you?.....

Can I please check if the following information is correct?

A11. Your **GP's** name .....

A12. **Gender** 1 = Male 2 = Female 3 = Other 4 = Refused ☐

A13. Can I please confirm that your **Date of Birth** is **(dd/mm/yyyy)?** ☐☐ ☐☐ ☐☐☐☐

A14. And, on your **last birthday** you were… ? ☐☐☐

A15. **Which ethnic group(s) do you belong to?**
(read all options and mark answers with 1 = Yes 0 = No)

New Zealand European ☐ Maori ☐ Samoan ☐
If NZ Maori, does your iwi tribal group come from the area where you live? ☐
Cook Island Māori ☐ Tongan ☐ Niuean ☐
Chinese ☐ Indian ☐ Other European ☐
Other, such as Japanese, Tokelauan (specify) _____ ☐

A16. Which country were you born in?

New Zealand[11]
Australia[12]
United Kingdom or other European countries[13]
China (People's Republic of)[21]
South Africa[22]
Samoa[31]
Cook Islands[32]
Other (specify)[61] _____

A17. Marital Status

Never married = 1 Married/partner = 2 Separated /divorced / widowed = 3

A18. Who do you live with most of the time?

Alone = 1
With spouse/partner only = 2
With spouse/partner and child/other relative = 3
With spouse/partner and non-relatives = 4
With child (not spouse/partner) = 5
Other(s) (specify) = 6 .....

A19. What best describes your home?

Private Dwelling, stand alone house[1]
Private unit or apartment - independent[2]
Unit or apartment on site with family dwelling[3]
Retirement village – villa or own unit[4]
Rest home[5]
Private hospital (own or shared room)[6]
Marae or iwi based housing[7]
Other[8] (specify) _____

A20. What is your highest education level?

Primary school or no schooling	secondary school, no qualification	secondary school qualification	trade, occupational	tertiary qualification
0	1	2	3	4

Interviewer: For A21 and A22, if two or more occupations are identified ask them how long they spent in each occupation. The occupation where they spent the longest time is their main lifetime occupation. For example: Many people have a variety of occupations during their lifetime. We want to know what their longest occupation was e.g. farmer for twenty years and then a banker for thirty years – main occupation would be banker.

If more than one spouse/partner – ask them for the main lifetime occupation of the person they were married to (lived with) the longest.

A21. What was your main lifetime occupation?

Legislator, Administrator & Manager[1]
Professional[2]
Technician and Associate Professional[3]
Clerk[4]
Service and Sales worker[5]
Agriculture and fishery worker[6]
Trades worker[7]
Plant and machine operator and assembler[8]
Elementary occupation[9]

A22. What was your spouse / partner's main lifetime occupation?

Legislator, Administrator & Manager[1]
Professional[2]
Technician and Associate Professional[3]
Clerk[4]
Service and Sales worker[5]
Agriculture and fishery worker[6]
Trades worker[7]
Plant and machine operator and assembler[8]
Elementary occupation[9]

B. MEDICAL, HEALTH QUESTIONS and NHI DATA

SMOKING

B1. Do you currently smoke cigarettes?

1 = Yes 0 = No

B2. If 'yes', on average, how many cigarettes do you smoke per day?

ALCOHOL CONSUMPTION

B3. Do you currently drink alcohol?

0 = Never 1 = Less than monthly
2 = monthly 3 = weekly 4 = daily or almost daily

B4. In the last year have you been admitted to a hospital?

1 = Yes 0 = No

FALLS

B5. Have you fallen in the previous year?
(Explanation: A fall is defined as a slip or trip in which you lost your balance and landed on the floor or ground or lower level)

1 = Yes 0 = No

If yes:

B5a. How many times have you fallen in the previous year?
Once = 1 Two or three = 2 Four or more = 3

B5a(i) If more than one fall – where do those falls typically occur

.....

B5b. What was the most serious injury from a fall in the previous year?

.....

B6. MEDICATION TABLE

List prescription medications first leave a line, then over the counter medications, note any medical devices used

Generic name	Strength	As required (PRN) Yes = 1 No = 0	Dose 1-4 x day record amount taken under breakfast, lunch, dinner, bedtime				Other Frequency D – Day; W – Weekly; M – Month; Y – Year Use the most relevant, add a number to identify frequency. For example: 5D = 5 times every day; 2M = twice each month	How do you get this medication? 1 – Prescription 2 – Bought, no script 3 – Other
			Breakfast	Lunch	Dinner	Bedtime		

AWESSoM: BASELINE Study ID No: ..... Date: .....

B6. MEDICATION TABLE

List prescription medications first leave a line, then over the counter medications, note any medical devices used

Generic name	Strength	As required (PRN) Yes = 1 No = 0	Dose 1-4 x day record amount taken under breakfast, lunch, dinner, bedtime				Other Frequency D – Day; M – Month; Y – Year Use the most relevant, add a number to identify frequency. For example: 5D = 5 times every day; 2M = twice each month	How do you get this medication? 1 – Prescription 2 – Bought, no script 3 – Other
			Breakfast	Lunch	Dinner	Bedtime		
Medical Devices used:								

B7. Total number of current prescribed medications ☐

AWESSoM: BASELINE Study ID No: ..... Date: .....

B8. Have you visited, or had a visit from or consultation with, any of the following health professionals? How many times in the last 12 months?

Show card Health Prof.

	Not at all	About once a year	About every 6 months	About every 3 months	About every month	About every week	Don't know	
a) General practitioner	0	1	2	3	4	5	6	
b) Hospital based doctor or private specialist	0	1	2	3	4	5	6	
c) After hours medical clinic	0	1	2	3	4	5	6	
d) Practice nurse	0	1	2	3	4	5	6	
e) Pharmacist/chemist	0	1	2	3	4	5	6	
f) Dentist	0	1	2	3	4	5	6	
g) Podiatrist - feet	0	1	2	3	4	5	6	
h) Audiologist – ears/hearing	0	1	2	3	4	5	6	
i) Optometrist – eyes/glasses	0	1	2	3	4	5	6	
j) District Nurse	0	1	2	3	4	5	6	
k) Physiotherapist	0	1	2	3	4	5	6	
l) Occupational Therapist	0	1	2	3	4	5	6	
m) Dietician	0	1	2	3	4	5	6	
n) Social worker	0	1	2	3	4	5	6	
o) Community worker	0	1	2	3	4	5	6	
p) Whanau ora worker	0	1	2	3	4	5	6	
q) Alternative health professional e.g. Naturopath/ Homeopath	0	1	2	3	4	5	6	
r) Tohunga / Maori healer	0	1	2	3	4	5	6	
s) Other health professional, specify	0	1	2	3	4	5	6	
.....	0	1	2	3	4	5	6	
.....	0	1	2	3	4	5	6	
.....	0	1	2	3	4	5	6	

AWESSoM: BASELINE Study ID No: ..... Date: .....

