Factors Affecting the Sleep Health of Older New Zealanders: The Role of Alcohol and Work Status

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Abstract

Increased life expectancy is contributing to proportionally longer retirements, necessitating improved insight on factors that impact healthy ageing. How work/retirement status influences sleep and alcohol consumption is under-researched in New Zealand (NZ). To bridge literature deficits, this study explored how alcohol influences sleep in older workers and retirees.

Retrospective analysis of the 2022 New Zealand Health Work and Retirement study used hierarchical regression modelling to assess whether the alcohol consumption (frequency/quantity) of retirees (no paid work, n=1774) and workers (n=3049) was independently associated with indicators of sleep disturbance (sleep duration (total hours per 24-hour day) (retiree *Mdn*=8 (*IQR*: 7-8), workers=7 (*IQ*R: 6.5-8))), and substantial sleep problems (SSP) (retirees=35.16%, workers= 31.04%). Regression analysis controlled for demographics, physical and mental health status, job satisfaction, and weekly work hours.

Workers' drinking ≤monthly reported sleeping 17 minutes less than abstainers (b=-0.29, 95% CI=-0.55– -0.04, β=0.09)). Drinking alcohol with any frequency above 'never' while employed correlated to increased SSP likelihood (drinking ≤monthly=122% increase (95% CI=1.34–3.68), drinking 2-4 times per month=99% (95% CI=1.19–3.33), drinking 2-3 times per week=151% (95% CI=1.51–4.17), and drinking ≥4 times weekly=175% (95% CI=1.63–4.64)). Retirees' drinking 3-4 standard drinks reported 33 minutes less sleep than abstainers (b=-0.55, 95% CI=-1.09–0.00, β=-0.12) and 157% increased likelihood of SSP (95% CI=1.01–6.49).

Shorter duration correlated with being female, better self-rated physical health, and not smoking for retirees (fit: R^2=.03, ΔR^2=0, p= .516), and with more diagnoses, worse self-rated mental health, and more weekly work hours for workers (fit: R^2= .04, ΔR^2= .01, p= <.001). SSP correlated with poorer living standards, poorer self-rated physical and mental health, and not smoking for retirees (fit: χ^2=240.9 (19), p=<.001, Nagelkerke's R^2= 0.25), and with being female, Māori, poorer living standards, poorer self-rated physical and mental health, and more diagnoses for workers (fit: χ^2=406.475 (21), p=<.001, Nagelkerke's R^2=0.26).

Alcohol was independently associated with sleep duration and SPP. Proposed mechanisms differed by work/retirement status, suggesting NZ policy needs clarity on how alcohol harms health during ageing. Future research exploring time use/scheduling, typical drinking routines, retirement causes, or longitudinal designs could further understanding and indicate health promotion opportunities.

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Glossary and Abbreviations

ABV	Alcohol by volume – refers to what percentage of an alcoholic beverage is ethanol
ADH	Alcohol dehydrogenase
Alcohol frequency (AF)	Alcohol frequency – how often alcohol is consumed (reported at days per month/week)
Alcohol quantity (AQ)	Alcohol quantity – the number of standard drinks typically consumed per drinking occasion
AUD	Alcohol Use Disorder
AUDIT	Alcohol Use Disorder Identification Test
Binge drinking	Consuming ≥6 drinks on one occasion
CES-D	Center for Epidemiologic Studies Depression Scale
Chronotype	Natural tendency to sleep and wake at certain times within the 24-hour day – associated with whether someone is a 'morning person' or an 'evening person'
Circadian system	Internal system that organises various bodily functions that fluctuate over the 24-hour period and synchronises these functions to occur at appropriate times; see also Process C
Circadian rhythms	Fluctuations in physiology, psychological state, and behaviour over a 24-hour cycle that are organised by the circadian system; some of which are involved in the regulation of the sleep/wake cycle
Daytime sleepiness	Level of difficulty maintaining wakefulness during the daytime; relates to level of alertness
ELSI-SF	Economic Living Standard Index – Short Form, a measure of socioeconomic status and standard of living
Entrain	Process of synchronising the circadian system to external time cues
Fragmentation	Sleep that is broken or non-continuous over the night

HART	Health and Ageing Research Team
Hazardous drinking	Patterns of alcohol consumption that increase risk of harm, injury, or mortality; associated with heavy and frequent drinking
Homeostatic sleep drive	Biological urge to sleep that linearly increases over waking hours, vital for the regulation of sleep and the maintenance of the sleep/wake cycle; see also Process S and sleep pressure
NZ-HWR/HWR	The New Zealand Health, Work and Retirement Study – the first study in New Zealand to focus on experiences of health, employment and retirement while ageing
insomnia	Sleep disorder characterized by problems initiating and maintaining sleep; often impairs normal waking function
MOH	Ministry of Health – Manatū Hauora
N1	Lightest stage of sleep – encompasses the transition between wakefulness and the onset of sleep; part of the NREM sleep phase
N2	Second lightest stage of sleep – important for memory consolidation; part of the NREM sleep phase
NIA	National Institute on Aging
NP	Non-parametric equivalent test
NREM	Non rapid eye movement – a sleep phase that encompasses sleep stages N1, N2, and SWS
NZCARET	New Zealand Comorbidity Alcohol Risk Evaluation Tool
NZHS	New Zealand Health Survey
NZLSA	New Zealand Longitudinal Study on Ageing
PA	Physical activity
Process C	Circadian Drive for Wakefulness – one of two processes considered responsible for the regulation of sleep within the Two Process Model; refer to circadian system and suprachiasmatic nucleus

Process S	Homeostatic Sleep Drive/Sleep Pressure – one of two processes considered responsible for the regulation of sleep within the Two Process Model; refer to the homeostatic sleep drive and sleep pressure
PSQI	Pittsburgh Sleep Quality Index – a subjective measure of sleep status
QOL	Quality of life
REM	Rapid Eye Movement – the sleep stage in which vivid dreaming occurs; important for memory and cognition
RU-SATED	Model of sleep health; encompasses dimensions of regularity, satisfaction, alertness, timings, efficiency, and duration
SAGE	WHO Study on global AGEing and adult health
SD	Standard deviation
SES	Socioeconomic status
SF-12	Short Form – 12 item Survey: Assesses how physiological and psychological health impact everyday life – including vitality, pain, general mental health, limiting activities, perception of health, and quality of life. Scores as two components (physical and mental).
Sleep architecture	The structural organization of sleep; categorised into sleep stages
Sleep continuity	How unbroken or continuous one's sleep is over their nighttime sleep period; can be inversely related to fragmentation and WASO
Sleep debt	The discrepancy between the amount of sleep obtained and the amount of sleep required for normal function. Accrued dose-dependently through insufficient sleep duration; positively linked to sleep pressure
Sleep disordered breathing	Category of sleep disorders characterized by abnormal breathing patterns during sleep – inclusive of loud or

	excessive snoring, and pauses in normal breathing; often impairs normal waking function
Sleep duration	Total length of time spent asleep over entire 24-hour period (including naps)
Sleep efficiency	The proportion of time in bed at night spent sleeping; often stated as a percentage
Sleep health	The status of the healthiness of sleep as it relates to sleep characteristics and wellbeing
Sleep pressure	Biological urge to sleep that increases over waking hours; see homeostatic sleep drive and process S
Sleep propensity	Likelihood that an individual will fall asleep; combination of sleep pressure and circadian influence
Sleep quality	Indicator of ‘good’ or ‘poor’ sleep, associated with the subjective satisfaction of one’s sleep
Sleep satisfaction	Subjective perception of one’s sleep quality; influenced by continuity and regularity
Sleep stages	Categorisation of sleep periods through distinct brain activity and motor movement: Stage 1 (N1), Stage 2 (N2), slow wave sleep, and rapid eye movement
Sleep timings	Where sleep is placed throughout the 24-hour period
Sleep/wake cycle	Pattern of oscillation between sleep and wake over the (usually) 24-hour period
Socio-ecological model	Framework that focuses on how health behaviours are influenced by individual, social, and societal level factors, and how these levels are bidirectionally interconnected
SOL	Sleep onset latency – length of time taken to fall asleep
SR	Standardised residual
Standard drink	Quantity of an alcohol beverage that contains 10 grams of pure alcohol
STATSNZ	Stats NZ – Tatauranga Aotearoa

Suprachiasmatic nucleus	Region of the hypothalamus associated with the regulation of circadian rhythms and the orchestration of the maintenance of the sleep/wake cycle; see also circadian system and Process C
SWS	Slow wave sleep (also known as deep sleep) – sleep stage that is important for physiological repair and growth; the deepest stage of sleep; a NREM sleep stage
Time in bed	Period of night spend in bed intending to sleep – from starting to try fall asleep to getting out of bed after finishing sleeping
Two Process Model	Framework that is generally accepted as an explanation of how sleep and wakefulness are regulated and maintained over the 24-hour period – encompasses the circadian system (Process C) and the homeostatic sleep drive (Process S); see also Process C and Process S
WASO	Wakefulness after sleep onset – periods of time spent awake after initially falling asleep while still in bed; see also fragmentation
WHO	World Health Organisation
WHOQOL	World Health Organisation Quality of Life survey
Zeitgebers	German for “time-givers” – external or environmental cues that the circadian system synchronises to

Introduction

Sleep is a vital part of ageing and is bidirectionally linked to many other aspects of health, including physiological, psychological, and social health (Dzierzewski et al., 2018; Li et al., 2022). Aotearoa New Zealand (Aotearoa, or NZ) has an increasingly ageing population, with both the proportion and number of older adults within the total population increasing more each year (Stats NZ – Tatauranga Aotearoa, 2022). In some parts of the Western world, the number of retirees is growing faster than the number of workers who can replace them in the workforce (Garrouste & Perdrix, 2022). Transitioning from employment to retirement is associated with changes to daily activities and wellbeing, including sleep health characteristics (Hagen et al., 2016; Myllyntausta & Stenholm, 2018), as well as changes to daily structure and routine (Crestani et al., 2022; Myllyntausta & Stenholm, 2018). The way that retirement as a life transition is experienced and conceptualised is shifting as improved longevity is resulting in an increasingly ageing population which means more people are spending more time in retirement. Cost-of-living increases are also changing the financial landscape of retirement. This means that researching the wellbeing of older adults around this transitionary period is important to understand how retirement influences health status and health behaviours.

While 65 years of age is associated with the age of retirement in NZ, some older adults may retire before or after this age. Compulsory retirement age was abolished in 1999 (Pond et al., 2010) to ensure that New Zealanders were able to choose whether they wanted to remain in the workforce. In 2019, 44% of New Zealanders aged between 65-69 were still employed, a rate higher than seen in several other Western countries

(Te Ara Ahunga Ora Retirement Commission, 2019). Additionally, regardless of retirement status, in NZ adults over 65 are eligible to get the New Zealand Superannuation (pension) if they are a citizen or hold resident status, normally live in NZ, and have lived in NZ for an extended period (typically 10-20 years depending on age) (Work and Income – Te Hiranga Tangata, 2024b). The average superannuation amount received (regardless of retirement status), is roughly $21,500 per annum (or 414.17 per week) (Work and Income – Te Hiranga Tangata, 2024a).

Assuming an adult works full time and gets adequate sleep, they will spend roughly a third of their life at work, and another third asleep. Public health policy and academia have begun to prioritise the importance of healthy ageing. However, sleep health is often overlooked. Furthermore, a better understanding is required of key (modifiable) behaviours associated with sleep. One such behaviour is alcohol consumption, but current NZ literature lacks depth on how alcohol relates to sleep health in older adults and how the retirement transition mediates the relationship between sleep and alcohol. The topic of alcohol is frequently associated with young people, meaning that the health status of older adults who drink is often overlooked (Hussain et al., 2022; Stevenson et al., 2015).

Alcohol has been found to negatively impact normal sleep physiology (Burgess et al., 2022; Burgess et al., 2024; Gardiner et al., 2025; Nelson et al., 2024), and in older adults consuming alcohol has been linked to worse sleep health status (Burgess et al., 2024; Garcia et al., 2024; Gardiner et al., 2025; He et al., 2019; Hussain et al., 2022; Morin et al., 2024). Several studies have examined the health status of older adults in NZ regarding alcohol consumption (Joyce et al., 2024; Stevenson et al., 2015; Szabo, Towers, Newcombe, et al., 2021; Szabo, Towers, Sheridan, et al., 2021; Towers et al., 2017). However, only a few studies have researched both sleep health and alcohol consumption in older New Zealanders (Gibson et al., 2023; Gibson et al., 2016; Henry, 2023; Jones, 2022), and none of these studies have focused on work and retirement status during ageing. Furthermore, results from these NZ studies have been generally inconsistent with wider literature, finding alcohol consumption to not be a risk factor for characteristics of poor sleep health (Gibson et al., 2023; Gibson et al., 2016; Henry, 2023; Jones, 2022), and half of these studies conceptualised alcohol consumption through diagnostic screening tools for prevalence of harmful drinking patterns (Gibson et al., 2023; Jones, 2022).

This demonstrates that NZ has a need for further research on alcohol and sleep in older adults, especially research that focuses on aspects of drinking behaviour beyond binary categorisations of harmful drinking patterns (Szabo, Towers, Sheridan, et al., 2021), and a need for improved information on how the retirement transition mediates the relationship between alcohol and sleep health in older New Zealanders.

To bridge these gaps in the literature, this study aimed to examine sleep status in relation to alcohol in two cohorts: older adults who are employed, and older adults who are retired. This was achieved through retrospective analysis of the New Zealand Health, Work, and Retirement Study (NZ-HWR). The NZ-HWR study explicitly focuses on the health of older adults (≥55 years old) in their later years of employment and throughout their retirement transition and has run biennial waves since 2006. Data from this survey will enable differentiation of how sleep health status and alcohol consumption patterns are related for retirees and workers. This will improve the current understanding of the ways that older adults consume alcohol, how this consumption impacts their sleep health and wellbeing, and how significant life transitions during ageing may influence sleep health and drinking behaviour.

Literature Review

This chapter involves a review of the relevant literature on sleep health and the sleep of older adults, alcohol, and retirement. Sleep health is framed using a holistic model (Buysse, 2014), and exploration of key variables (alcohol and retirement status) will be guided by Grandner's (2019) social-ecological model of sleep health. This model allows examination of the different levels of influence that various factors may have on sleep health outcomes and provides useful context for exploring the different ways that ageing, retirement, and alcohol may be interconnected to sleep health.

Sleep

Sleep is a multidimensional process that is bidirectionally linked to overall health and wellbeing and is a vital component of the whole 24-hour period (Matricciani et al., 2018). Sleep has been identified as having functions that support aspects of cognition (Dzierzewski et al., 2018; Li et al., 2022), mental health (Horvat Davey et al., 2024), physiological health (Wang et al., 2023), and social wellbeing (Li et al., 2022; Matricciani et al., 2018). This means that sleep health encapsulates and directly impacts the wider health and wellbeing of an individual. Buysse's (2014) model of sleep health outlines five dimensions, known as the RU-SATED model which includes: *regularity* - the consistency of sleep health characteristics over an extended period, relates to timing and duration; *satisfaction* – subjective sleep satisfaction, a self-report assessment of sleep quality; *alertness* – the ability to maintain wakefulness throughout the day, relates to levels of daytime sleepiness; *timing* – the placement of sleep period(s) within the 24-hour day; *efficiency* – the proportion of time in bed that is spent sleeping, often given as a percentage; and *duration* – the total amount of sleep in a 24-hour period.

This model frames sleep as a holistic process that is bidirectionally linked to waking hours and functioning (Buysse, 2014; Matricciani et al., 2018) and emphasises that sleep health encompasses both subjective and objective characteristics (Buysse, 2014). While a comprehensive inclusion of every sleep dimension would provide the greatest depth of understanding, research may not always have the scope or funding to focus on all of the sleep health dimensions. Work that focuses on a portion of the dimensions is useful for deepening understanding of sleep health in those respective areas, provided it acknowledges how this partial inclusion cannot encapsulate the full, holistic nature of sleep health. Focusing on a limited range of sleep health dimensions may also be beneficial in providing a basis for future work that is more encompassing.

Sleep Structure and Regulation

Before exploration of the impact of ageing and alcohol on sleep health, it is important to understand the typical structure of sleep (sleep architecture), its role in various functions within the body, and how the sleep/wake cycle is regulated and maintained.

Sleep Stages/Architecture. The physiological structure and function of sleep appear to be fairly consistent across humans, meaning that there are set patterns of brain activity that cycle throughout the night that are coordinated alongside the activation (and deactivation) of various physiological processes and functions. This has enabled the phases of sleep to be categorised into various stages (known as sleep architecture). There are two main phases that occur over a sleep cycle: non-rapid eye movement (NREM), followed by rapid eye movement (REM) sleep (Burman & Muzumdar, 2020; Institute of Medicine et al., 2006; Patel et al., 2024). NREM sleep is split into three stages: N1, N2, and slow wave sleep (SWS or formerly N3) (Institute of Medicine et al., 2006; Patel et al., 2024). These NREM sleep stages generally occur linearly (from N1 to SWS) and each stage results in progressively 'deeper' sleep (i.e. it takes more stimuli to wake the individual). These stages occur sequentially approximately every 90 minutes (N1 – N2 – SWS – REM) (Patel et al., 2024).

Stage N1 involves the transition phase from wake to sleep and encompasses both waking drowsiness right before sleep onset and the lightest form of sleep (Patel et al., 2024). During this stage, brain activity shows alpha waves, and the individual can be easily awakened by external stimulation. Stage N2 follows, which marks the end of the transition from wakefulness to sleep. While still considered light sleep, this stage is deeper than N1. N2 has low voltage mixed frequency brain activity, with characteristic K-complexes and sleep spindles (Patel et al., 2024), the latter of which is considered important for memory consolidation (Institute of Medicine et al., 2006; Patel et al., 2024). In the first sleep cycle of the night, N2 lasts roughly 10-25 minutes, and lengthens slightly with each sequential cycle over a night's sleep (Institute of Medicine et al., 2006). Of all the sleep stages, N2 constitutes the largest proportion of sleep, encompassing approximately 45% of the total night's sleep (Patel et al., 2024). N2 is typically followed by SWS. SWS is the deepest sleep, requiring the highest level of stimuli to wake from, and is characterised by high voltage and slow wave activity (Burman & Muzumdar, 2020). SWS involves muscle relaxation and is associated with muscle repair. After SWS, REM sleep occurs. The transition from deep SWS to lighter REM sleep may be bridged briefly by a return to N2, however this does not occur in every sleep cycle, nor for every individual (Waterhouse et al., 2012). While the architecture of sleep is generally consistent across humans, sleep is not a homogenous experience, and there is normal individual variation regarding the exact duration and order of sleep stages over both a single night and over the lifetime (Waterhouse et al., 2012). During REM sleep, there is characteristic rapid movement of the eyes, and the brain activity during this stage is similar to wakefulness. In contrast to the NREM sleep stages, the majority of dreams occur during REM sleep, and there is a complete loss of muscle tone (atonia) to prevent individuals from 'acting out' their dreams (Institute of Medicine et al., 2006). A typical night's sleep for a healthy adult is 7-9 hours, meaning that on average, 4-6 sleep cycles occur every night (Burman & Muzumdar, 2020). At the start of the night, a larger portion of each cycle is spent in SWS, which shifts to more time spent in N2 and REM sleep later on (at the cost of less SWS).

Sleep Regulation. The most commonly accepted model outlining the regulation of the sleep/wake cycle was proposed by Borbély (1982) and is known as the 'two process model'. In this model, regulation is maintained by the oscillation and synchronisation of two processes: the homeostatic sleep drive (Process S), which promotes sleep, and the circadian system (Process C), which determines oscillations of sleepiness and wakefulness across the 24-hour day (Borbély, 2022; Borbély, 1982; Institute of Medicine et al., 2006). The homeostatic sleep drive encompasses the basic biological need for sleep and involves building sleep pressure throughout waking hours. The level of sleep pressure (i.e. sleepiness) exerted by Process S is proportional to the amount of time spent awake. In the morning after a good night's sleep, an individual will experience low sleep pressure, but throughout wakefulness sleep pressure linearly increases. In the evening, after being awake for several hours, sleep pressure will be much higher. This sleep pressure increases sleep propensity (the likelihood of falling asleep) until the onset of sleep at nighttime.

As humans are diurnal (i.e. awake during the day), wakefulness and sleep are typically synchronised to daytime and nighttime, respectively. Atypical synchronisation (i.e. sleeping when it is daytime) can negatively impact health and wellbeing (Desai et al., 2024). To maintain optimal timings (i.e. sleeping once every 24 hours during the night) the sleep/wake cycle is regulated by the circadian system, which is entrained by external time cues, known as '*zeitgebers*' (German for 'time-givers'). This synchronises circadian rhythms with the external daylight/dark cycle over the 24-hour day (Quante et al., 2019). Circadian rhythms are intrinsic daily biological, biochemical and behavioural processes that regulate the timings of bodily functions (Hastings et al., 2018; Quante et al., 2019). *Zeitgebers* include light, temperature, food consumption, socialising, and physical activity (Quante et al., 2019). This entrainment is organised by a master 'pacemaker' in the suprachiasmatic nucleus (SCN) (Desai et al., 2024; Hastings et al., 2018; Quante et al., 2019).

These two processes (S and C) are essential for the regulation of the sleep/wake cycle (Borbély, 1982). The homeostatic sleep drive ensures that humans meet their daily sleep needs, and the circadian system promotes sleep at night, ensuring that it is placed appropriately within the 24-hour day (Borbély, 1982). An updated version of the model (Borbély et al., 2016) acknowledges how the two processes are interconnected; the SCN orchestrates circadian rhythms over the day/night cycle and homeostatic sleep drive can modulate this orchestration based on accrued sleep debt.

Acknowledgement of this more dynamic interaction reflects how information and knowledge on sleep and sleep health is ever improving (Borbély et al., 2016).

A key zeitgeber for the SCN and the sleep/wake cycle is light. The SCN is connected to specialised neuron receptors in the back of the eye that detect levels of blue light (i.e. daylight) (Burgess et al., 2022; Institute of Medicine et al., 2006), and the input from these neurons synchronises the neuronal behaviour of the SCN and can determine the placement of the sleep/wake cycle within the 24-hour day. As blue light levels decrease as it gets darker at night, the circadian pacemaker begins to trigger various processes that stop promoting wakefulness and prepare the body for sleep.

Another key zeitgeber relevant to the current study is eating and drinking. The circadian system has been linked to appetite fluctuations throughout the day (Borbély et al., 2016; McHill & Butler, 2024; Sharma & Kavuru, 2010), and generally the period of sleep is associated with fasting, and wakefulness with eating (Sharma & Kavuru, 2010). This means that generally humans have increased appetite during waking hours, and decreased appetite when asleep, and the circadian system can be entrained by the timing of meals throughout the day. Eating close to bedtime can delay the onset of sleep, and consuming food within three hours before bed is associated with negative impacts to sleep duration (Iao et al., 2022), and inversely, eating four to six hours before sleep has been linked to more optimal sleep health outcomes (Iao et al., 2022).

However, there are also various environmental and social factors that can influence the timings of both mealtimes and sleep, including daily structure (Goheer et al., 2021), which is notable given the focus on employment and retirement. Days with less structure and more ability to 'freely' choose schedule (e.g. weekends, holidays,

days off, retirement, etc) are associated with more flexible meal and sleep timings (Goheer et al., 2021). The placement of physical activity throughout the day also acts a zeitgeber for the circadian system (Leota et al., 2025), and engaging in high levels of physical exertion before bed can delay sleep onset (Alnawwar et al., 2023; Leota et al., 2025). Like food, drinking beverages before bed can also impact the regulation and timing of sleep and impact sleep quality, and alcohol is no exception (Bailey, 2026), but this will be explored further later on in this chapter. Zeitgebers are informed behaviourally, environmentally, and socially (Quante et al., 2019), meaning that an understanding of sleep health requires attending to broader factors and contextual dynamics.

Social-Ecological Model of Sleep Health

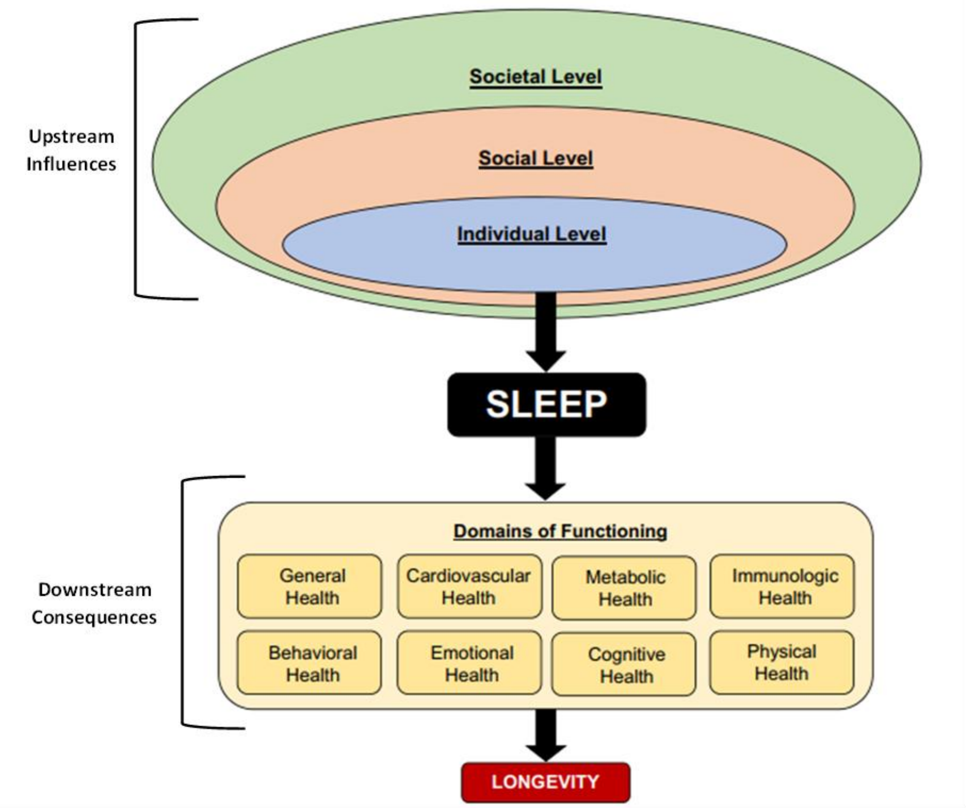
Sleep is an "important domain of health behaviour" (Grandner, 2019, p. 46), that is mediated by other health domains, as well as various lifestyle and environmental factors that can influence underlying mechanisms in sleep regulation (Yang et al., 2022). The interrelation between sleep behaviours and overall health is complex, meaning contextual and contributing factors are essential to understand both good and poor sleep health outcomes. The Social-Ecological model (Bronfenbrenner, 1977) outlines how individual health is situated within various levels of an increasingly wider environmental context (Bronfenbrenner, 1977; Grandner, 2019). This context influences both health determinants and health outcomes, and the model acknowledges how these health outcomes are linked to risk factors and available health opportunities. Applying this model to sleep health enables a greater understanding of the various nested levels of context that influence sleep health status (Grandner, 2019).

The original socio-ecological model outlined four levels of influence on health: individual, micro, meso, and macro (Bronfenbrenner, 1977). However, this study will reference a simplified version of Bronfenbrenner's (1977) original model, designed by Grandner (2019) specifically for application to sleep health (an overview of this model can be seen in Figure 1). This version consolidates Bronfenbrenner's original model into three levels: individual, social, and societal. Grandner's model also emphasises how "upstream influences and downstream consequences" (Grandner, 2019, p. 50) combine to influence health outcomes for individuals. Rather than act as a full framework, the social-ecological model of sleep health will guide discussion around the relationship between sleep, ageing, and alcohol, and other various contextual factors that may influence health behaviour and health outcomes in these domains.

Figure 1 illustrates how, each upstream nested level (individual, social, and societal) includes elements that directly influence that respective level of health and behaviour, and increasing levels include elements that directly affect that level and indirectly influence the elements in, and context of, the level below. This means the individual level includes elements that directly affect individual health, such as genetics, attitudes, beliefs, choices, etc. The social level includes elements such as home, work, family, ethnicity, culture, etc. These elements also influence and contextualise the individual level. For example, ethnicity influences genetics, culture may influence attitudes and beliefs, and so on. The highest level is the societal level, which includes elements that exist on the widest sphere of influence that directly influence the social (and therefore also indirectly the individual) level. Policy, globalisation, economic systems, and the modern 24/7 society structure all exist within the societal level.

Figure 1

The Social-Ecological Model of Sleep Health (Visualisation Diagram)



Note. Adapted from "Chapter 5 - Social-ecological model of sleep health," by M. A. Grandner, in M. A. Grandner (Ed.), Sleep Health (pp.45-53), 2019, Academic Press. Copyright 2019 by Elsevier. Adapted with permission (square brackets added to clarify relevant theory (pp. 50-51)).

This model acknowledges how determinants and impacts of health behaviours are influenced by factors within increasingly broad levels of influence. Sleep health is a modifiable health domain (Horvat Davey et al., 2024), meaning that improving an individual's sleep health status often beneficially impacts other aspects of health (like cardiovascular health or mood) due to the bidirectional relationship between sleep and several other health domains (Matricciani et al., 2018).

Grandner's sleep health model will be considered in relation to alcohol and ageing throughout this thesis, with reference to the ways that individual, social, and societal level factors influence drinking behaviour and experiences of ageing (Grandner, 2019). In addition to sleep health status, both an individual's health and wellbeing during ageing (Jason et al., 2015), and older adults' patterns of drinking behaviour are impacted by factors spread across the individual, social, and societal levels of influence (Bareham et al., 2019). Physiology and genetics (Jason et al., 2015), the attitudes and beliefs held by an individual (as well as the way these attitudes are reinforced socially) (Bareham et al., 2019; Crestani et al., 2022), how an individual plans their daily time usage and structure (Kim & Moen, 2002), health status and health media literacy (Yuan, 2024), social interaction and loneliness (Kim & Moen, 2002), their employment or retirement status (Jason et al., 2015), and wider societal/policy level factors (Yuan, 2024) all influence the relationship between sleep health and alcohol consumption during ageing.