B9. Can you let me know of any significant medical history or major health problems that you feel we should be aware of. Has a Doctor ever told you that you have (or had) any of the following conditions:

Yes = 1 No = 0 Don't know = 2

1. High blood pressure (hypertension)	
2. Diabetes	
3. Cancer (other than a minor skin cancer)	
4. Chronic lung disease	
5. Heart attack	
6. Congestive heart failure	
7. Angina (chest pain caused by heart disease)	
8. Asthma	
9. Arthritis	
10. Stroke	
11. Kidney disease	
12. Epilepsy/seizure disorder	
13. Parkinson's disease	
14. Depression	
15. Sleep disorder, eg sleep apnoea, restless legs, chronic insomnia	
16. Other (specify)	
17. Other (specify)	
18. Other (specify)	
19. Other (specify)	

Have you had any of the following procedures:

1. Hip fracture or replacement	
2. Knee replacement	

B10. How much does your eyesight interfere with normal day-to-day functioning?

Not at all	Somewhat	Moderately	Very	Extremely	
1	2	3	4	5	

B11. How much does your hearing interfere with normal day-to-day functioning?

Not at all	Somewhat	Moderately	Very	Extremely	
1	2	3	4	5	

B11a. Do you have a hearing aid? 1 = Yes 0 = No ☐

B11b. If 'yes', how often do you use it?

None of the time	Some of the time	Most of the time	All of the time	
1	2	3	4	

AWESSoM: BASELINE Study ID No: ..... Date: .....

C. HEALTH RELATED QOL, SF12

These next questions ask for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. If you are unsure about how to answer a question, please give the best answer you can.

C1. In general, would you say your health is:

Excellent	Very Good	Good	Fair	Poor	
1	2	3	4	5	

C2. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

	Yes, limited a lot	Yes, limited a little	No, not limited at all	
a. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1	2	3	
b. Climbing several flights of stairs	1	2	3	

C3. During the PAST 4 WEEKS, how much of the time have you had any of the following problems with your work or other regular daily activities AS A RESULT OF YOUR PHYSICAL HEALTH?

Show card SF-12

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	
a. Accomplished less than you would like	1	2	3	4	5	
b. Were limited in the kind of work or other activities	1	2	3	4	5	

C4 During the PAST 4 WEEKS, how much of the time have you had any of the following problems with your work or other regular daily activities AS A RESULT OF ANY EMOTIONAL PROBLEMS (such as feeling depressed or anxious)?

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	
a. Accomplished less than you would like	1	2	3	4	5	
b. Did work or activities less carefully than usual	1	2	3	4	5	

AWESSoM: BASELINE Study ID No: ……. Date: ……

C5. These questions are about how you feel and how things have been with you 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:

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	
a. Have you felt calm and peaceful?	1	2	3	4	5	
b. Did you have a lot of energy?	1	2	3	4	5	
c. Have you felt downhearted and depressed?	1	2	3	4	5	

C6. During the PAST 4 WEEKS, how much did PAIN interfere with your normal work activities? (including both work outside the home and housework)?

Not at all	Slightly	Moderately	Quite a bit	Extremely	
1	2	3	4	5	

C7. 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	Some of the time	A little of the time	None of the time	
1	2	3	4	5	

AWESSoM: BASELINE Study ID No: ……. Date: ……

D. NOTTINGHAM EXTENDED ACTIVITIES OF DAILY LIVING (NEADL)

Show cards NEADL

The next questions ask about a few more common everyday activities. For each question please tell me whether you do the activity on your own, on your own with difficulty, with help from someone else, or whether you don't do the activity at all. We are interested in whether you have actually DONE the activity in the last few weeks, not whether you CAN do it. Interviewer: ask all the questions first and record 0,1,2 or 3 in the first column. Then go back to all activities the person said they have help to do. For each activity they said they have help, ask who helps. Record either a '1' for receives help from this group or a '0' they do not receive help from this group under each heading.

Scoring:
No = 0
With help = 1
On my own with difficulty = 2
On my own = 3

Help received from….

		Someone in the same household	Family outside the household	Paid help (eg home help)	Others
D1.	**Mobility**					
	a. Do you walk around outside?					
	b. Do you climb stairs?					
	c. Do you get in and out of the car?					
	d. Do you walk over uneven ground?					
	e. Do you cross roads?					
	f. Do you travel on public transport?					
D2.	**In the kitchen**					
	a. Do you manage to feed yourself?					
	b. Do you manage to make yourself a hot drink?					
	c. Do you take hot drinks from one room to another?					
	d. Do you do the washing up?					
	e. Do you make yourself a hot snack?					
D3.	**Domestic tasks**					
	a. Do you manage your own money when you are out?					
	b. Do you wash small items of clothing?					
	c. Do you do your own housework?					
	d. Do you do your own shopping?					
	e. Do you do a full clothes wash?					
D4.	**Leisure activities**					
	a. Do you read newspapers or books?					
	b. Do you use the telephone?					
	c. Do you write letters/send emails?					
	d. Do you go out socially?					
	e. Do you manage your own garden?					
	f. Do you drive a car?					

D5. During the last 4 weeks how often have you …..?

	Every day	Every week	More than once a week but less than weekly	Once	Not at all	
a) Driven a car	1	2	3	4	5	
b) been driven by others in a car	1	2	3	4	5	
c) taken public transport	1	2	3	4	5	
d) taken a taxi	1	2	3	4	5	
e) taken 'driving Miss Daisy' or similar	1	2	3	4	5	

AWESSoM: BASELINE Study ID No: ……. Date: ……

E. RUDAS MEMORY SCREEN

The Rowland Universal Dementia Assessment Scale

Memory

1. (Instructions) I want you to imagine that we are going shopping. Here is a list of grocery items. I would like you to remember the following items which we need to get from the shop. When we get to the shop in about 5 mins. time I will ask you what it is that we have to buy. You must remember the list for me.

   Tea
   Cooking Oil
   Eggs
   Soap

   Please repeat this list for me (ask person to repeat the list 3 times)
   (If person did not repeat all four words, repeat the list until the person has learned them and can repeat them, or, up to a maximum of five times.)

Visuospatial Orientation

2. I am going to ask you to identify/show me different parts of the body. (Correct = 1). Once the person correctly answers 5 parts of this question, do not continue as the maximum score is 5.
   (a) show me your right foot …../1
   (b) show me your left hand …../1
   (c) with your right hand touch your left shoulder …../1
   (d) with your left hand touch your right ear …../1
   (e) which is (indicate/point to) my left knee …../1
   (f) which is (indicate/point to) my right elbow …../1
   (g) with your right hand indicate/point to my left eye …../1
   (h) with your left hand indicate/point to my left foot …../1

…./5

Praxis

3. I am going to show you an action/exercise with my hands. I want you to watch me and copy what I do. Copy me when I do this . . . (One hand in fist, the other palm down on table - alternate simultaneously.) Now do it with me: Now I would like you to keep doing this action at this pace until I tell you to stop - approximately 10 seconds. (Demonstrate at moderate walking pace). Score as:

Normal	= 2	(very few if any errors; self-corrected, progressively better; good maintenance; only very slight lack of synchrony between hands)
Partially Adequate	= 1	(noticeable errors with some attempt to self-correct; some attempt at maintenance; poor synchrony)
Failed	= 0	(cannot do the task; no maintenance; no attempt whatsoever)

…./2

Visuoconstructional Drawing

4. Please draw this picture exactly as it looks to you (*Show cube on back of page*). (Yes = 1)
   Score as:
   (a) Has person drawn a picture based on a square? …../1
   (b) Do all internal lines appear in person's drawing? …../1
   (c) Do all external lines appear in person's drawing? …../1

…./3

AWESSoM: BASELINE Study ID No: ……. Date: ……

Judgment

5. You are standing on the side of a busy street. There is no pedestrian crossing and no traffic lights. Tell me what you would do to get across to the other side of the road safely. (If person gives incomplete response that does not address both parts of answer, use prompt: "Is there anything else you would do?") Record exactly what participant says and circle all parts of response which were prompted.

   ……
   ……
   ……

Score as:
Did person indicate that they would look for traffic? (Yes = 2;Yes prompted = 1; No = 0) …../2

Did person make any additional safety proposals? (Yes = 2;Yes prompted = 1; No = 0) …../2

…./4

Memory Recall

1. (Recall) We have just arrived at the shop. Can you remember the list of groceries we need to buy? (Prompt: If person cannot recall any of the list, say "The first one was 'tea'." (Score 2 points each for any item recalled which was not prompted – use only 'tea' as a prompt.)
   Tea …../2
   Cooking Oil (oil is acceptable)…../2
   Eggs …../2
   Soap …../2

…./8

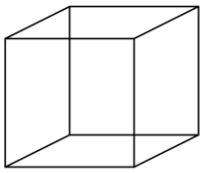
Language

6. I am going to time you for one minute. In that one minute, I would like you to tell me the names of as many different animals as you can. We'll see how many different animals you can name in one minute. (Repeat instructions if necessary). Maximum score for this item is 8. If person names 8 new animals in less than one minute there is no need to continue.

   Write down the animal's names **…./8**

……
……
……
……
……

Total Score **…./30**



For REDCap – use this sheet to record comments for JUDGEMENT and LANGUAGE:

5. Judgement – record exactly what participant says and circle all parts of the response which were prompted

6. Language - List animals (up to 8 then stop)

F. NUTRITION

SCREEN II (14 items)
I'm now going to ask you some questions about your eating habits. I want to find out about your normal eating habits – so we'll talk about a TYPICAL day. There are no right or wrong answers to any of these questions. Several questions on SCREEN II use value judgement responses. When scoring these questions the following interpretation is appropriate: Rarely means once a week or less; sometimes means 2-4 times per week; often means 5-6 times per week and always means at least daily.

F1. Has your weight changed in the past 6 months?

No, my weight has stayed within a few kilos *(Go to F2)*	Yes (Go to F1a)	I don't know how much I weigh or if my weight has changed *(Go to F2)*
0	1	2

F1a. How much has it changed?

I gained			I lost		
More than 5kg	2½ - 5kg	About 2-2½ kg	More than 5kg	2½ - 5kg	About 2-2½ kg
1	2	3	4	5	6

F2. Have you been trying to change your weight in the past 6 months?

No	Yes	No, but it changed anyway
0	1	2

F3. Do you think your weight is…

More than it should be	Just right	Less than it should be
1	2	3

F4. Do you skip meals?

Never or rarely	Sometimes	Often	Almost every day
1	2	3	4

F5. Do you limit or avoid certain foods?

I eat most foods	I limit some foods and I am managing fine	I limit some foods and I am finding it difficult to manage
1	2	3

F6. How would you describe your appetite?

Very good	Good	Fair	Poor
1	2	3	4

F7. How many pieces or servings of fruit and vegetables do you eat in a day?
Can be canned, fresh, frozen or juice. A handful is a serving, count each vegetable as a separate serving.

Five or more	Four	Three	Two	Less than two
1	2	3	4	5

F8. How often do you eat meat, eggs, fish, poultry or meat alternatives?
Meat alternatives are dried peas, beans, lentils, nuts, peanut butter or tofu.

Two or more times a day	One to two times a day	Once a day	Less than once a day
1	2	3	4

F9. How often do you have milk products?
Includes fluid milk, cooking with milk, milk puddings, ice cream, cheese, yoghurt and milk alternatives like soy beverages.

Three or more times a day	Two to three times a day	One to two times a day	Usually once a day	Less than once a day
1	2	3	4	5

F10. How much fluid do you drink in a day?
Includes: water, tea, coffee, herbal drinks, juice, and soft-drinks but not alcohol

Eight or more cups	Five to seven cups	Three to four cups	About two cups	Less than two cups
1	2	3	4	5

F11. Do you cough, choke or have pain when swallowing food OR fluids?

Never	Rarely	Sometimes	Often or always
1	2	3	4

F12. Is biting or chewing food difficult for you?