Sleep and Ageing

In order to understand the changes to sleep that occur with ageing, it is necessary to consider the various levels of the social-ecological model of sleep health. The following section will cover individual level physiological changes to sleep during ageing, including sleep architecture and timings, genetics, and increased risks of developing sleep disorders. After this, consideration will be given to the experience and context of the retirement transition, and the way various factors at the individual, social, and societal level can influence aspects of physical health and cognition (mood, emotions, attitudes, beliefs) during this transition, which in turn impact health outcomes and behaviour. Consideration will also be given to the way perceptions and beliefs about sleep health are mediated and reenforced socially.

At the individual level, a large determinant of sleep health during ageing is genetic. Genetics impact the duration of sleep needed to feel refreshed and energised, timings of circadian rhythm placement throughout the 24-hour day, how significant sleep debt feels, and the arousal threshold needed to wake from deep sleep (Grandner, 2019). While ageing, physiological changes to sleep stages and architecture (Ohayon et al., 2004) can reduce sleep duration and quality, causing sleep to feel disrupted and less refreshing (Li et al., 2022). Circadian rhythms become less robust with age (Li et al., 2022), impacting various areas of sleep health, and advancing the position and timing of sleep within the 24-hour day (sleep phase advancement) (Landry et al., 2015). This advancement occurs from a degradation of the wake promotion role of the circadian system.

Ageing is associated with an increased amount of time spent awake after initially falling asleep (wakefulness after sleep onset (WASO)) (Amidi et al., 2024; Li et al., 2022; Ohayon et al., 2004). Infrequent but long periods of WASO can decrease sleep efficiency and sleep duration as more time in bed is spent not sleeping, and frequent shorter WASO periods can disrupt continuous sleep (i.e. cause fragmented sleep) (Ohayon et al., 2004), leading to reduced quality and satisfaction (Li et al., 2022). Increased fragmentation can also reduce sleep efficiency and sleep duration. Therefore, if older adults do not change the amount of time spent in bed each night, they will likely have less sleep than when they were younger adults. Fragmentation can also lead to a reduction in quality and satisfaction with ones sleep (Li et al., 2022).

Genetics also impact the likelihood of developing co-morbid conditions that impact sleep quality or other sleep health characteristics (Grandner, 2019). Ageing is associated with increased likelihood of a variety of physiological and cognitive conditions (e.g. Alzheimer's, dementia, cancer, etc), and these conditions can contribute to poorer sleep. At the social level, ethnicity and family history of co-morbid health conditions can further modify the likelihood of developing these disorders. Additionally, sleep is important for cognitive functioning in older adults, and worse sleep health is linked to poorer cognitive wellbeing (Dzierzewski et al., 2018). Mental health is also associated with the individual level (Horvat Davey et al., 2024), and better mental health can lead to better sleep quality (Horvat Davey et al., 2024).

Another determinant of sleep health outcomes is ethnicity (Johnson et al., 2019). Generally, after adjusting for demographic characteristics, socioeconomic status (SES), health behaviour, and clinical features, non-white populations experience disproportionately poorer sleep health status and outcomes than white populations (Johnson et al., 2019). Māori are the indigenous people of *Aotearoa* (the original indigenous name for NZ) (Hogarth & Rapata-Hanning, 2023), and have been historically marginalised by colonisation and racism (Hogarth & Rapata-Hanning, 2023; Reid et al., 2019). Identifying as Māori has been linked to poorer health outcomes across many health domains (Reid et al., 2019), inequitable access to health opportunities, and experiencing inequalities regarding social determinants of health (i.e. housing, education, income and employment, etc) compared to non-Māori counterparts (Hogarth & Rapata-Hanning, 2023). Māori are more likely to report sleep problems and have poorer health as a result of sleep problems (Paine et al., 2005). Māori also have a greater risk of mortality associated with reported sleep problems (Gibson et al., 2020).

Some research shows Māori have higher rates of shorter sleep duration compared to non-Māori (Gibson et al., 2023), although this disparity may be less among populations of older adults (Gibson et al., 2023).

The likelihood of developing certain primary sleep disorders increases with age. Sleep disordered breathing refers to a category of conditions that relate to abnormal breathing during sleep (McMillan & Morrell, 2016). These may range from excessive snoring to pauses in breathing (apnoea). Disordered breathing is associated with disrupted sleep quality, and poorer health outcomes as the reduction in oxygen intake overnight impairs functioning (McMillan & Morrell, 2016). These disorders are more prevalent in older adults (McMillan & Morrell, 2016) as ageing is associated with increases to fat in the upper airway and a decrease in muscle mass, making it more prone to collapsing while asleep (Antonaglia et al., 2025). In older adults, sleep disordered breathing tends to cause more negative health outcomes than in middle aged adults (McMillan & Morrell, 2016).

Insomnia is a sleep disorder relating to difficulty with going to, and staying, asleep (Ellis et al., 2021; O'Keeffe et al., 2012). It is characterised by long SOL times, fragmentated sleep, and waking too early, and these sleep difficulties often impair waking function (Patel et al., 2024). Risk of insomnia is linked with ageing (León-Barriera et al., 2025), as the normative changes to sleep physiology tend to make sleep lighter and more fragmented (Li et al., 2022), making it harder for older adults to get enough sleep (León-Barriera et al., 2025). Māori have been identified as more likely to both have insomnia, and have inequalities in access to health services for insomnia treatment (Paine et al., 2005).

The Retirement Transition

The shift from employment to retirement often involves significant changes to several aspects of life. Literature that focuses on how the retirement transition can change daily life, health and wellbeing, and functioning has existed for several decades (Carter & Cook, 1995; Rosenkoetter & Garris, 1998). Key factors identified as mediating the transition appear to be being satisfied with retirement, success navigating changes to professional identity after leaving employment, being able to adapt to shifts in social roles, financial preparation and having enough funds for retirement, and having positive spousal relationships (Carter & Cook, 1995; Rosenkoetter & Garris, 1998).

More recent research has found that the transition from working to retirement is associated with marked changes to sleep health characteristics (Myllyntausta & Stenholm, 2018). Changes to sleep characteristics in the years following retirement include longer sleep duration as well as delayed sleep phase (i.e. going to bed later and waking later in the day than in working years) (Hagen et al., 2016). Retirement often involves increase in flexibility of daytime scheduling, increases to leisure activities, and, more obviously, the removal of the typical '9-5' workday. While sleep is not always prioritised (Crestani et al., 2022), generally having more free time during retirement means that older adults often sleep in later in the morning, and therefore have longer sleep durations (Hagen et al., 2016; Myllyntausta & Stenholm, 2018). Individuals with existing sleep conditions often have more time and freedom to manage their symptoms after retirement, which can also lead to improvements in sleep health (Kontturi et al., 2024).

Level of satisfaction with retirement both during and after the transition period is central to how the experience of retirement is perceived (Martinčeková & Škrobáková, 2019; Rosenkoetter & Garris, 1998). Retirement is associated with an increase in leisure time, and for some this can be exciting as they have more time for hobbies and can spend more time with family and loved ones. However, for others this can lead to increased boredom and loneliness. Being able to remain active and social during retirement is associated with higher rates of satisfaction (Rosenkoetter & Garris, 1998).

At the individual level, attitudes and beliefs can mediate prioritisation of health behaviours, and influence emotions and mood that can further mediate health outcomes. Whether an individual has agency around when they retire, and whether they choose to advance or delay retirement can also impact their transition (Martinčeková & Škrobáková, 2019; Yuan, 2024). Lack of agency (e.g. from unemployment, illness, financial strain, etc) can lead to worse outcomes for retirees (Martinčeková & Škrobáková, 2019).

Remaining in employment also means that their sleep schedules could stay constrained by employment and the structure of Western society (Hagen et al., 2016; Myllyntausta & Stenholm, 2018), and that the general improvements to sleep health associated with retirement are delayed. This means that the cause of retirement, when it occurs, health status, and the resources available to individuals throughout the transition period can all influence the perceptions and attitudes of the individual, particularly around their satisfaction and agency, and the perceived level of ‘freedom’ or ‘relaxation’ retirement brings.

Attitudes and beliefs about both the importance of healthy sleep, and how this is conceptualised, also have a marked impact on sleep health status (Grandner, 2019). Older adults often have the perception that poorer sleep while ageing is expected (and therefore acceptable) (Crestani et al., 2022) or inevitable (Breheny et al., 2023) meaning they may deprioritise sleep health (Crestani et al., 2022; Ross et al., 2024). Beliefs and attitudes about sleep are established to be mediated socially (Crestani et al., 2022), so loved ones' beliefs around the importance and conceptualisation of healthy sleep can reinforce individual beliefs and attitudes (Crestani et al., 2022). Furthermore, the wider social conceptualisations of sleep can also impact individual health behaviour. In Western culture, retirement is often viewed as a period of freedom, where the pressure of working is suspended, and is seen as a time where an individual is 'finally' able to dictate the structure and routine of their daily life. Deprioritising sleep health during retirement may become more likely if it is in favour of spending time with loved ones or engaging with hobbies (Crestani et al., 2022).

Alcohol

Alcohol (ethanol) is a psychoactive substance that can modify cognition, mood, and behaviour by acting on various tissues throughout the body, most notably the central nervous system (CNS) (Mukherjee, 2013). The level of impact depends on the concentration of alcohol within the bloodstream (blood alcohol concentration (BAC)) (Zakhari, 2006), which is determined by the amount of alcohol consumed, the rate of consumption, and metabolic rate (which can be impacted by stomach emptiness, genetics, or existing health conditions). The following sections outline how alcohol is metabolised throughout the body, its psychoactive effects, the impact of alcohol usage on various systems within the body, and definitions of hazardous drinking and alcohol use disorder in research.

Metabolism

After consumption, alcohol passes from the stomach into the small intestine, where it is transported to the liver to be metabolised (Zakhari, 2006). Cells in the liver produce alcohol dehydrogenase (ADH), which breaks down the ethanol into acetaldehyde, which is toxic and carcinogenic (cancer-causing) (World Health Organization, 2024; Zakhari, 2006). However, acetaldehyde is rapidly further broken down via aldehyde dehydrogenase into acetate, and then into water and carbon dioxide, where it is expelled from the body via the urinary tract and the lungs. The liver can metabolise approximately one ‘standard’ drink every hour (10 grams of ethanol) (Health New Zealand – Te Whatu Ora, 2022).

Psychoactive and Physiological Effects

Drinking alcohol commonly leads to drowsiness and dizziness (Varghese & Dakhode, 2022), loss of motor coordination (including slurred speech), sedation, nausea and emesis, amnesia, and, at higher doses, unconsciousness (Varghese & Dakhode, 2022). Cognitive effects include lowered anxiety, mood-boosting properties, and drowsiness. Once consumed, alcohol impacts several key organ systems, including the CNS, cardiovascular system, digestive system, and immune system (Tyler & Leggio, 2024; Varghese & Dakhode, 2022). Alcohol acts as a CNS depressant, slowing down normal brain activity and inhibiting neuronal arousal and excitation (Varghese & Dakhode, 2022). Transmission of neurotransmitters at the synapse is impaired, sometimes leading to chronic reductions in excitability (Varghese & Dakhode, 2022).

Alcohol also impairs normal cardiovascular system functions and blood circulation and exerts a dose-dependent increase in blood pressure (hypertension) (Varghese & Dakhode, 2022). The cerebrovascular system is also impacted, leading to an increased risk of stroke. Overconsumption impacts “almost all [of] the major organs” within the body (Varghese & Dakhode, 2022, p. 5). Most notable is the liver; chronic high quantity drinking can lead to increased fat in liver cells, progressing to fatty liver disease, or (with time) even cirrhosis.

Hazardous Drinking and Alcohol Use Disorder (AUD)

Alcohol is an addictive substance, and chronic consumption can cause dependence (World Health Organization, 2024). While consumption of alcohol has been found historically in many cultures, growing research suggests that drinking any amount of alcohol can negatively impact health outcomes (World Health Organization, 2023), including increasing risks of developing liver disease, certain cancers, and cardiovascular conditions (World Health Organization, 2024).

Research on alcohol often refers to alcohol use disorder (AUD) and ‘hazardous drinking’ behaviour. AUD is defined as chronic frequent drinking, preoccupation with alcohol and drinking, and periods of withdrawal when drinking is ceased (Tyler & Leggio, 2024). Hazardous drinking encapsulates high frequency, high quantity, and episodes of binge drinking. These three factors are often combined to gauge the ‘riskiness’ or potential harm outcomes of an individual’s drinking behaviour. Generally, the more often an individual drinks, the more they drink on a given occasion, and the more regularly they have binge drinking sessions, the more hazardous the drinking behaviour will be. While AUDs are often considered disorders of the brain, they do impact the entire body (Tyler & Leggio, 2024; Varghese & Dakhode, 2022). This impact is dependent on the concentration of alcohol within the bloodstream, determined by the amount of alcohol consumed, the rate of consumption, and the rate of an individual's metabolism (Zakhari, 2006). Understanding the context of AUD and addiction is important to understand how and why individuals may drink, as well as how alcohol may impact sleep and daily routine (as well as overall health).

In NZ, binge drinking is defined as drinking more than five (or ≥6) standard drinks in a session (Health New Zealand – Te Whatu Ora, 2022). Drinking six or more drinks is associated with increased injury and alcohol related harm. After a binge drinking session, individuals can experience withdrawal (Tyler & Leggio, 2024), which may be caused by homeostatic processes that attempt to counterbalance the effects of alcohol on the CNS. These withdrawal symptoms often involve excitatory CNS symptoms because alcohol acts as a CNS inhibitor (Tyler & Leggio, 2024). Individuals may seek to counteract these symptoms through alcohol use, possibly leading to a cycle of addictive behaviour. While binge drinking is not a direct focus on this study, it is a legitimate aspect of drinking behaviour, and it is useful to understand the local context and policy around the threshold for high quantity alcohol consumption.

Alcohol Use in New Zealand

This section outlines contextual information on alcohol within NZ to provide detail on relevant local context of this study. Focus will be given to the current policy regulating alcohol within NZ, how this policy can influence drinking behaviour, and the social perceptions and prevalence of drinking within the population.

Alcohol Regulation in New Zealand

Policy is a key societal level factor that can affect alcohol consumption. Within NZ, the major regulation for alcohol is the Sale and Supply of Alcohol Act 2012. The Act does not outline a minimum drinking age, but states that alcohol cannot be supplied to minors without parental/guardian consent (s. 241 (1-3)). Generally, alcohol is sold in two main ways: on-license vendors where all alcoholic beverages sold are consumed on location (e.g. pubs, bars, nightclubs, restaurants, hotels etc), and off licence vendors where alcohol is sold to be consumed elsewhere (e.g. supermarket/grocery stores, liquor stores, etc). Key differences between these two types of vendors are that liquor stores and supermarkets are required to state how much of the beverage is ethanol (known as 'alcohol by volume' (ABV)) and the total amount of ethanol in each drink container (determined using the unit 'standard drink', equal to 10g of pure ethanol (Health New Zealand – Te Whatu Ora, 2022)), and that supermarkets are limited to selling beverages under 15% ABV (e.g. beer, wine, cider) (Sale and Supply of Alcohol Act, 2012, s. 58 (1)). In contrast, venues like bars and pubs are not required to report standard drinks per beverage but are required to provide food to reduce the likelihood that alcohol is metabolised more rapidly through an empty stomach.

Understanding the contexts in which alcohol can be purchased and consumed enables better understanding of how NZ adults may drink. It also highlights how the location in which alcohol is purchased and/or consumed can offer drastically different experiences of drinking, particularly regarding the types of alcoholic beverages available for consumption, the availability of food, and the availability and accessibility of health information.