Never (Go to F13)	Rarely (Go to F12a)	Sometimes (Go to F12a)	Often or always (Go to F12a)
1	2	3	4

F12a If rarely, sometimes or often/always – why is chewing difficult? Choose up to 3 main reasons

Pain in mouth (other than gums/teeth)	Gum disease	Teeth sore	Dentures don't fit	Other (specify)
1	2	3	4	5

F12a. Other

……

……

F13 How often does your mouth feel dry ?

Never	Occasionally	Frequently	Always	Don't Know
1	2	3	4	5

F14. Do you use commercial meal replacements or supplements? *(protein shakes, energy bars, Complan, Ensure)*

Never or rarely	Sometimes	Often or always
1	2	3

F15. Do you eat one or more meals a day with someone?

Never or rarely	Sometimes	Often	Almost always
1	2	3	4

F16. Who usually prepares your meals?

I do	I share my cooking with someone else	Someone else cooks most of my meals
1	2	3

F17. Which statement best describes meal preparation for you?

I enjoy cooking most of my meals	I sometimes find cooking a chore	I usually find cooking a chore	I'm satisfied with the quality of food prepared by others	I'm not satisfied with the quality of food prepared by others
1	2	3	4	5

F18. Do you have any problems getting your groceries?
Can be poor health or disability, limited income, lack of transportation, weather conditions, or finding someone to shop

Never or rarely	Sometimes	Often	Always
1	2	3	4

G. ORAL HEALTH - Teeth

G1. Do you have ANY of your own teeth?
1 = Yes 0 = No
If no skip to G2

G1a. How many teeth do you have in your UPPER jaw?
Numeric range 1–16

G1b. How many teeth do you have in your LOWER jaw?
Numeric range 1–16

G2. Do you have a denture or false teeth (removable) for your UPPER jaw?
1 = Yes 0 = No

G3. Do you have a denture or false teeth (removable) for your LOWER jaw?
1 = Yes 0 = No

G4. OHIP - Each of the following questions applies to you during the last 3 months. Because of trouble with your teeth, mouth or dentures:
Show card OHIP

	Never (0)	Hardly Ever (1)	Occasionaly (2)	Fairly Often (3)	Very Often (4)	
a) Have you had **trouble pronouncing any words**?						
b) Have you felt that your **sense of taste has worsened?**						
c) Have you had **painful aching** in your mouth?						
d) Have you found it **uncomfortable to eat** any foods?						
e) Have you been **self-conscious**?						
f) Have you felt **tense**?						
g) Has your **diet been unsatisfactory**?						
h) Have you had to **interrupt meals**?						
i) Have you found it **difficult to relax**?						
j) Have you been a bit **embarrassed**?						
k) Have you been a bit **irritable** with other people?						
l) Have you had **difficulty doing your usual jobs**?						
m) Have you felt that **life in general was less satisfying**?						
n) Have you been **totally unable to function**?						

G5. Do you have a dentist who you usually go to if you need dental care or dental advice?
1 = Yes 0 = No

G6. How would you describe the health of your teeth or mouth?

Excellent	Very Good	Good	Fair	Poor
1	2	3	4	5

G7. Do you feel that you currently need dental treatment?
1 = Yes 0 = No

G8. Do you feel that you see a dental professional often enough?
1 = Yes 0 = No

G9. When did you last go to a dentist?

within the last year	12-24 months ago	more than 24 months
1	2	3

G10. How often do you brush your teeth or clean your dentures?

never	< 1x week	1-2 x week	>2xweek <1x day	1x daily	2x daily	>2 x daily
1	2	3	4	5	6	7

G11. Do you have any physical problems that make it difficult for you to clean your teeth such as opening your mouth or moving your hand?
1 = Yes 0 = No

H. SHORT PHYSICAL PERFORMANCE BATTERY

Date Short Physical Performance Battery conducted _____ (dd/mm/yyyy)
(if completed on a different date to questionnaire)

Time Short Physical Performance Battery commenced _____ (hh:mm)
(if completed on a different date to questionnaire)

Now I'd like to ask you to do some physical performance tests. I will first describe and show each movement to you. Then I'd like you to try to do it. If you cannot do a particular movement or you feel it would be unsafe to try to do it, tell me and we'll move on to the next one. Let me emphasise that I do not want you to try to do any test that you really feel you are unable to do.

Reason not attempted or not completed CODE

Tried but unable	1
Participant could not hold position unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (specify)	6
Participant refused	7

H1. BALANCE TEST
Instructions: **Start with B: Semi-tandem stand**. If the person cannot hold the position for 10 seconds, ask them to attempt A: Side-by-side stand. If they manage the semi-tandem stand for 10 seconds, go straight to C: Tandem stand.

A. Side-by-side stand
I want you to try to stand with your feet together, side by side, for about 10 seconds.

Attempted 1=Yes; 0=No ☐	Number of seconds held: ☐☐.☐☐	Held for 10 sec 1=Yes; 0=No ☐	If not attempted or failed, enter reason: *(Code box above* ☐.....

If not attempted or not held for 10 seconds, end balance tests and go to gait speed test

B. Semi-Tandem Stand
Now I want you to try to stand with the side of the heel of one foot touching the big toe of the other foot for about 10 seconds. You may put either foot in front, whichever is more comfortable for you.

Attempted 1=Yes; 0=No ☐☐	Number of seconds held: ☐☐.☐☐	Held for 10 sec 1=Yes; 0=No ☐☐	If not attempted or failed, enter reason: *(Code box above* ☐.....

If not attempted or not held for 10 seconds, go to A: Side-by-Side stand

C. Tandem Stand
Now I want you to try to stand with the heel of one foot in front of and touching the toes of the other foot for about 10 seconds. You may put either foot in front, whichever is more comfortable for you.

Attempted 1=Yes; 0=No ☐	Number of seconds held: ☐☐.☐☐	Held for 10 sec 1=Yes; 0=No ☐	If not attempted or failed, enter reason: *(Code box above* ☐.....

H2. GAIT SPEED TEST

Now I am going to observe how you normally walk. This is our walking course. I want you to walk to the other end of the course at your usual speed, just as if you were walking down the street to go to the store. Keep walking until I ask you to stop.

	First walk	Second walk
Test was attempted 1=Yes; 0=No	☐	☐
Time for 3 metres (min' sec)	☐☐.☐☐.☐☐ (min) (sec) (ms)	☐☐.☐☐.☐☐ (min) (sec) (ms)
Aids for walk (1 = None, 2 = Cane, 3 = Other)	☐	
If not attempted or failed, enter reason (Code box above)	☐.....	☐.....