Drinking in New Zealand

Generally, alcohol consumption within NZ is culturally ingrained. In 2019 research on adults views of alcohol showed 87% of respondents agreed that adults should be able to drink alcohol on social occasions (New Zealand Alcohol Beverages Council, 2019). NZ research on alcohol published around the mid-to-late 2010’s suggests that, compared to previous years, older adults in NZ had an increasing alcohol consumption (Stevenson et al., 2015; Towers et al., 2017). However, in recent years this trend may have changed.

The most up to date data on nationwide drinking behaviour in NZ is sourced from the New Zealand Health Survey (NZHS) (Ministry of Health – Manatū Hauora, 2025). Since 2019/20, the proportion of the total population that has consumed alcohol in the past year has declined. Hazardous drinking (determined using the Alcohol Use Disorders Identification Test (AUDIT) (Babor et al., 2001; Saunders et al., 1993) and monthly heavy/binge drinking (consuming more than 6 standard drinks in a session) also declined after 2019/20, but increased in 2023/24 for both the total population and those who had drunk in the past year. Weekly heavy/binge drinking peaked in 2020/21 and has declined since then for both current drinkers and the total population (Ministry of Health – Manatū Hauora, 2025). In 2024/25, the prevalence of older adults who had drunk alcohol in the past year was 78.9% of 55–64-year-olds, 74.4% of 65–74-year-olds, and 70.2% in those aged ≥75. Of these cohorts, hazardous drinking patterns were prevalent in 19%, 15.4% and 5.5% respectively (Ministry of Health – Manatū Hauora, 2025).

Since 2019/20, the proportion of those who had drunk in the past year decreased significantly (>99% CI) for all age categories between 25-54 years old (Ministry of Health – Manatū Hauora, 2025). While data from the NZHS does not show a completely linear reduction (i.e. there is some fluctuation between years) generally it seems the proportion of young people (15-24) who drink alcohol has also decreased over the last 5 years (Ministry of Health – Manatū Hauora, 2025; New Zealand Alcohol Beverages Council, 2025), and that younger people are drinking with more moderation than past generations (New Zealand Alcohol Beverages Council, 2025, 2026). Additionally, it seems a higher proportion of younger people drink low alcohol (i.e. low ABV) beverages than previous generations (New Zealand Alcohol Beverages Council, 2026).

While these results potentially indicate that future generations of retirees could have lower rates of alcohol consumption, research on alcohol consumption among current retirees is still important. In countries in which the proportion of older adults with AUD is relatively stable, improved longevity means that the total number of older adults is increasing, and therefore the number of older adults who qualify as drinking in harmful ways is increasing (White et al., 2023). Alcohol is associated with many risks to health (World Health Organization, 2023, 2024), which can impede healthy ageing, leading to increased mortality and disease burden (White et al., 2023).

While the NZHS shows a general decline in alcohol consumption in recent years, with a slight rise in some areas since 2023, more fully understanding the context in which older New Zealanders drink is important because older adults are also more likely to have co-morbid health conditions that complicate hazardous or heavy drinking (Joyce et al., 2024), or have prescribed medications that may interact with the effects of alcohol (Joyce et al., 2024; Stevenson et al., 2015). Like the NZHS, Joyce and colleagues (2024) found that the number of drinks consumed was decreasing in recent years, but that this did not necessarily translate to a decrease in injury, hospitalisation, or harm from alcohol use for older adults. Additionally, Māori are disproportionately more likely to have substance disorders relating to alcohol (Hogarth & Rapata-Hanning, 2023), and experienced higher mortality and harm from alcohol use (Hogarth & Rapata-Hanning, 2023).

Recent research (Szabo, Towers, Sheridan, et al., 2021) that examined the quantity and frequency of alcohol consumption in older New Zealanders found five main profiles, showing that older adults who drank low amounts of alcohol tended to be grouped into irregular, moderately regular, and highly regular drinkers, and those who drink high amounts of alcohol tended to drink either moderately or highly regularly. This demonstrates that drinking patterns of older adults in NZ are not linear with regards to quantity and frequency, and that older adults consume alcohol in diverse ways.

Alcohol and Sleep

Alcohol has been found to impact sleep in numerous ways, including changes to circadian processes (Burgess et al., 2022; Burgess et al., 2024; Nelson et al., 2024) and sleep architecture (Burgess et al., 2022; Gardiner et al., 2025). Alcohol use has also been linked to insomnia (Burgess et al., 2024; Hussain et al., 2022; Morin et al., 2024) and reduced sleep quality and satisfaction (Garcia et al., 2024; Hussain et al., 2022). These changes are explored in more depth in the following sections.

Circadian System

Heavy drinking can negatively impact the body's ability to be entrained to the day/night cycle by external light cues, causing misalignment and dysregulation of normative sleep/wake timings and circadian rhythms (Burgess et al., 2022). Heavy alcohol consumption (defined as ≥10 drinks per week by Burgess and colleagues) has been associated with the degeneration of retinal neurons (Burgess et al., 2024), which can impair the SCN's ability to detect (and therefore be entrained by) external light levels, disrupting the ability to promote sleep/wake processes at the appropriate times (Burgess et al., 2022). This degradation further reduces the normal functioning of circadian rhythms, exacerbating the disruption of the sleep/wake cycle that occurs during normal ageing, and is associated with negative repercussions for the sleep health of older adults (Li et al., 2022).

As mentioned previously, eating and drinking act as zeitgebers for the circadian system, and consuming food or beverages close to bedtime and sleep onset are associated with impacts to the circadian system and normal sleep timings (Iao et al., 2022). Alcohol impacts the normal regulation of the sleep/wake cycle, and these effects can be further exacerbated if alcohol is drunk close to bedtime. Evening chronotypes (those who tend to sleep later and wake up later in the 24-hour day) are more likely to drink alcohol closer to bedtime and the onset of sleep (Burgess et al., 2022; Leger et al., 2022; Nelson et al., 2024). Identifying as this chronotype is also associated with increased impulsivity (Burgess et al., 2022; Nelson et al., 2024) and higher rates of hazardous drinking (Nelson et al., 2024). While being an evening chronotype is associated with shorter sleep duration (due to social structures that revolve around set wake times), some research has found that this is compensated for by sleeping in (Burgess et al., 2022).

Sleep Architecture and Fragmentation

Alcohol usage is also associated with changes to typical sleep architecture (Burgess et al., 2022). Research has found that alcohol consumption close to bedtime and the onset of sleep negatively correlated with the proportion of the night spent in REM sleep (Gardiner et al., 2025; Stein & Friedmann, 2006), and that this effect can occur after relatively low doses of alcohol (2 standard drinks) (Gardiner et al., 2025). While this reduction in REM sleep generally plateaus with chronic consumption (Stein & Friedmann, 2006), as alcohol wears off in the latter portion of the night individuals may experience ‘REM rebound’ (Roehrs & Roth, 2001). REM-rebound can occur after experiencing inadequate quantities of REM sleep and is characterised by a disruption to typical sleep architecture, in which intense periods of REM sleep take up proportionally more of the sleep cycle. Chronic drinkers may also experience REM rebound after they cease drinking (Stein & Friedmann, 2006). These periods of more intense REM sleep can lead to more awakenings as REM sleep requires less stimulus to wake from, leading to increased issues with insomnia and reduced sleep efficiency. Alcohol based disruption to sleep later in the night (Hussain et al., 2022; Roehrs & Roth, 2001) can further exacerbate existing sleep quality issues caused by ageing and fragmentation (Li et al., 2022).

Increased alcohol consumption has been positively linked to increased snoring (Park et al., 2015; Zheng et al., 2024) and increased risk of sleep disordered breathing (He et al., 2019). Insomnia has been linked to increased drinking (Burgess et al., 2024), however it is possible that this relationship is bidirectional as individuals with sleep issues may use alcohol to self-medicate symptoms (Burgess et al., 2024; Leger et al., 2022; Morin et al., 2024).

Research on Alcohol and Sleep in Older Adults

There have been several studies from other countries that have utilised data from national surveys or databases to examine the relationship between alcohol and sleep health in large representative samples of adults (inclusive of those aged >55 years) (Hayley et al., 2017; Horvat Davey et al., 2024; Hwang et al., 2024; Leger et al., 2022; Thorne et al., 2021; Wang et al., 2023; Zheng et al., 2024), as well as some studies that specifically focused on only older adults (Hussain et al., 2022; Midorikawa et al., 2019). These studies include data from the USA (Blazer & Wu, 2009; Horvat Davey et al., 2024; Qeadan et al., 2024), Canada (Hussain et al., 2022; Morin et al., 2024), the United Kingdom (UK) (Zheng et al., 2024), France (Leger et al., 2022), China (Wang et al., 2023), Japan (Midorikawa et al., 2019), Korea (Hwang et al., 2024), and Australia (Hayley et al., 2017; Thorne et al., 2021).

Of these studies, evidence for the relationship between sleep duration and alcohol is mixed. Some studies found an association between atypical sleep duration and alcohol quantity in adults (Midorikawa et al., 2019; Zheng et al., 2024) and specifically older adults (Midorikawa et al., 2019; Zheng et al., 2024), while some studies have found no association (Hussain et al., 2022; Leger et al., 2022). Higher frequency of alcohol consumption has been found to be associated with short sleep duration (Wang et al., 2023), as well as not associated (Horvat Davey et al., 2024). Identifying as an evening chronotype was associated with riskier drinking behaviour

(Leger et al., 2022; Zheng et al., 2024). Those studies that investigated alcohol and sleep quality or aspects of sleep continuity found that heavy drinking was linked to sleep dissatisfaction (Hussain et al., 2022), and that quantity was linked to disrupted sleep (Hayley et al., 2017; Zheng et al., 2024) and poor sleep quality (Thorne et al., 2021). Increased frequency of alcohol consumption was linked to poor sleep quality (Thorne et al., 2021) and sleep difficulty (Hwang et al., 2024), however the latter found that while this relationship was robust in young and middle-aged adults, the clear link between sleep difficulty and alcohol consumption was less significant in older age.

One study that focused on older adults (≥65 years old) and included employment as a variable alongside sleep and alcohol found that being employed was a significant predictor for at-risk and high-risk drinking (Midorikawa et al., 2019). Compared to the low-risk group, employed older adults were 124% more likely qualify as at-risk drinkers, and 132% more likely to qualify as high-risk drinkers (Midorikawa et al., 2019). Notably, this study did not include retirement status as a variable, defining employment status as either employed or unemployed, which makes it difficult to know whether unemployment was due to inability to work or find work, or because participants were retired.

For studies that focused on the use of alcohol as a sleep aid (Leger et al., 2022; Morin et al., 2024), it was found that some older adults report using alcohol to counteract sleep complaints associated with ageing (Leger et al., 2022), and that older males are more likely to choose alcohol over other sleep aids (e.g. medication) (Morin et al., 2024). Furthermore, in a Canadian population, an association was found between insomnia and binge drinking (Hussain et al., 2022). This means that examination of the relationship between sleep and alcohol requires a bidirectional focus, acknowledging that alcohol consumption may negatively impact sleep, but also that poor sleep health can lead to alcohol consumption as a form of self-medication to treat symptoms of poor sleep health.

Alcohol, Ageing, and Retirement

This section applies the individual, social, and societal levels of the socioecological model of sleep health (Grandner, 2019) to alcohol consumption, ageing, and retirement. In particular, the impact of genetics and physiology, social interaction and social drinking, home and work environment, and policy will be examined.

Physiology and Health Status

An individual's likelihood of developing AUD is linked to genetics, as is the metabolism rate of alcohol within the liver (Zakhari, 2006). Throughout the process of ageing, the rate of alcohol metabolism in the liver is slowed, meaning that, compared to younger adults, consuming the same quantity of alcohol typically causes older adults to experience higher levels of intoxication, and higher BAC (Stevenson et al., 2015; White et al., 2023). This individual level change in physiological metabolism is closely linked to the societal level of the socioecological model of sleep health. The availability and accessibility of public health information on changes to alcohol metabolism during ageing has a marked impact on individual behaviour and health status. A lack of information on these changes means that individuals may be unaware of the increased risk of harm that is associated with drinking as an older adult, and this may lead to harmful impacts to overall health, as well as sleep health status.

A recent review of literature on changes to levels of functioning after retirement found ambiguous results; retirees were found to have both improvement and decline in functioning, indicating the need for further research in this area (Saha et al., 2023). However, the study also found inequalities in functioning levels after retirement, mediated by gender, education status, and socioeconomic status (SES) (Saha et al., 2023), meaning that certain demographics may be more likely to maintain better physiological and cognitive functioning, and therefore have a more satisfying and positive retirement experience than others.

Whether an individual smokes tobacco (i.e. cigarettes) also has an impact on their health outcomes. The tobacco plant contains the addictive stimulant nicotine (Yildiz, 2004), and smoking tobacco allows nicotine to be rapidly absorbed into the blood and CNS through the respiratory system (Yildiz, 2004). Smoking is associated with an increased risk of lung and throat cancers (Yanbaeva et al., 2007), inflammation (Ishida et al., 2024; Yanbaeva et al., 2007), and cardiovascular disease (Ishida et al., 2024). Smoking has been shown to have a dose-dependent impact on sleep health (Leger et al., 2022), and is associated with increased risk of sleep disordered breathing and insomnia (Grigoriou et al., 2024), and reduced sleep quality (Hayley et al., 2017). Smoking has also been found to positively correlate with binge drinking (Blazer & Wu, 2009) and risky (i.e. hazardous) drinking patterns (Midorikawa et al., 2019). The relationship between smoking and sleep disturbances has been found to be mediated by alcohol consumption (Hayley et al., 2017), indicating the complex dynamic between polysubstance usage and sleep health.

Social Interaction

Like sleep, alcohol use later in life is also mediated by social relationships and stereotypes. Socially, alcohol is often viewed as aiding sleep and may often be used to self-medicate insomnia (Leger et al., 2022; Midorikawa et al., 2019; Morin et al., 2024). Despite this common perception, it is not an effective sleep aid when consumed frequently or chronically (Leger et al., 2022) and alcohol consumption has been shown to worsen sleep health (Hussain et al., 2022; Midorikawa et al., 2019). Often social drinking is seen as more acceptable than drinking alone, and alcohol is commonly used to modify mood (Horvat Davey et al., 2024; Moskal et al., 2025), particularly in shared social settings.

When understanding the sleep health of older adults, it is important to understand the context (Gibson et al., 2023). Sleep is bidirectionally linked to daytime function and other health behaviours. Having poor sleep health can predict motivations for alcohol consumption at both the individual and social level (Moskal et al., 2025), and this effect can occur in both directions. Good sleep can lead to drinking through motivations to 'enhance' an already positive mood, and poor sleep may lead to drinking as a way to 'reduce' the negative effects of poor sleep (Moskal et al., 2025).

Poor sleep can also contribute to alcohol usage as a sleep aid or for sleep disorder symptom management (Morin et al., 2024). High alcohol consumption can worsen sleep health (Hwang et al., 2024) and disrupt normal sleep architecture, leading to increased daytime dysfunction (Chueh et al., 2009) and poorer mood. The perception that alcohol improves poor sleep is often reproduced through social channels, but in reality it is only potentially beneficial when used very sparingly (Leger et al., 2022).