If not attempted or failed, go to chair stand test

H3. Timed Up and Go

Safe to attempt timed up and go 1 = Yes 0 = No ☐

Walking Aid used Yes ☐ WF ☐ Stick ☐ No ☐

Instructions

When I say 'Go,' stand up and walk at your usual pace to the mark on the floor, turn around, and walk back to the chair and sit down again."

The stopwatch starts when you say go and is stopped with the participant's buttocks touch the seat.

Time taken ☐☐.☐☐ **(seconds + 2 decimal points)**

If not attempted or failed, code reason (code box above) ☐

H4. CHAIR STAND TEST

Let's do the last movement test. Do you think it would be safe for you to try to stand up from a chair without using your arms?

So let's do the test. This test measures the strength in your legs. First, fold your arms across your chest and sit with your feet flat on the floor; then stand up keeping your arms folded across your chest.

(Single)

Safe to stand without help (1=Yes; 0=No)	☐
Results: Participant stood without using arms	☐ *If "Yes" Go to Repeated Chair Stand Test, if "No", end the test and go to the next section*
If not attempted or failed, code reason (Code box above)	☐ .....

Please stand up as QUICKLY as you can 5 times without stopping in between. After standing up each time, sit down and then stand up again. Keep your arms folded across your chest. I'll be timing you with a stopwatch.

(Repeated Chair Stand Test)

Safe to stand five times (1=Yes; 0=No…)	☐
Time to complete five stands (in seconds)	☐☐.☐☐ (sec) (ms)
If not attempted or failed, code reason (Code box above)	☐ .....

H5. PHYSICAL ASSESSMENT

HEIGHT (cm)	Reading 1	Reading 2	Reading 3 (if > .5cm	Calculated height
Standing	☐☐☐.☐	☐☐☐.☐	☐☐☐.☐	
Demispan*	☐☐.☐	☐☐.☐	☐☐.☐	☐☐☐.☐
Ulna length*	☐☐.☐	☐☐.☐	☐☐.☐	☐☐☐.☐

* Measure demispan or ulna length only if standing height cannot be obtained

COMMENTS:

.....

.....

Date of Birth *(copy from page 4)* ☐☐-☐☐-☐☐☐☐ *(dd) (mm) (yyyy)*

Interviewer: Before using Tanita Inner Scan – check with participant if they have a pacemaker – if yes, do not complete this task

TANITA INNER SCAN – WEIGHT AND BODY COMPOSITION Results		
Body Weight (kg) ☐☐☐.☐ kg	BMI ☐☐.☐	Body Fat (%) ☐☐.☐ %
Total Body Water (%) ☐☐.☐ %	Muscle mass (kg) ☐☐.☐ kg	Physique rating ☐
Bone mass (kg) ☐.☐ kg	Basal Metabolic Rate (kcal) ☐☐☐☐ kcal	Basal Metabolic Rate (kJ) ☐☐☐☐ kJ
Metabolic Age ☐☐	Visceral fat rating ☐☐.☐ level	

COMMENTS:

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.....

BLOOD PRESSURE (mmHg)	Reading 1	Reading 2	Reading 3	Arm used
Sitting	S: ☐☐☐ D: ☐☐☐	S: ☐☐☐ D: ☐☐☐	S: ☐☐☐ D: ☐☐☐	L
Time (24hrs)	☐☐☐☐	☐☐☐☐	☐☐☐☐	R
Standing	S: ☐☐☐ D: ☐☐☐	S: ☐☐☐ D: ☐☐☐	S: ☐☐☐ D: ☐☐☐	L
Time (24hrs)	☐☐☐☐	☐☐☐☐	☐☐☐☐	R
Arrhythmia detected		1 = Yes 0 = No		☐

COMMENTS:

.....

	Reading 1	Reading 2	Reading 3 (if >1cm diff)
NECK CIRCUMFERENCE (cm)	☐☐☐.☐	☐☐☐.☐	☐☐☐.☐

COMMENTS:

.....

		Reading 1	Reading 2	Reading 3 (if >1cm diff)
WAIST CIRCUMFERENCE (cm)		☐☐☐.☐	☐☐☐.☐	☐☐☐.☐
HIP CIRCUMFERENCE (cm)		☐☐☐.☐	☐☐☐.☐	☐☐☐.☐
MID-ARM CIRCUMFERENCE (cm) *Note: use non-dominant arm if possible*	L / R	☐☐☐.☐	☐☐☐.☐	☐☐☐.☐
CALF CIRCUMFERENCE (cm)	L / R	☐☐☐.☐	☐☐☐.☐	☐☐☐.☐
	sitting / standing *(circle)*			

COMMENTS:

.....

GRIP STRENGTH		Reading 1	Reading 2	Reading 3
Grip width (mm) ☐☐.☐	Right Hand	☐☐.☐ kg	☐☐.☐ kg	☐☐.☐ kg
	Left Hand	☐☐.☐ kg	☐☐.☐ kg	☐☐.☐ kg
Test conducted: sitting / standing *(circle)*		**Dominant Hand:** Left / Right *(circle)*		

COMMENTS:

.....

Time Short Physical Performance Battery finished (if completed on a different date to questionnaire) _____ (hh:mm)

ACCELEROMETER – START UP (7 days) (ensure consent given)

Accelerometer attached? ☐

1 = Yes 0 = No

If not attached, specify reason

.....

Accelerometer serial number ☐

ID 7 Day Metadata: Session ID

NZE			
Study	Study site (Centre ID enter : 01 Tauranga; 02 Howick)	Participant ID	Time Point (enter: 01 Baseline; 02 Post0 followup)

AX6 Height (in metres) (accelerometer placement – height from ground):

☐.☐☐☐

Date of start recording (dd/mm/yyyy): ☐☐ ☐☐ ☐☐☐☐

Hour and Minute of start recording (24hr clock HR:MM) _____

ACCELEROMETER – Validation Sub-Study (20 minute activity)

ONLY 20 participants in HOWICK

Ensure consent signed **(only complete this section if the participant consented to the validation sub-study but NOT the 7 day accelerometer)**

Accelerometer attached? ☐

1 = Yes 0 = No

If not attached, specify reason

.....