The social mediation of alcohol behaviours can also impact retirement experiences. During retirement, it is possible that having the agency to choose daily activities and structure may increase alcohol consumption, as there may be more time for social events in which alcohol is consumed, or more time to drink in the evening without attention to how this could impact employment the following day (Edgar et al., 2016). Feelings of isolation and social connection have also been found to mediate alcohol consumption. For some adults, ageing is associated with an increased loneliness and a reduction in social connection opportunities (Kuerbis & Sacco, 2012). In some cases, individuals may increase their drinking if they feel the psychoactive properties of alcohol can help them cope with this loneliness (Kuerbis & Sacco, 2012).

Thematic analysis of face-to-face interviews with a sample of older Māori suggests that *whānau* (family) and perception and attitudes of alcohol consumption in social groups can act as a key mediator of drinking behaviour (Herbert et al., 2017). The perceived acceptability of alcohol consumption within participants' whānau and within cultural spaces was linked to how much they drank (Herbert et al., 2017). Participants tended to report drinking less when they were acting within leadership roles, citing the importance of being a good older role model, as well as within certain cultural settings (Herbert et al., 2017).

Environment

Early life experiences with alcohol, including parental alcohol misuse, have been identified as contributing factors towards hazardous drinking later in life (Szabo, Towers, Newcombe, et al., 2021). Drinking later in life is associated with disrupted sleep during childhood (Sabatier et al., 2024) and lower childhood SES (Szabo, Towers, Newcombe, et al., 2021). Research also shows that adults whose parents regularly drank alcohol are more likely to drink higher quantities of alcohol during adulthood (Barnes & Welte, 1990).

Work Environment. While NZ has no legal definition of how many weekly work hours constitute 'full-time' employment, it is generally accepted that full time means working roughly 30 to 40 hours per week (Employment New Zealand, 2026). 'Part-time' work encompasses work that is less than 30 hours. Adults who work full time will spend roughly a third of their life at work, meaning that their experience of their work environment encapsulates a significant portion of their life and daily structure.

Work environment can have a large impact on sleep and health. For example, shift work is related to a greater risk of exposure to multiple workplace hazards (Jay et al., 2017), and negatively impacts sleep duration and quality, leading to a decrease in sleep health. Higher levels of work stress are associated with increased alcohol consumption (Frone, 2016), meaning that retirees may drink less than their working counterparts.

Interestingly, high stress work environments have been shown to actually ease retirement transitions, as individuals experience an improvement in wellbeing as a result of leaving a demanding work environment, making the change in routine positive and 'relaxing' (Martinčeková & Škrobáková, 2019). Often individuals in this category are in good health, and see retirement as a way to 'optimise' their period of good health before it normatively declines with age (Pond et al., 2010). While this study focuses on retirement with no paid work, some older adults may remain active in part time or volunteer work throughout retirement. Participation in part time work during retirement has been associated with positive outcomes if the work is related to the sector they previously worked in (i.e. reducing hours at one's job without changing to a new work environment, or moving to a job with less hours in the same field) (Martinčeková & Škrobáková, 2019). Individuals who participate in volunteering report better perceived satisfaction during retirement than those who stop working altogether (Martinčeková & Škrobáková, 2019).

The influence of work environment on alcohol consumption is exacerbated for some groups, including Māori. NZ's history of colonisation includes inequitable access to education for Māori (compared to non-Māori) (Hogarth & Rapata-Hanning, 2023) and pressured disproportionately more Māori to occupations related to menial labour (Pearson, 2011), which can be associated with higher presence of 'drinking culture' (i.e. heavier consumption of alcohol that is normalised socially) (Herbert et al., 2017). This culture can influence both individually and socially held attitudes about drinking, and increase rates of alcohol consumption among Māori (Herbert et al., 2017).

Public Health and Policy

When considering the societal level, alcohol is a modifiable target to consider for improving sleep health outcomes (Horvat Davey et al., 2024). NZ research around alcohol has found SES to be significantly associated with certain drinking patterns (Szabo, Towers, Newcombe, et al., 2021). Specifically, adults with lower childhood SES and then higher mid-to-late life SES were far more likely to have frequent and high quantity alcohol consumption (Szabo, Towers, Newcombe, et al., 2021). Furthermore, the regulation and policy regarding the retirement transition can influence many aspects of health and therefore contribute to secondary implications of drinking behaviours and sleep health. This will be explored in the following section.

Retirement Context. An aspect that is important for conceptualisations of retirement is where this transition occurs over the life course. Working New Zealanders exist within a capitalist economic system, which focuses on economic growth and prioritises productivity and financial capital (Noonan, 2024). This can contribute to a demand for efficient and high performance, and contribute to job stress (Noonan, 2024). Increased job stress may impact reasons for retirement, or health and wellbeing during retirement (Martinčeková & Škrobáková, 2019). Similarly, finances and SES can also impact the transition to retirement.

Causes of Retirement. There are several potential reasons older New Zealanders may advance or delay retirement. For some older adults, delayed retirement may be related to financial security concerns and financial strain. Improved longevity means that retirees can often expect to remain retired for longer. Longer retirement periods require more retirement funds, and this could increase financial strain for some individuals, which has been suggested as a reason for the higher rates of older adults in NZ who remain employed past usual retirement age (Te Ara Ahunga Ora Retirement Commission, 2019). As the Superannuation is given to adults over 65 years old regardless of work or retirement status, working past 65 years old allows older adults to receive a secondary form of income in additional to their usual wages or salary (Pond et al., 2010; Te Ara Ahunga Ora Retirement Commission, 2019). Other older adults may remain employed because their professional identity is important to their self-image/esteem, and change to this perception of self is anxiety inducing (Taylor et al., 2024). Individuals who freely choose to delay retirement often have improved mental health from being able to maintain normal routines and remaining active (Yuan, 2024).

The attitudes of older adults who retire early often fall into two key categories: those who do so voluntarily (typically with planning), and those who retire early for sudden reasons (unemployment, disease, etc), who are often unprepared. The wellbeing of older adults who retire early (before age 65) depends on how voluntary and planned this decision was (Martinčeková & Škrobáková, 2019). Voluntary early retirees who have adequate preparation and planning often have easy transitions into retirement, and generally have better health outcomes and emotional wellbeing than their counterparts (Martinčeková & Škrobáková, 2019). Individuals for whom early retirement was unplanned or determined by situation (e.g. unemployment, health conditions that impair work ability, etc) often find the transition from working life to retirement substantially more difficult, and often have worse financial stability, possibly because a longer retirement period requires more funds, and the sudden nature of the decision often means this transition was unable to be appropriately planned (Martinčeková & Škrobáková, 2019). In this case, individuals often view retirement as less 'free' than their counterparts who choose to retire early.

Involuntary retirement has been linked to increases in alcohol consumption (Kuerbis & Sacco, 2012), and similarly, higher perception of self-agency surrounding the transition is associated with reductions in problematic and heavy drinking behaviour (Bacharach et al., 2008). Individuals with chronic sleep conditions or sleep difficulties (e.g. insomnia) have been identified as more likely to retire early due to health issues or disability (Hale et al., 2017; Myllyntausta & Stenholm, 2018). This means that poor sleep health before retirement can contribute to earlier retirement timing and therefore is associated with lower perceived agency and lower satisfaction during the transition, as well as potentially increased financial strain. It also potentially indicates that there is a link between existing poor sleep health and increased alcohol consumption through retirement agency mechanisms. However, these dynamics may be mediated by the way that retirement can increase the amount of hours per day that are available for sleep, leading to improved sleep duration (Hagen et al., 2016). In cases where retirement has led to a decrease in existing sleep health problem symptoms, improvement in life satisfaction has been found (Kontturi et al., 2024).

Rationale

Good sleep health is an important aspect of healthy ageing (Dzierzewski et al., 2018; Li et al., 2022; Ravyts & Dzierzewski, 2024). Changes to sleep health during ageing are associated with decreased sleep quality and insufficient duration (León-Barriera et al., 2025; Li et al., 2022), insomnia (León-Barriera et al., 2025; Morin et al., 2024), and sleep disordered breathing (McMillan & Morrell, 2016). Alcohol consumption among older adults has negative impacts on their health and wellbeing (Stevenson et al., 2015; White et al., 2023), including sleep health (Chueh et al., 2009; Park et al., 2015; Zheng et al., 2024).

In NZ, alcohol is consumed in a variety of ways during older adulthood (Szabo, Towers, Sheridan, et al., 2021), and there is insufficient research examining how alcohol mediates sleep health status in older NZ adults. As mentioned in the introduction, the limited research on alcohol and sleep in older adults in NZ (Gibson et al., 2023; Henry, 2023; Jones, 2022) has reported findings that are generally inconsistent with the findings found in literature from other countries that have found associations between alcohol and poor sleep health. In NZ, hazardous drinking was found to not be a significant predictor of atypical sleep duration in older adults (short or long) (Gibson et al., 2023) or associated with profiles of poor sleep health (Jones, 2022), and daily alcohol consumption was not associated with poor sleep status (Henry, 2023).

Half of these aforementioned NZ studies conceptualised alcohol by using the AUDIT to categorise participants by whether they engaged in hazardous drinking (Gibson et al., 2023; Jones, 2022). As suggested by Jones (2022), it is possible that this conceptualisation led to the inconsistent results, and Jones found that after shifting to an alternative metric based on the quantity of alcohol consumed, drinking three or more standard drinks was associated with excessive daytime sleepiness in older adults. Furthermore, conceptualising alcohol through quantity and frequency is more closely aligned with the diverse ways that older adults have been found to consume alcohol, especially regarding the non-linear relationship between the quantity and frequency of alcohol typically consumed (Szabo, Towers, Sheridan, et al., 2021).

To explore the relationship between alcohol and sleep in older adults, this study will utilise retrospective analysis of the 2022 wave of the New Zealand Health Work and Retirement study. The NZ-HWR study has a rich focus on older adults' experiences of health, employment, and retirement during ageing, and analysis of this dataset should improve the quality of depth of information available within NZ literature. This dataset is also unexplored regarding sleep and alcohol in older adults.

While the NZ-HWR study has included alcohol for several waves, it has only recently included a more comprehensive selection of items relating to sleep and sleep health characteristics. This makes the 2022 wave appropriate for analysis on sleep health and alcohol. Furthermore, as retirement is a significant and complex life transition that occurs during ageing, there are a variety of factors that could influence sleep health status and drinking behaviour.

Employment and retirement offer two different contexts for sleep health and drinking behaviour, but as NZ has no compulsory retirement age, the retirement status of older adults is varied and cannot be based on age. Therefore, this study will stratify participants by employment and retirement status. This was deemed necessary because of the variety of social-ecological and health status variables that can contribute to early or late retirement, and the ways these can impact sleep health and drinking behaviours, and the different ways that the retirement transition is associated with both sleep health and overall wellbeing. Research using the NZ-HWR dataset will enable better understanding of how alcohol consumption and sleep health can change and impact each other during the years leading up to retirement, and cohort stratification will enable more detailed investigation on whether there are significant differences in sleep and drinking behaviour between workers and retirees.

Aims

This thesis aims to explore the relationship between alcohol consumption and sleep status among older New Zealanders participating in the 2022 wave of the NZ-HWR study. It will explore whether indicators of poor sleep are independently associated with quantity and/or frequency of drinking between groups of older adults stratified by status of working or retirement.

Hypotheses

Based on the reviewed data, it is hypothesised that:

1. Poor sleep status will be more likely in the participants who are working compared to those who are retired.
2. That the retired group will have less alcohol consumption than the working group.
3. That high frequency and high quantity drinking are independently associated with poor sleep status.
4. That the profiles of poor sleep and alcohol differ between retirement status, for example with regards to indicators of stress, and poor physical and/or mental health status.

Methods

This study utilised a cross-sectional design to examine the effects of alcohol consumption on sleep health in retirees and workers. To achieve this, data was sourced for retrospective analysis of the New Zealand Health, Work, and Retirement (NZ-HWR) study's 2022 wave dataset. This chapter will provide an outline of the NZ-HWR study, ethical considerations and data handling, information on relevant measures for key variables, an explanation of steps taken during data preparation, and methods of statistical analysis.

Subjective Measures

Sleep health is holistic and multidimensional and measurement of sleep characteristics often benefits from mixed methods (Buysse, 2014). However, subjective measures are considered beneficial when understanding the impact of attitudes and perceptions on sleep health and related behaviours. Additionally, subjective measures (such as surveys) are often more cost-effective and able to be used on significantly larger samples sizes than objective sleep measures like laboratory or home-based technological sleep studies (Hughes et al., 2018; Natsky et al., 2021).

The New Zealand Health, Work, and Retirement Study (NZ-HWR)

The NZ-HWR study (Allen et al., 2020) was the first nationwide study to focus on ageing and older New Zealander's health status and experiences of ageing during their latter work years and throughout retirement. It has been previously known as the New Zealand Longitudinal Study of Ageing (NZSLA) and the Independence Contribution Connection (ICC) and is overseen by the Health and Ageing Research Team (HART) at

Massey University. The survey is primarily administered through the post, with some additional face-to-face or phone interviews for some cohorts/participants, to adults around retirement age (>55 years). It has run biennial waves since 2006, with occasional off wave surveys. Each wave core includes health and well-being, social participation, and economic participation and each year has a focus component to research a specific topic (Allen et al., 2020). In earlier years, sleep was primarily included through questions about disordered aspects of sleep health or as an aspect/symptom of other health conditions (e.g. depression, asthma). In recent years sleep has become included as its own area of health and the 2022 wave included items pertaining to sleep duration, subjective satisfaction, and daytime sleepiness, alongside the older questions around prevalence of sleep disorders and their treatment, and how mental health issues impact sleep (Health and Ageing Research Team, 2022). However, it is worth noting that no validated sleep measure was included in its entirety, and majority of the items on sleep were single items drawn from validated sleep scales, or included as aspects of health scales that focus on other aspects of health (e.g. an item on prevalence of restless sleep/insomnia from an anxiety or depression scale, etc).

Alcohol has been included in every main survey since the NZ-HWR study began in 2006, and most years questions have been based on a shortened version of the AUDIT (Babor et al., 2001; Saunders et al., 1993), the Alcohol Use Disorder Identification Test – Concise (AUDIT-C) developed by Bush and colleagues (1998). The only exception was in 2016, which used a modified NZ version of the Comorbidity Alcohol Risk Evaluation Tool (NZCARET). The AUDIT-C (Bush et al., 1998) questions assess current drinking status, the amount of drinking typically consumed on a given drinking occasion, alongside a screening question on binge drinking frequency (six or more standard drinks). An additional question around history of past drinking for those who currently reported typically never drinking was also added by the HART team (Health and Ageing Research Team, 2022).

The NZ-HWR 2022 Wave

The 2022 survey of the NZ-HWR included 5,558 adults aged 55 and over. It was funded by the Ministry of Business, Innovation and Employment (MBIE, MAUX1705), and had a focus on employment and workplace discrimination.

Recruitment and Participation. Alongside recruiting a general population sample, the NZ-HWR study purposefully oversamples Māori participants. Analysing data through Māori ethnicity from only the general sample would be problematic as the sample size would be inefficient for analysis and meaningful representations on factors affecting the wellbeing of older Māori (Towers, 2007). This is important as, compared to their non-Māori counterparts, Māori encounter different challenges and health outcomes throughout ageing and retirement. Oversampling therefore enables Māori - led research to provide a better understanding of experiences and outcomes for older Māori and improves insight on planning future health interventions that address current ethnic and cultural disparities (Towers, 2007).

The 2022 wave recruited both participants who were existing from previous cohort waves, and a new ‘refresh’ cohort comprised of new participants (Phillips, 2023). Inclusion criteria for the existing cohort required participation in previous waves (2006, 2009, 2014, 2016, 2018, or 2020) and a response since 2018, provided they had not relocated overseas, withdrawn from the study, or been deemed deceased or lost to contact (i.e. were unable to be contacted, typically if they had moved address and changed their phone number without providing an alternate/new method of contact (mail forwarding, new phone number, etc)).

The ‘refresh’ participants were recruited using a steady state sampling design and were aged between 55-65 in 2022, to enable the continuation of the necessary sample size while the existing cohort aged (Phillips, 2023). Any persons on the electoral role born between 12/07/1956 and 11/07/1967, that resided in NZ, and who had not participated in previous waves between 2006-20, were eligible for random selection. As in previous years, Māori were oversample from this eligible population. Initial sample size was also adjusted for the target sample size after factoring the predicted 2022 drop-out rate (based on previous years) for both the general and Māori populations.

All potential participants were posted a package consisting of an introductory letter, an information sheet, a complimentary pen, the 32-page survey booklet, a consent form (if they were new participants), and a reply-paid return envelope to mail the survey (and, if applicable, the consent form) to the HART team once completed (Phillips, 2023). The introductory letter for the existing cohort thanked them for their history of participation and explained the 2022 wave.

The refresh cohort received an alternative introductory letter than explained the purpose of the study and invited them to participate. The information sheet included an explanation of the history of the study, the participant selection method, data security and confidentiality, their rights as participants, ethics approval, and information regarding the data linkage to the national dataset and the Accident Compensation Corporation (ACC, an entity that provides coverage for no-fault injury or harm). The consent form included the option for new participants to agree or decline to data-linkage (existing participants were not sent this form as they had previously indicated their consent preference during the 2020 wave) (Phillips, 2023).

After three weeks, participants were sent a postcard that thanked those who were able to promptly return their survey for their participation and reminded participants who had not yet completed their survey that if they wished to participate, they should do so soon. Twelve weeks after the initial package, a final reminder letter was sent to those who had not yet participated, along with an additional copy of the original information sheet, survey booklet, consent form, and pre-paid return envelope. Any participants who within these 12 weeks had withdrawn from the study, been lost to contact, or been notified as deceased were not sent the final reminder package (Phillips, 2023).

Ethical Considerations

Ethical approval for the 2022 NZ-HWR wave was granted by the Massey Human Ethics Committee: Southern A Application – 22/23; (Reference: MAUX1705). A proposal outlining the present research aims, hypotheses, data handling, and requested item content was sent to the HART team for review, who then granted data access.

All conduct was aligned with the HART ‘Data access and conditions of use agreement’ document (Version 2, August 2016). The HART team has a commitment to the Treaty of Waitangi (*Te Tiriti o Waitangi*) and their duty to protect the data of Māori participants, meaning ethnic demographic information is only given to projects that require it for their purpose or analysis methodology. All participant data was anonymised, and any potential identifying information was removed during analysis.

Care was taken to ensure that any presentation of older adults was conducted in a respectful manner, and that the language used did not perpetuate stigma associated with alcohol consumption or portray participants who drank alcohol more frequently and/or in higher quantities in a negative light. Care was also taken to be mindful of how health outcomes are often impacted by privilege and opportunity, and that findings did not criticize participants who had 'poorer' health status. All data was stored in a secure university OneDrive folder and was accessed only from a personal password-protected computer on secure private or university wi-fi networks. Two-factor authentication was enabled for added security. The original data file from the HART team was further password protected for added security, and all additional iterations or backups of this original data file (i.e. with raw data) were similarly password protected.

Research Design

This research utilised a cross-sectional matched model design to examine relationships between alcohol and sleep across the working and retirement cohorts, including any variables that were significant at the bivariate stage for either or both cohorts. Multivariate analyses involved hierarchical regression models exploring alcohol consumption as an independent predictor of the sleep outcome variables indicative of sleep disturbances. The design and analysis were conducted solely by the author; however, a supervision team gave guidance on scope and variable selection.

Variables

To address the present research aims, variables were selected pertaining to key areas of sleep health, work status, and alcohol consumption as well as other demographic and health related covariates. These are summarised below.

Demographics

Age, gender, ethnicity, SES, and work/retirement status were requested as demographic variables. Age was calculated at time of participation (2022) using date of birth. This was done prior to data access by the HART team. Participants under the age of 55 were removed as most research uses either age 55 or 65 as lower thresholds for older adulthood, and it was possible that literature on ageing and associated factors could be less relevant to those under 55 years old. No participant was missing an age.

Gender was sourced from an item asking what gender participants identified as, with options to pick one of the following: *tāne/male*, *wāhine/female*, or *gender diverse*. Gender remained unchanged during analysis, but the amount of participants who had selected “gender diverse” was very low (n=3) so to avoid issues in analysis with low statistical power these participants had their gender data scored as missing (i.e. the full dataset and the actual gender data was not removed, but all analysis would treat their gender fields as unanswered).

Ethnicity was requested to describe the sample, and because it would be utilised as a covariate in final regression models as Māori were purposefully over sampled. Data was obtained from asking participants to “indicate below which ethnic group or groups you belong to”. Participants were instructed to select *all* categories that applied, from the following: *Māori, Niuean, New Zealand European, Chinese, Samoan, Indian, Cook Island Māori, Tongan*, or *Other* (with space to specify which ethnicity). This meant that some participants belonged to several ethnic categories. For simplified variable usage, prioritised ethnicity was utilised to categorise participants into the highest priority ethnicity they entered, even if they selected multiple categories.

The category order was, Māori, Pacific People (Niuean, Samoan, Cook Island Māori, and Tongan), Asian (Chinese and Indian), NZ European, and a final category for those who specified other. After this, an additional binary categorical ethnicity variable was created (for regression analysis) which refined the prioritised ethnicity variable into Māori and non-Māori categories.

Socioeconomic Status and Living Standards. The Economic Living Standard Index (ELSI, (Jensen et al., 2005)) was developed to replace the Material Wellbeing Scale (Fergusson et al., 2001) which lacked the capacity to function as a unidimensional index of SES (Jensen et al., 2002). As a measure the ELSI examines several aspects of SES to calculate an overall index score of living standard. This index was developed for the NZ context and was created with awareness of how preferences and tastes can impact preferences and therefore perceived standard of living (e.g. whether someone lacks a telephone because the cost is too high, or because they do not want to own one). The NZ-HWR 2022 wave used an abbreviated version of the ELSI, the ELSI – Short Form (ELSI-SF) (Health and Ageing Research Team, 2022; Jensen et al., 2005).

The ELSI-SF has four sections which examine necessities, luxuries, economising habits (avoiding purchases to save money), and personal assessment of living standards. The first section included seven items that enquired about ownership of specific necessities (e.g. telephone, insurance, a best outfit for special occasions), and answers included indicating whether it was owned, or why it was not owned: *yes – have it*, *no – because I don't want it*, *no – because of the cost*, or *no – for some other reason*. The second section had seven items focusing on how SES impacts accessing services and engaging with social activities (e.g. Giv[ing] presents to family or friends on birthdays, Christmas or other special occasions, or visit[ing] the hairdresser once every three months). Like the first section, answers took the format of indicating yes/no, with reasons as to why not: *yes – do it*, *no – because I don't want to*, *no – because of the cost*, or *no – for some other reason*. The third section included eight items asking whether participants economise (go without essentials to save money). Examples included if participants had gone without fresh fruit and vegetables, or if they had postponed or put off visits to the doctor to help keep down costs. Answers took the format of multiple choice: *not at all*, *a little*, or *a lot*. The fourth section included three items, enquiring how participants would rate their standard of living, their satisfaction with their standard of living, and the adequacy of income. Self-rated standard of living could be answered in the format of a 5-point Likert scale: *high*, *fairly high*, *medium*, *fairly low*, or *low*. Satisfaction with current living standard was also answered in a 5-point Likert scale: *very satisfied*, *satisfied*, *neither satisfied nor dissatisfied*, *dissatisfied*, or *very dissatisfied*. The final item asked, "How well does your (and your partner's combined) total income meet your everyday needs for such things as accommodation, food, clothing and other necessities?" and participants could select one of the following options: *not enough*, *just enough*, *enough*, or *more than enough*. ELSI-SF data was scored according to the Ministry of Social Development guidelines (Jensen et al., 2002). The ELSI-SF was designed for usage within NZ, and the shortened version has been deemed appropriate for administration in populations of older adults (Jensen et al., 2005).

The ELSI-SF was scored from 0-31, and higher scores were indicative of better economic standard of living. It was scored by the HART team prior to data access was granted, and their method of scoring accounted for some missing data on certain questions (i.e. if certain non-essential items were missing a single score, the mean of item scores in the same category could be used to avoid removal of the entire dataset; however, this was not utilised for essential scoring items or if multiple answers were missing). This scoring method allowed for a greater proportion of the original participants to have their data included during analysis, which was deemed ethically important as this research had a duty to only exclude participants when it was necessary, especially because there was a significant time burden surrounding participation.

Sleep Health

Several variables related to aspects of sleep disturbance were included preliminarily, with the intention to conduct univariate and bivariate analysis to determine which variables were most associated with alcohol and ageing, meaning that final regression analysis would only be conducted on a subset of the initially included sleep variables. The variables included at this stage were: restless sleep, sleep problems, sleep duration, daytime sleepiness, and sleep satisfaction.

Restless sleep was investigated through a singular item that was part of the Center for Epidemiologic Studies Depression Scale (CES-D) (Andresen et al., 1994). Answers took the format of a 4-point Likert frequency scale: *rarely or none of the time*, *some or a little of the time*, *occasionally or a moderate amount of the time*, or *all of the time*. The CES-D version included in the NZ-HWR study was an abbreviated ten item version, shown to be reliable in screening depression in older adult populations (Andresen et al., 1994). Restless sleep was split into a binary category, restless sleep (which included 'rarely or none of the time' or 'some or a little of the time') and not restless sleep (answers of 'occasionally or a moderate amount of the time' or 'all of the time').

Reported sleep problems (i.e. sleep complaints) was sourced from the WHO Study on Global Ageing and Adult Health (SAGE) (World Health Organization, 2006). The item asked, "overall in the last 30 days, how much difficulty did you have with sleeping, such as falling asleep, waking up frequently during the night or waking up too early in the morning?". Difficulty was defined as "increased effort, discomfort or pain, slowness or changes in the way [participants did] the activity", and participants could select one of the following options: *none*, *mild*, *moderate*, *severe*, or *extreme/cannot do*. The SAGE is specifically focused on health during ageing making it appropriate for administration in older adults (World Health Organization, 2006). The sleep problems variable was sorted into two categories: 'substantial' sleep problems (which included moderate, severe, or extreme/cannot do levels of difficulty) and 'non substantial' sleep problems (which included participants who had answered none, or mild).

Sleep duration was included through an item asking, "how many hours of sleep do you usually get in a 24-hour period, including <u>all naps</u> and sleeps", and participants could report a single number of average hours (range 1-24). A single value self-report average of sleep duration is utilised within the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989). The PSQI is a comprehensive, validated, and reliable sleep health measure that is widely used throughout sleep research. The original single-item in the PSQI has been shown to be a suitable measure of *subjective* sleep duration (although values may vary from objectively measure sleep duration). Sleep duration was calculated using the reported typical total hours slept per day, but answers were rounded down to the closest half hour. No answers were changed further than this, even if participants reported typically sleeping unusually short or long (e.g. 1 hour, 20 hours, etc) as sleep duration was inclusive of all naps over the 24-hour period and it was not possible to differentiate those with insomnia or those who napped from participants who did neither and mis-answered the item.

Daytime sleepiness was assessed through an item asking, "how often have you had trouble staying awake while driving, eating meals or engaging in social activity?". Participants could select one of the following options: *not during the last month*, *less than once a week*, *once or twice a week*, or *three or more times a week*. This item was also taken from the PSQI (Buysse et al., 1989), and has been shown to be an adequate indicator of alertness and sleepiness. Daytime sleepiness was binned into two categories: frequent ('once or twice a week', or 'three or more times a week') and infrequent ('not during the last month' or 'less than once a week').

Sleep satisfaction was included through an item from the WHO Quality of Life survey (WHOQOL) (Skevington et al., 2004), which asked participants "How satisfied are you with your sleep", allowing selection of one on the following options on a 5-point Likert satisfaction scale: *very dissatisfied*, *dissatisfied*, *neither satisfied nor dissatisfied*, *satisfied*, or *very satisfied*. A shortened version of the WHOQOL-Brief (WHOQOL-BF (Skevington et al., 2004)), which was utilised by the NZ-HWR study, has been shown to be generally suitable and reliable in populations of community dwelling older adults (Hwang et al., 2003). Sleep satisfaction was binned into two categories: dissatisfied (which included dissatisfied and very dissatisfied) and not dissatisfied (inclusive of neither satisfied nor dissatisfied, satisfied, or very satisfied).

Excluded Variables. Initially, analysis was planned to include two additional variables as indicators of sleep disturbance or related sleep health information: prevalence of fatigue/exhaustion, and sleep disorder diagnosis. After beginning preliminary analysis, both variables were removed. While fatigue was intended for use as an indicator of sleep health, it was decided that the source item of the fatigue variable (the Paulson– Lichtenberg Frailty Index (Paulson & Lichtenberg, 2015)) did not have enough specific relevance to sleep health and was more focused on frailty and physiological health. While other potential sleep disturbance indicators were sourced from scales not directly related to sleep health, the source conceptualisation of frailty had unique implications. Some research has found links between fatigue and sleep health characteristics (Åkerstedt et al., 2018), including in older adults (Endeshaw, 2015). However, fatigue can be associated with many aspects of ageing, and can be mediated by other aspects of health such as mood, perception of sleep quality, and overall health (Lavidor et al., 2003). Therefore, it is possible that inclusion of this variable could have led to inaccurate conclusions. This also made it unsuited for regression analysis as it could potentially be conceptually correlated with several external variables (e.g. chronic health conditions, ageing related illness that is outside the scope of this study, etc) and was not purely representative of a sleep health characteristic like the other potential variables were.

Sleep disorder diagnosis information was initially planned to be included as a covariate but was excluded for two reasons. Firstly, while 7.4% of retirees and 5.9% of workers reported being diagnosed with a sleep disorder, there was no indication of disorder type. This heterogeneity may have caused issues in analysis as each sleep disorder may impact sleep health characteristics in different, and potentially contradictory, ways (for example, insomnia compared to hypersomnia, delayed versus advanced sleep phase disorders, sleep disordered breathing may result in compromised or over-compensatory sleep health outcomes, variations in employment structure can mediate experiences of shift work disorders, etc). Secondly, given this was sourced from a section of the diagnosed comorbid conditions variable, only one (i.e. either comorbid condition count *or* sleep disorder diagnoses) could be suited for usage in regression analysis, as using both variables at once may have caused issues with collinearity. Therefore, with the uncertain heterogeneous context of the reported sleep disorder prevalence, the sleep disorder variable was removed in favour of keeping the comorbid conditions covariate as an indicator of overall physical health status.