Accelerometer serial number ☐

ID 7 Day Metadata: Session ID

NZE			
Study	Study site (Centre ID enter : 01 Tauranga; 02 Howick)	Participant ID	Time Point (enter: 01 Baseline)

AX6 Height (in metres) (accelerometer placement – height from ground):

☐.☐☐☐

AWESSoM: BASELINE Study ID No: ……
Date: ……

Date of start recording (dd/mm/yyyy): ☐☐ ☐☐ ☐☐☐☐

Hour and Minute of start recording (24hr clock HR:MM) _____

Hour and Minute of stop recording (24hr clock HR:MM) _____

Activities not completed (list):

Details if any data loss is to be expected:

Reason for data loss	Method or participant reason	**Select One** ○ Technical Issue ○ Participant-related reason
	Reason for data loss	**Select One** ○ Data did not record ○ Sensor fell off but returned ○ Sensor fell off and lost ○ Irritated participant's skin ○ Participant admitted to hospital ○ Other (please specify in notes)
Notes (used if reason is not provided above)		

Data Uploaded (Validation Sub-Study)? ☐

1 = Yes 0 = No

I. SLEEP HEALTH

The following questions relate to your usual sleep habits during the past month only. The first section is concerning sleep timing. The second is concerning sleep quality and disturbances. Your answers should indicate the most accurate reply for the majority of days and nights in the past month.

I1	At what time in the evening do you feel tired, and, as a result, in need of sleep? (*approximately*)	Before 9:00 PM [5]	9:00 PM–10:15 PM [4]	10:15PM–12:45AM [3]	12:45AM–2:00AM [2]	2:00 AM–3:00 AM [1]	
I2	When have you usually gone to bed? *(at night)*	[time]					
I3	How long (in minutes) has it taken you to fall asleep each night? *(when you initially try to sleep at night)*	[minutes]					
I4	What time have you usually got up in the morning? *(for the day)*	[time]					
I5	On a typical night, how many times do you wake?	[Number 0-X]					
I5a	*If 1+ awakenings*…How much of a problem is it for you to fall back to sleep?		No problem at all [0]	Somewhat of a problem [1]	Very much a problem [2]		
I6	How many hours of actual sleep do you get at night? *(this may be different than the number of hours you spend in bed)*	[hours]					
I7	Considering only your own rhythm, at what time would you get up if you were entirely free to plan your day?	Before 6:30 AM [5]	6:30 AM–7:45 AM [4]	7:45 AM–9:45 AM [3]	9:45AM–11:00AM [2]	11:00 AM–12noon [1]	
I8	After the first half hour after having woken in the morning, how tired do you feel? *(after your final wake up)*		Very refreshed [4]	Fairly refreshed [3]	Fairly tired [2]	Very tired [1]	
I9	At what time of the day do you think that you reach your "feeling best" peak? (approximately)	5.00AM–8.00AM [5]	8.00AM–10.00AM [4]	10.00AM–5.00PM [3]	5.00PM–10.00PM [2]	10.00PM–5.00AM [1]	
I10	Do you nap during the day?		No [0]	Yes [1]			
I10a			*If yes*	For how long?	[Hours]	[minutes]	
I10b			*If yes*	Is this usually a	Scheduled nap? [1]	Unintentional nap? [2]	
I11	One hears about "morning types" and "evening types." Which one of these types do you consider yourself to be?		Definitely a morning type [6]	Rather more a morning type than an evening type [4]	Rather more an evening type than a morning type [2]	Definitely an evening type [1]	
I12	**We are interested in your story… Is there anything else you would like to tell us about the timing or schedules of your sleep?** [open ended]						

The next questions are about your sleep quality and disturbances. Please check the one best response.

Show Card Sleep

	I13 During the past month, how often have you had trouble sleeping because you…	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week	
A	Cannot get to sleep within 30 minutes	[0]	[1]	[2]	[3]	
B	Wake up in the middle of the night or early morning	[0]	[1]	[2]	F|4 [3]	
C	Have to get up to use the bathroom	[0]	[1]	[2]	[3]	
D	Cannot breath comfortably	[0]	[1]	[2]	[3]	
E	Cough or snore loudly	[0]	[1]	[2]	[3]	
F	Feel too cold	[0]	[1]	[2]	[3]	
G	Feel too hot	[0]	[1]	[2]	[3]	
H	Have bad dreams	[0]	[1]	[2]	[3]	
I	Have pain	[0]	[1]	[2]	[3]	
J	Other reason(s), please describe, including how often you have had trouble sleeping because of this					
	j.a	[0]	[1]	[2]	[3]	
	j.b	[0]	[1]	[2]	[3]	

I14	**How would you rate your sleep quality overall?**				
	Score - Fairly bad or Very bad consider for Actigraphy - ensure consent.	Very good [0]	Fairly good [1]	Fairly bad [2]	Very bad [3]
I15	**How often have you taken medicine (prescribed or "over the counter") to help you sleep? *(can include herbal supplements)***	Not during the past month [0]	Less than once a week [1]	Once or twice a week [2]	Three or more times a week [3]
I15a	***If answer 1,2, or 3…***	**Please describe medicines or supplements used** [short text]			
I16	**How often have you had trouble staying awake while driving, eating meals or engaging in social activity?**	Not during the past month [0]	Less than once a week [1]	Once or twice a week [2]	Three or more times a week [3]

I17	**How much of a problem has it been to keep up enough enthusiasm to get things done?**	No problem at all [0]	Only a very slight problem [1]	Somewhat of a problem [2]	A very big problem [3]
I18a	**Do you have a bedpartner or roommate?**	No bed partner or roommate [0]	Partner/roommate in another room [1]	Partner in same room, but not same bed [2]	Partner in same bed [3]

	I18b If you have a roommate or bedpartner, please ask him/her how often in the last month you had *(if unavailable, indicate whether they have reported these symptoms to you)*	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
A	Loud snoring	[0]	[1]	[2]	[3]
B	Long pauses between breaths while asleep	[0]	[1]	[2]	[3]
C	Legs twitching or jerking while asleep	[0]	[1]	[2]	[3]
D	Episodes of disorientation or confusion while asleep	[0]	[1]	[2]	[3]
E	Other restlessness while you sleep	[0]	[1]	[2]	[3]
E.a	Please describe other restlessness	[short text]			

I19 We are interested in your story… Is there anything else you would like to tell us about your sleep quality or things which disturb your sleep?
[open ended]

SLEEP - ACTIGRAPHY DEVICE (ensure consent)

Actigraphy wrist device attached? ☐

1 = Yes 0 = No

If not attached, specify reason

……

Actigraphy serial number ☐

AWESSoM: BASELINE Study ID No: ……..
Date: ……

J. SOCIAL QUESTIONS

This section is about who you would turn to for help in different situations, if you needed it.