Alcohol

The 2022 wave of NZ-HWR included four items on alcohol and drinking behaviour. These included the complete AUDIT-C (Babor et al., 2001; Bush et al., 1998) which screens frequency, quantity, and prevalence of binge drinking behaviour to determine the hazardousness of an individual's alcohol consumption, and one additional item added by the HART team as a screening question (history of lifetime drinking). The first item of the AUDIT-C focused on frequency, and asked, "how often do you have a drink containing alcohol?" and gave participants the option to select one of the following answers: *never*, *monthly or less*, *two to four times per month*, *two to three times per week*, or *four or more times a week.*

Following this, an additional item was added by the HART team to screen for history of drinking and lifetime non-drinkers. If participants answered ‘never’ to the frequency item, they were asked “have you ever drunk alcohol in the past?” with the option to select a dichotomous *yes/no* option. If participants selected ‘no’ they were directed to skip the rest of the alcohol items and move to the next section, meaning that quantity was only assessed for participants who had drank alcohol at some point in their lives, regardless of recency. The second item from the AUDIT-C related to quantity and asked, “how many drinks containing alcohol do you have on a typical day when drinking?”. Participants were instructed to select one of the following responses: *1 or 2*, *3 or 4*, *5 or 6*, *7 to 9*, or *10 or more*. The third and final item from the AUDIT-C concerned binge drinking and was not used during analysis as binge drinking was not a focus of this study.

The AUDIT – Concise. Traditional scoring of the AUDIT-C involves combining quantity, frequency, and binge drinking risk into a total score that indicates potential risk of hazardous drinking behaviour. In a clinical setting this is useful, but as this project explored how alcohol impacts sleep, there was a benefit in taking a richer and more nuanced approach. The AUDIT-C total score does not allow a more in-depth examination of how quantity and frequency interact and are often juxtaposed (Szabo, Towers, Sheridan, et al., 2021). Because the AUDIT-C combines the total scores from the quantity, frequency, and binge questions, the total score (higher being indicative of ‘hazardous’ drinking) does not allow for nuance when examining more in-depth patterns of drinking. For example, someone who reports drinking 3-4 drinks four or more times a week with no prevalence of binge drinking would score the same as an individual who has a binge episode of 6 drinks once a month (both scoring moderate risk of 5), even though each hypothetical individual's relationship with alcohol is distinctly different. NZ research has found that both high and low quantity drinking is associated with low to high drinking frequency (Szabo et al., 2021), and that certain demographic characteristics (SES and gender) were found to moderate the likelihood of certain pattern classifications (Szabo et al., 2021). This makes a traditional AUDIT-C scoring method (0-12 scale of the level of hazardous drinking) less useful for analysis because it lacks nuance and compiles multiple aspects of drinking behaviour into a single score. Additionally, NZ research using the traditional AUDIT/AUDIT-C scoring has found a lack of association between alcohol and sleep health in older adults (Gibson et al., 2023; Jones, 2022), and has explicitly suggested that isolated quantity metrics may be better at capturing potential relationships between alcohol and sleep in older adults (Jones, 2022). Fortunately, the AUDIT-C can be further split into two validated derivative measures: the Quantity-Frequency version (AUDIT-QF) where only the first two questions are scored, and the AUDIT-3, where only the third question (binge drinking) is scored.

The AUDIT – Quantity-Frequency Version. The AUDIT-QF can be used as per the typical scoring (adding the scores together as per the AUDIT guidelines) or can use the two items without scoring, enabling evaluation of raw values without additional data processing. This enables quantity-frequency information with significantly more nuance than the simple 'hazardous' drinking risk classification the AUDIT-C provides. Research that lies outside clinical screening (such as this project) benefits from being able to use the available data in multiple ways. Additionally, this project had an ethical duty to acknowledge the time burden placed on participants, and the AUDIT-C scoring categorisation may have resulted in a much smaller sample size as the percentage of participants who would likely score as 'hazardous drinkers' was relatively low. Conceptualising drinking patterns as more complicated than levels of hazard risk enables fulfilment of this ethical duty, alongside a potentially richer examination of the ways older adults drink and how this impacts their sleep health.

Regression analysis methodology required a baseline group for all variables, including alcohol frequency and quantity. The structure of the frequency item meant that the baseline group for alcohol frequency was participants who 'never' drank alcohol. However, alcohol quantity had no such option (there was no inclusion of a zero/no quantity category), so a baseline group needed to be created. To avoid issues conflating alcohol frequency with quantity (and to avoid collinearity in regression analysis), the baseline group for quantity included participants who had drunk in the past (i.e. yes to part drinking history but currently never drank (quantity of zero drinks). This enabled separate analysis of "never" drinkers, and non-current drinkers. Participants who had answered inconclusively (i.e. never drank but drank 7 to 9 drinks per session) had their alcohol data removed from analysis (n=5) (but remain included in the study overall).

Physical and Mental Health Status

The Short Form Survey – 12 Items. The Short Form Survey – 12 items version (SF-12) is a self-report survey that measures the impact of health on everyday life. Based off the SF-36, the SF-12 is condensed to twelve items (Frieling et al., 2013) for usage within larger surveys. Both versions measure outcomes across the same eight domains: limitations in physical activities because of health problems, limitations in social activities because of physical or emotional problems, limitations in usual role activities because of physical health problems, bodily pain, general mental health (psychological distress and well-being), limitations in usual role activities because of emotional problems, vitality (energy and fatigue), and general health perceptions.

The version used by the NZ-HWR study was validated for usage within NZ (Ware et al., 2005), and its brevity makes is more suited for usage within large surveys and older populations. Its content includes twelve items, which cover: self-rated assessment of health, activity level and whether it is limited by health status, problems with work or regular daily activities as a result of physical health, emotional problems/mental health, or pain, an assessment of how often participants felt different emotional, and assessment of proportion of the time that physical health or emotional problems interfered with social activities.

Because of its shorter length, the SF-12 is scored as two components (instead of the eight domains like the SF-36) to calculate the physical component summary (PCS) and the mental component summary (MCS). Scores range from 0-100 and generally, higher scores are associated with better health. The SF-12 PCS and MCS were both scored prior to data access by the HART team, and was scored according to the method of Frieling and colleagues (2013).

Physical Activity. This was determined using a combination of three items. These asked “how often do you take part in sports or activities that are [1] vigorous (e.g., running or jogging, swimming, aerobics), [2] moderately energetic (e.g., gardening, brisk walking), and [3], mildly energetic (e.g., vacuuming, laundry/washing)” (numbering added for clarity). For each level of physical activity participants could select *more than once a week*, *once a week*, *one to three times a month*, or *hardly ever or never*.

Participants who identified as engaging with moderate or vigorous physical activity at least once a week were classified as active, and the remaining were categorised as inactive.

Current Smoking Status. This was calculated through two items. The first was a dichotomous yes/no item asking, "Have you, at any stage of your life, ever been a regular smoker?". The second asked "If you currently consider yourself a regular smoker, how many do you think you would smoke on an average day?", and participants could select ranges of cigarettes smoked per day. Any participant who answered yes and gave a quantity of cigarettes per day was scored as a current smoker. No distinction was made between non-current smokers and people who had never smoked, both categories were scored as 'non-smokers'.

General Health. The count of comorbid conditions participant had was obtained from the item "Please indicate whether a health professional has ever told you that you have any of the following condition". Options for answering included: *no*, *yes* (*in the last 12 months)*, or *yes (prior to the last 12 months)*. The conditions available for responses were: arthritis or rheumatism, disorder of the neck or back (e.g., lumbago, sciatica, chronic back or neck pain, vertebrae or disc problems), diabetes, any other specified disability, heart trouble (e.g., angina or heart attack), high blood pressure or hypertension, depression, a different specified mental illness, respiratory condition (e.g., bronchitis, asthma), sleep disorder, stroke, active or chronic gout, active/chronic hepatitis, cirrhosis or other liver condition, cancer (with space to specify type), and finally, any other specified illness. For the number of comorbid conditions participant had, any condition that had been indicated as diagnosed (regardless of whether it had been in the last 12 months or prior) was included in the count.

Quality of Life. Quality of life was determined through a self-report item asking how participants would rate their quality of life. Answers were in the format of a 5-point Likert scale: *very poor*, *poor*, *neither good nor poor*, *good*, or *very good*. This was sourced from the WHOQOL (Skevington et al., 2004) which is suited for assessment in older adult populations. Participants who answered either ‘very poor’ or ‘poor’ were scored as having poor QOL, and the rest were scored as ‘not poor’.

Work/Retirement Status

A key focus of this study was exploration of how alcohol and sleep behaviours differed by work/retirement status. This stratification was determined through asking participants, “which of the following best describes your current work status?”, and participants could select one of the following options:

- full-time paid work, for an employer;
- part-time paid work, for an employer;
- full-time self-employed paid employment;
- part-time self-employed paid employment;
- flexible work schedule negotiated with employer;
- project or contract work (short term and full time);
- project or contract work (short term and part time);
- fully retired, no paid work;
- full-time homemaker;
- full-time student;

- unable to work due to health or disability issue;
- unemployed and seeking work; or
- other (please specify).

Regarding cohort stratification, retirees were defined as participants who answered the current employment status item with “fully retired, no paid work”, and workers were defined as participants who answered any of the employment options. Any participant who was a homemaker, a student, unemployed, or unable to work was entirely excluded from analysis.

Employment Variables

Job satisfaction and the reported total hours worked per week were included as covariates for the working cohort to enable assessment of how employment could impact alcohol and sleep health. Job satisfaction was assessed through an item on career trajectory: “I am satisfied with the progress I have made toward meeting my overall career goals” (Greenhaus et al., 1990). Participants could select one of the following from a 5-point Likert scale: *disagree*, *somewhat disagree*, *neither agree nor disagree*, *somewhat agree*, or *agree*. Participants who did not work or for whom this did not apply, were able to select “N/A” as an option instead. This enabled examination of job and career satisfaction, as well as trajectory of career path and perception of career plateau as employees were nearing retirement age. For the working only cohort variables, job satisfaction was changed to a binary category. Answers of ‘disagree’ or ‘somewhat disagree’ were categorised as being dissatisfied with one’s job, Answers of ‘neither agree nor disagree’, ‘somewhat agree’, or ‘agree’ were classified as not dissatisfied. Any retirees who answered this item (i.e. it is possible some retirees may have given their assessment of their work satisfaction in possible unpaid/volunteer employment) were changed to be blank, as they had already indicated they worked no hours of paid employment per week.

Hours worked per week was sourced from the NZ-HWR study and the NZLSA. This item asked, “how many hours do you currently work in paid employment per week?”, and participants could answer as an open-ended self-report number of hours. This variable was only used for the working cohort, and their reported total amount of hours values remained unchanged during analysis. For retirees, answers other than zero were changed to zero, as participants had already indicated they did not work any hours of paid employment.

Data Preparation

The initial data cleaning (e.g. checking anomalies and screening for outliers) was done by the HART team before data access was granted. Participant data for the existing cohort was included if both the gender and birthdate given matched the previous records. If birthdate differed by one numeral in any timeframe placement (day, moth or year), participants remained included as long as their gender matched previous records. In cases where participants appeared to put day in the month place (or vice versa), these were corrected, and participants remained included. If gender varied from previous records, it was updated if birthdate matched. The refresh cohort had no previous data records, no exclusion criteria regarding correct information was applied. This prior preparation by the HART team resulted in excluding n=20 participants who had inconclusive demographic data and n=24 who were considered lost to contact, leaving a sample size of 5,514.

Analysis

The methodology of this project did not require participants to have answers for every variable, allowing for restraint around definitions of exclusion criteria and a high retention of initial sample size. However, to ensure key variables did not have a significant portion of missing values, SPSS was used to conduct a missing value analysis. Parametric analysis (Kolmogorov-Smirnov tests) was conducted on all continuous variables to assess skewness, kurtosis, and whether any variables violated the assumption of normal distribution. In cases where the assumption was violated, equivalent non-parametric tests (indicated from here on as NP) were used instead. Histograms were also created to assess distribution.

Univariate analysis was conducted on all variables and was stratified by cohort to separately portray the demographics of the retiree and worker populations. Included statistics were frequency (*n*), percentage, and mean (*SD*) (NP: median (*Mdn)* (interquartile range (*IQR*)). Bivariate analysis was utilised to determine which sleep variables were most associated with the alcohol variables, to finalise which aspects of sleep health and sleep disturbance were the most appropriate to design inferential and multivariate analysis. As both the alcohol variables were categorical, a one-way ANOVA (NP: Kruskal Wallis Test) was utilised for continuous sleep variables, and chi-square tests were utilised for categorical sleep variables. Sleep variables that were significant above the 95% threshold were noted, and the results of analysis were considered alongside conceptual validity to determine which sleep variables remained included. Further bivariate analysis on all variables was conducted to analyse whether there were significant differences between the two cohorts. This included an independent samples t-test (NP: Mann-Whittney U test) for continuous variables, and chi-square distribution tests and contingency tables for the remaining categorical variables by work/retirement status.

Multivariate regression analysis was conducted for each of the finalised dependent (sleep) variables and any variable that was significant for either cohort at the bivariate level. This project utilised hierarchical, block wise entry, meaning that variables were entered in groups (known as 'blocks') and the entry order of these blocks was determined by the researcher. This method of regression requires analysing and reporting every model iteration, which enabled examination of changes to results throughout the stages, alongside the ability to examine how different covariates impacted the relationship between alcohol and sleep. The blocks were categorised by variable type: demographic and independent variable (alcohol), physical health covariates, mental health covariates, and employment covariates (analysis was conducted only for workers). Both binary logistic (for categorical indicators of sleep disturbance) and linear regression (for continuous/scale indicators of sleep disturbance) were conducted according to Field's (2009) method.

Both regression methods (linear and logistic) required formatting all categorical variables into a binary dichotomy format (Field, 2009). This process was outlined for all demographic, sleep, and covariate variables in previous sections of this chapter. However, alcohol quantity and frequency were purposefully conceptualised and defined as ordinal multinominal categorical variables. Fortunately, as each alcohol variable's answer categories were mutually exclusive (i.e. participants could only pick one answer per variable), indicator coding (colloquially known as 'dummy' coding)

(Field, 2009) was utilised to enable each alcohol variable (quantity, frequency) could function as a set of related and mutually exclusive binary categories.

Logistic regression required a baseline group and exposure group(s) for each categorical variable, and linear regression requires ≥1 unit difference for all variables (continuous variables naturally already had a range of units, and for categorical variables this unit was defined as the difference between baseline and exposure). The baseline for all categorical variables included in regression was set as either the majority category (for nominal variables (i.e. *female* for gender, *non-Māori* for ethnicity)) or the category generally associated with less poor health outcomes (for ordinal variables, e.g. non-drinkers for alcohol quantity, *never* for alcohol frequency, *not dissatisfied* for sleep satisfaction, *not poor* for quality of life assessment, etc)). Exposure conditions for categorical variables were any category not previously selected as the baseline. All continuous variables remain unchanged from their proposed scoring as baselines were not required and they already contained the relevant units required to model regression trends (e.g. one year for age, a score increase of 1 for the ELSI-SF, etc). All statistical analysis was conducted using Statistical Package for the Social Sciences (SPSS) (International Business Machines Corporation (IBM), version 31.0.2.0 (126)). Construction of forest plots visualising logistic regression results was done using Microsoft Excel (Microsoft Excel for Microsoft 365 (Version 2510, Build 16.0.19328.20266)).