UCLA loneliness 3 item loneliness

J1. How often in the past 4 weeks have you felt that…

	Never	Rarely	Sometimes	Often	Very often	Can't choose	
a. you lack companionship?	1	2	3	4	5	9	
b. you are isolated from others?	1	2	3	4	5	9	
c. you are left out?	1	2	3	4	5	9	

For each of the following situations, please SELECT one box to say who you would turn to first. If there are several people you are equally likely to turn to, please SELECT the box for the one you feel closest to.

Lubben Social Network Scale

J2. FAMILY: Considering the people to whom you are related by birth, marriage, adoption, etc.:

	None	One	Two	3-4	5-8	9 or more	Can't choose	
a. How many relatives do you see or hear from at least once a month?	1	2	3	4	5	6	9	
b. How many relatives do you feel at ease with so that you can talk about private matters?	1	2	3	4	5	6	9	
c. How many relatives do you feel close to so that you could call on them for help?	1	2	3	4	5	6	9	

J3. FRIENDSHIPS: Considering all of your friends including those who live in your neighbourhood:

	None	One	Two	3-4	5-8	9 or more	Can't choose	
a. How many of your friends do you see or hear from at least once a month?	1	2	3	4	5	6	9	
b. How many friends do you feel at ease with so that you can talk about private matters?	1	2	3	4	5	6	9	
c. How many friends do you feel close to so that you could call on them for help?	1	2	3	4	5	6	9	

AWESSoM: BASELINE Study ID No: ……..
Date: ……

J4. During the last 4 weeks how often have you …..? Show Card Social

	Every day	Every week	More than once but less than weekly	Once	Not at all	
a) Gone to the shops	1	2	3	4	5	
b) Gone to the doctor	1	2	3	4	5	
c) Taken care of pets?	1	2	3	4	5	
d) Gone to a restaurant, café, pub or bar	1	2	3	4	5	
e) Gone to a TAB (betting shop) or casino	1	2	3	4	5	
f) Attended a family event?	1	2	3	4	5	
g) Attended a social occasion (such as a barbeque or hangi)	1	2	3	4	5	
h) Gone to the library or museum	1	2	3	4	5	

J5. How much time do you spend by yourself? Are you:

Always alone	Often alone	Seldom alone	Never alone	
1	2	3	4	

J6. Would you say that you:

Always feel lonely	Often feel lonely	Sometimes feel lonely	Never feel lonely	
1	2	3	4	

J7. How comfortable are you with new technology, mobile phones and computers?

Very uncomfortable	Mainly uncomfortable	Neither uncomfortable nor comfortable	Mainly comfortable	Very comfortable	
1	2	3	4	5	

J8. Do you use the internet? 1 = Yes 0 = No

If yes:

J8a. How often in the past four weeks did you use the internet for:

	All of the time	Most of the time	Some of the time	A little of the time	None of the time	
Communication	1	2	3	4	5	
Daily activities eg banking/shopping	1	2	3	4	5	
Medical appointments/prescriptions	1	2	3	4	5	

AWESSoM: BASELINE Study ID No: ……..
Date: ……

J9. Do you use a mobile phone? 1 = Yes 0 = No

J10. Do you watch Pay to View TV (eg SkyTV, Netflix, Vodafone)? 1 = Yes 0 = No

J11. Thinking of your money situation right now, would you say:
I can't make ends meet = 0 I have just enough to get along on = 2 I am comfortable = 3

AWESSoM: BASELINE Study ID No: ……..
Date: ……

K. CHAMPS ACTIVITY

K.1 CHAMPS Activities Questionnaire for Older Adults
This questionnaire is about activities that you may have done in the past 4 weeks.
INSTRUCTIONS: If participant DID the activity in the past 4 weeks:
Step #1: fill in *1 (Yes)* in the box
Step #2: ask the participant to think about how many TIMES a week he/she usually did it and write the response in the space provided.
Step #3: Circle how many TOTAL HOURS in a typical week the participant did the activity.
If the participant DID NOT do the activity, fill in *0 (No)* in box and move to the next question

If less than four weekly: 0.25 (once in four weeks); 0.50 (twice in four weeks); 0.75 (three times in four weeks)

Show card CHAMPS

In a typical week during the past 4 weeks, did you…	1=Yes 0=No	How many TIMES a week?	How many TOTAL hours a week did you usually do it? Less than 1 hour	1-2½ hrs	3-4½ hrs	5-6½ hrs	7-8½ hrs	9 or more hrs
1. Visit with friends or family (other than those you live with)?	☐	☐☐	1	2	3	4	5	6
2. Go to a senior centre?	☐	☐☐	1	2	3	4	5	6
3. Do volunteer work?	☐	☐☐	1	2	3	4	5	6
4. Attend church or take part in church activities?	☐	☐☐	1	2	3	4	5	6
5. Attend other club or group meetings?	☐	☐☐	1	2	3	4	5	6
6. Use a computer?	☐	☐☐	1	2	3	4	5	6
7. Dance (such as square, folk, line, ballroom) (do not count aerobic dance here)?	☐	☐☐	1	2	3	4	5	6
8. Do woodworking, needlework, drawing, or other arts or crafts?	☐	☐☐	1	2	3	4	5	6
9. Play golf, carrying or pulling your equipment (count walking time only)?	☐	☐☐	1	2	3	4	5	6
10. Play golf, riding a cart (count walking time only)?	☐	☐☐	1	2	3	4	5	6
11. Attend a concert, movie, lecture, or sport event?	☐	☐☐	1	2	3	4	5	6
12. Play cards, bingo, or board games with other people?	☐	☐☐	1	2	3	4	5	6
13. Play pool or billiards?	☐	☐☐	1	2	3	4	5	6
14. Play singles tennis (do not count doubles)?	☐	☐☐	1	2	3	4	5	6
15. Play doubles tennis (do not count singles)?	☐	☐☐	1	2	3	4	5	6

AWESSoM: BASELINE Study ID No: ..... Date: .....

In a typical week during the past 4 weeks, did you…	1=Yes 0=No	How many TIMES a week?	How many TOTAL hours a week did you usually do it? Less than 1 hour	1-2½ hrs	3-4½ hrs	5-6½ hrs	7-8½ hrs	9 or more hrs
16. Skate (ice, roller, in-line)?	☐	☐☐	1	2	3	4	5	6
17. Play a musical instrument?	☐	☐☐	1	2	3	4	5	6
18. Read?	☐	☐☐	1	2	3	4	5	6
19. Do heavy work around the house (such as washing windows, cleaning gutters)?	☐	☐☐	1	2	3	4	5	6
20. Do light work around the house (such as sweeping or vacuuming)?	☐	☐☐	1	2	3	4	5	6
21. Do heavy gardening (such as spading, raking)?	☐	☐☐	1	2	3	4	5	6
22. Do light gardening (such as watering plants)?	☐	☐☐	1	2	3	4	5	6
23. Work on your car, truck, lawn mower, or other machinery?	☐	☐☐	1	2	3	4	5	6
Please note: For the following questions about running and walking, include use of a treadmill.								
24. Jog or run?	☐	☐☐	1	2	3	4	5	6
25. Walk uphill or hike uphill (count only uphill part)?	☐	☐☐	1	2	3	4	5	6
26. Walk fast or briskly for exercise (do not count walking leisurely or uphill)?	☐	☐☐	1	2	3	4	5	6
27. Walk to do errands (such as to/from a store or to take children to school (count walk time only)?	☐	☐☐	1	2	3	4	5	6
28. Walk leisurely for exercise or pleasure?	☐	☐☐	1	2	3	4	5	6
29. Ride a bicycle or stationary cycle?	☐	☐☐	1	2	3	4	5	6
30. Do other aerobic machines such as rowing, or step machines (do not count treadmill or stationary cycle)?	☐	☐☐	1	2	3	4	5	6
31. Do water exercises (do not count other swimming)?	☐	☐☐	1	2	3	4	5	6
32. Swim moderately or fast?	☐	☐☐	1	2	3	4	5	6
33. Swim gently?	☐	☐☐	1	2	3	4	5	6
34. Do stretching or flexibility exercises (do not count yoga or Tai-chi)?	☐	☐☐	1	2	3	4	5	6
35. Do yoga or Tai-chi?	☐	☐☐	1	2	3	4	5	6
36. Do aerobics or aerobic dancing?	☐	☐☐	1	2	3	4	5	6

AWESSoM: BASELINE Study ID No: ..... Date: .....

In a typical week during the past 4 weeks, did you…	1=Yes 0=No	How many TIMES a week?	How many TOTAL hours a week did you usually do it? Less than 1 hour	1-2½ hrs	3-4½ hrs	5-6½ hrs	7-8½ hrs	9 or more hrs
37. Do moderate to heavy strength training (such as hand-held weights of more than 5 lbs., weight machines, or push-ups)?	☐	☐☐	1	2	3	4	5	6
38. Do light strength training (such as hand-held weights of 5 lbs, or less or elastic bands)?	☐	☐☐	1	2	3	4	5	6
39. Do general conditioning exercises, such as light calisthenics or chair exercises (do not count strength training)?	☐	☐☐	1	2	3	4	5	6
40. Play soccer, racquetball or basketball (do not count time on sidelines)?	☐	☐☐	1	2	3	4	5	6
41. Do other types of physical activity not previously mentioned (please specify)?	☐	☐☐	1	2	3	4	5	6
42. Other (specify)	☐	☐☐	1	2	3	4	5	6
43. Other (specify)	☐	☐☐	1	2	3	4	5	6
44. Other (specify)	☐	☐☐	1	2	3	4	5	6

Finish Time: _____

AWESSoM: BASELINE Study ID No: ..... Date: .....

ACCELEROMETER – POST COLLECTION

Date of stop recording (dd/mm/yyyy): ☐☐ ☐☐ ☐☐☐☐

Hour and Minute of stop recording (24hr clock HR:MM) _____

Details if any data loss is to be expected:

Reason for data loss	Method or participant reason	**Select One** ○ Technical Issue ○ Participant-related reason
	Reason for data loss	**Select One** ○ Data did not record ○ Sensor fell off but returned ○ Sensor fell off and lost ○ Irritated participant's skin ○ Participant admitted to hospital ○ Other (please specify in notes)
Notes (used if reason is not provided above)		

Data Uploaded? ☐

1 = Yes 0 = No

Interviewer to answer the following:

How do you rate the….	Very poor	Poor	Neither good nor poor	Good	Very Good	
Reliability of the participant's responses	1	2	3	4	5	
Participant's understanding of the questions	1	2	3	4	5	
Participant's level of interest	1	2	3	4	5	
Participant's level of stamina	1	2	3	4	5	

COMMENTS

Please write clearly in CAPITAL LETTERS

Appendix B

One-Sample Kolmogorov-Smirnov Test

			Age	Do you currently drink alcohol?	Total Number Prescriptions	NEADL_TOTAL	AGG_PHYS_SF12	AGG_MENT_SF12	RUDAS	PSQI-GlobalScore
N			88	88	88	88	88	88	88	88
Normal Parameters[a,b]	Mean		80.24	2.08	5.75	19.61	31.6875	53.9097	27.00	6.42
	Std. Deviation		6.605	1.510	4.012	2.535	6.39946	11.65446	2.213	3.290
Most Extreme Differences	Absolute		.112	.183	.131	.211	.063	.144	.152	.124
	Positive		.051	.154	.131	.173	.046	.116	.106	.124
	Negative		-.112	-.183	-.076	-.211	-.063	-.144	-.152	-.078
Test Statistic			.112	.183	.131	.211	.063	.144	.152	.124
Asymp. Sig. (2-tailed)[c]			.009	<.001	<.001	<.001	.200[e]	<.001	<.001	.002
Monte Carlo Sig. (2-tailed)[d]	Sig.		.009	<.001	<.001	<.001	.522	<.001	<.001	.002
	99% Confidence Interval	Lower Bound	.007	.000	.000	.000	.509	.000	.000	.001
		Upper Bound	.012	.000	.002	.000	.535	.000	.000	.004

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. Lilliefors' method based on 10000 Monte Carlo samples with starting seed 2000000.

e. This is a lower bound of the true significance.