Results

This study aimed to investigate the relationship that alcohol quantity and frequency have with sleep health characteristics, and how this differed between older adults who were retired, versus those who were still working. Descriptive statistical summaries are given for sleep, alcohol, and demographic variables (as well as any notable covariates) for both retirees and workers. Parametric testing and bivariate analysis were conducted to determine the most appropriate variables for multivariate analysis. After this, linear and logistic regression analyses were conducted using a hierarchical block wise method with separate models for the retired and the working cohorts.

Excluded Data

Of the 5,514 original participants, 4,823 participants remained included in the study. In total, 691 participants were excluded based on the following criteria: being under the minimum age of 55 years (*n*=2), and those who did not fit within definitions of employment (for this study), including those who were fulltime homemakers (*n*=139) or students (*n*=8), unemployed (*n*=69), unable to work (due to health or disability) (*n*=186), specified other when asked about employment status (n=93), and participants who did not answer the employment status item (*n*=195).

Of remaining participants, 36.78% (*n*=1774) identified as “retired” and did not work any hours of paid employment per week. The other 64.28% (*n*=3049) identified themselves as working. This included both full time and part time work, as well as a mix of employment types including traditional employment, self-employment, or flexible/contract work (see Table 1). More than half of the workers (59.73%) identified as being employed full time.

Table 1

Distribution of Current Work Status Categories for the Working Cohort

Work Status	*n*=3049	%
Paid work for an employer		
Full time	1451	47.59
Part time	686	22.50
Self-employed paid employment		
Full time	328	10.76
Part time	342	11.22
Flexible work schedule negotiated with employer	92	3.02
Project or contract work short term and		
Full time	42	1.38
Part time	108	3.54

Missing Value Analysis

None of the variables were missing more than 15% of their values, which is within the generally acceptable 5-20% range (Yeatts & Martin, 2015) so no additional datasets were excluded from analysis (the table of data missing for each variable per cohort and combined can be found in Appendix A). Majority of the variables were missing less than five percent of their values which is considered highly acceptable in surveys using large samples (Yeatts & Martin, 2015). The SF-12 PCS and MCS, current smoking status, and job satisfaction were the only variables missing between five to ten percent of their data per cohort. When considering missing data, it is important to evaluate the context of why data may be missing. Given both the SF-12 variables were calculated from other survey items, some missing values are not unexpected if participants lacked answers that were required for scoring. Smoking status was missing similar proportions for each cohort, so this was also deemed acceptable. The only variable that had more than 10% of its data missing per cohort was alcohol quantity, which was only relevant for participants who drank alcohol at frequencies higher than 'never', meaning a higher proportion of missing data was also to be expected.

Parametric Analysis

Parametric analysis for all linear variables was conducted using Kolmogorov Smirnov tests (see Table 2). The *p* values for all the continuous variables indicated a violation of the assumption of normality (≥.05), meaning that all bivariate analysis on continuous variables was conducted using non-parametric equivalent tests.

Table 2

Kolmogorov Smirnov Tests for Continuous Sleep, Demographic, and Covariate Variables

Variable	*D*	*df*	*p*	Skewness (*SE*)	Kurtosis (*SE*)
Duration (hours)					
Retired	0.184	1552	**<.001**	1.00 (0.06)	4.61 (0.12)
Working	0.184	2685	**<.001**	1.12 (0.05)	9.03 (0.09)
Total	0.188	4237	**<.001**	1.10 (0.04)	6.90 (0.08)
Age (years)					
Retired	0.093	1552	**<.001**	0.31 (0.06)	-0.44 (0.12)
Working	0.102	2685	**<.001**	0.96 (0.05)	1.46 (0.09)
Total	0.123	4237	**<.001**	0.77 (0.04)	0.10 (0.08)
ELSI -SF					
Retired	0.161	1552	**<.001**	-1.55 (0.06)	2.70 (0.12)
Working	0.147	2685	**<.001**	-1.42 (0.05)	2.28 (0.09)
Total	0.152	4237	**<.001**	-1.47 (0.04)	2.43 (0.08)
SF-12 PCS					
Retired	0.092	1552	**<.001**	-0.71 (0.06)	-0.24 (0.12)
Working	0.121	2685	**<.001**	-1.10 (0.05)	0.88 (0.09)
Total	0.114	4237	**<.001**	-1.00 (0.04)	0.50 (0.08)
Comorbidities (count)					
Retired	0.141	1552	**<.001**	0.75 (0.06)	0.58 (0.12)
Working	0.174	2685	**<.001**	0.95 (0.05)	0.97 (0.09)
Total	0.163	4237	**<.001**	0.88 (0.04)	0.79 (0.08)
SF-12 MCS					
Retired	0.128	1552	**<.001**	-1.25 (0.06)	1.45 (0.12)
Working	0.111	2685	**<.001**	-1.16 (0.05)	1.56 (0.09)
Total	0.117	4237	**<.001**	-1.20 (0.04)	1.53 (0.08)
Work Hours (p/w)					
Working	0.194	2685	**<.001**	-0.38 (0.05)	0.09 (0.09)

Note. ELSI-SF: Economic Living Standard Index – Short Form; SF-12 PCS: Short Form Survey – 12 item physical component summary; SF-12 MCS: Short Form Survey – 12 item mental component summary; p/w: per week. *p* values ≤.05 are bolded.

Descriptive Statistics

This section contains information on averages and proportions of each cohort within each variable. Histograms for key continuous variables (sleep duration, work hours per week) are also presented. The final set of sleep variables (functioning as indicators of sleep disturbance for multivariate analyses) was not determined until after exploratory bivariate analysis. Therefore, some sleep variables were excluded partway through the bivariate stage because they were not significantly associated with either alcohol quantity or frequency. This exclusion stage occurred after the initial descriptive statistics, but before analysis of statistically significant distribution and proportions within each cohort per variable. Consequently, this analysis of observed versus expected distributions cannot be presented alongside the descriptive statistics because the tests were not conducted on every initially included sleep variable. For this reason, tests of distribution and proportion for each cohort (i.e. Mann-Whitney U Tests and chi-square tests) will be presented separately and can be found later in the chapter within the bivariate analysis section. Any discussion of cohort proportions/differences in the current univariate section is based entirely on averages or percentages and does not indicate statistical comparison of observed versus expected distributions.

Demographics

The median age for the working cohort indicated an unsurprising trend of ‘younger’ older adults, compared to the retired ‘older’ older adults (see Table 3). Both groups also had similar ELSI-SF scores (indicative of SES). More retirees were non-Māori than workers. There was a higher proportion of females than males across both groups (57.3% of the retied group were female, compared to 54% of the working group).

Table 3

Descriptive Statistics for Demographic Variables (by Work/Retirement Status)

	Retired			Working			Total		
Variable	*n*	%	*Mdn* (*IQR*)	*n*	%	*Mdn* (*IQR*)	*n*	%	*Mdn* (*IQR*)
Age	1774		71 (67-77)	3049		62 (59-65)	4823		65 (61-71)
Gender	1769			3049			4818		
Tāne/Male	756	42.74		1404	46.05		2160	44.83	
Wāhine/Female	1013	57.26		1645	53.95		2658	55.17	
Gender diverse [a]	3	-					3	-	
Ethnicity	1742			3005			4747		
Māori	490	28.13		1148	38.20		1638	34.51	
Pacific peoples	8	0.46		40	1.33		48	1.01	
Asian	13	0.75		45	1.50		58	1.22	
NZ European	1151	66.07		1621	53.94		2772	58.39	
Other	80	4.59		151	5.02		231	4.87	
ELSI-SF	1731		26 (22-29)	2991		26 (22-29)	4722		26 (22-29)

Note. ELSI-SF: Economic Living Standard Index – Short Form.

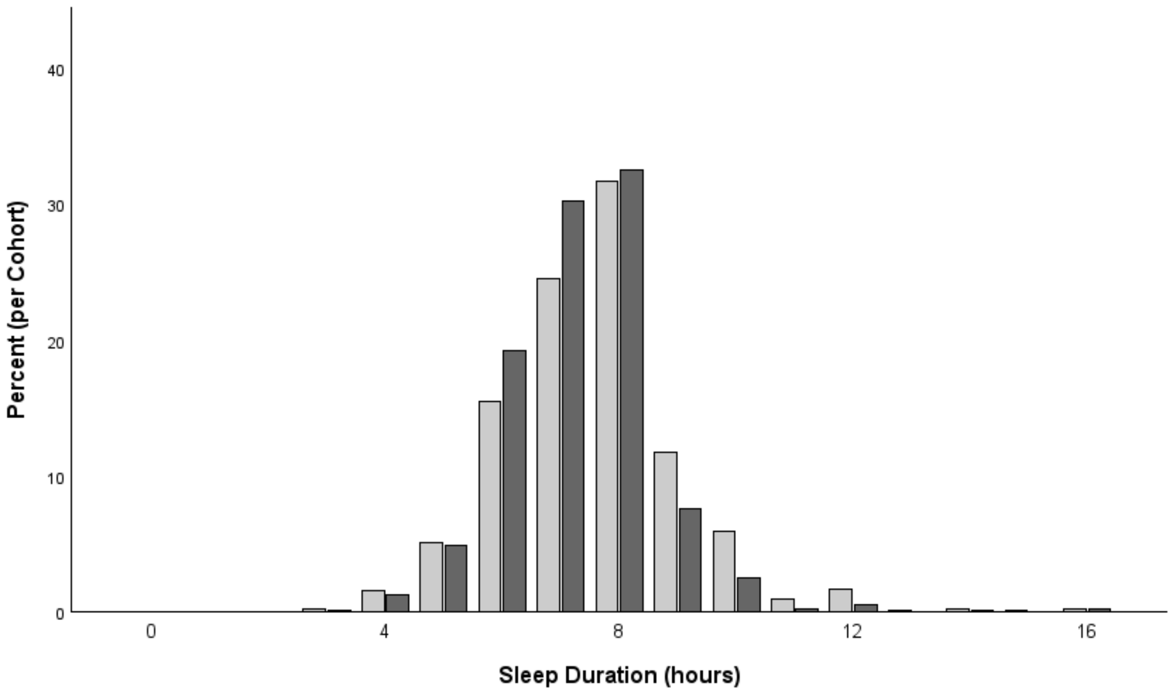
[a] Participants who identified as gender diverse had their gender data removed from analysis (as indicated by the dash) because the sample size (*n*=3) was not large enough to conduct meaningful analysis.

Sleep

The median sleep duration was an hour shorter (7 hours) for the working cohort than for retirees (8 hours), and workers reported within a slightly lower IQR than retirees (see Table 4). Comparison of distributions between cohorts is visualised in Figure 2.

Figure 2

Distribution of Sleep Duration (hours) for Retirees (Light Grey) and Workers (Dark Grey)



Note. Light grey indicates retirees (*n*= 1725), and dark grey indicates workers (*n*=2987). To maintain readability, duration was binned as full hours (rounded down) and durations >16 hours (retirees *n*=4, workers *n*=3) were excluded visually (but remained included in analyses).

For sleep satisfaction, while the proportion was slightly higher for workers, approximately a quarter of each cohort reported being dissatisfied with their sleep. Similarly, around a third of participants in both cohorts reported substantial sleep problems (but was slightly higher in retirees). Frequent restless sleep was reported in just over a third of both cohorts. Frequent daytime sleepiness was very rare, only 1.8% of retirees and 3.9% of workers reported experiencing it more than once a week.

Table 4

Descriptive Statistics for Indicators of Sleep Variables (by Work/Retirement Status)

	Retired			Working			Total		
Variable	*n*	%	*Mdn* (*IQR*)	*n*	%	*Mdn* (*IQR*)	*n*	%	*Mdn* (*IQR*)
Sleep Duration	1729		8 (7-8)	2990		7 (6.5-8)	4719		7 (7-8)
Restless Sleep	1759			3026			4785		
Frequent	610	34.70		1052	34.80		1662	34.70	
Infrequent	1149	65.30		1974	65.20		3123	65.30	
Satisfaction	1771			3035			4806		
Not dissatisfied	1361	76.85		2209	72.78		3570	74.28	
Dissatisfied	410	23.15		826	27.22		1236	25.72	
Problems	1752			3012			4764		
Not substantial	1136	64.84		2077	68.96		3213	67.44	
Substantial	616	35.16		935	31.04		1551	32.56	
Daytime Sleepiness	1755			3017			4772		
Frequent	31	1.80		118	3.90		149	3.10	
Infrequent	1724	97.20		2899	96.10		4623	96.90	

Alcohol

The vast majority of both retirees (95.12%) and workers (96.43%) had drunk alcohol at some point in their lives (i.e. they were not lifetime 'non-drinkers') (see Table 5). Furthermore, 81.54% of retirees and 85.54% of workers identified as 'current drinkers' (i.e. reported a frequency other than 'never'). Compared to retirees, the working cohort had a larger proportion of participants who reported higher levels of alcohol consumption (>6 drinks). However, this accounted for only a small portion of the sample, and the majority of both cohorts reported typically drinking 1 or 2 standard drinks on days where they drank alcohol.

Table 5

Descriptive Statistics for Alcohol Quantity and Frequency (by Work/Retirement Status)

	Retired		Working		Total	
Alcohol Variable	*n*=1774	%	*n*=3049	%	*n*=4823	%
Quantity	1516		2680		4196	
Non-drinkers (lifetime) [a]	74	4.88	96	3.58	170	4.05
1-2 standard drinks	1121	73.94	1714	63.96	2835	67.56
3-4 standard drinks	217	14.31	534	19.93	751	17.90
5-6 standard drinks	55	3.63	213	7.95	268	6.39
7-9 standard drinks	26	1.72	73	2.72	99	2.36
≥10 standard drinks	23	1.52	50	1.87	73	1.74
Frequency	1763		3037		4800	
Never (non-current) [b]	327	18.55	439	14.46	766	15.96
≤1 time p/month	368	20.87	639	21.04	1007	20.98
2-4 times p/month	277	15.71	579	19.06	856	17.83
2-3 times p/week	363	20.59	737	24.27	1100	22.92
≥4 times p/week	428	24.28	643	21.17	1071	22.31

Note. p/month: per month; p/week: per week.

[a] Quantity baseline category ‘non-drinker (lifetime)’ refers to participants who had abstained from alcohol from their entire lifetime.

[b] Frequency baseline category ‘never (non-current)’ refers to participants who typically never drank alcohol (i.e. current non-drinkers).

Covariates

While the SF-12 MCS was similar across the cohorts, the retired cohort had worse physical health (SF-12 PCS) (see Table 6). Similarly, on average the retired cohort had one more diagnosed comorbid condition than their younger working counterparts. More workers were current smokers. The working cohort was less physically active than their retired peers and reported slightly lower median self-rated QOL. The majority of workers (92.8%) were not dissatisfied with their job. The IQR for work hours reflects the fact that approximately 40% of the sample did not identify as working full time. Distribution of the number of hours worked per week for the working cohort (n=2921) shows there was some range in the reported time spent working with 69.5% of workers reporting working at least 30 hours per week. Additionally, 31.1% of workers who stated weekly total work hours reported working the traditional 40-hour work week (see Figure 3). This figure also shows that 1.6% (*n*=48) of workers identified as working zero hours per week while currently employed.

Table 6

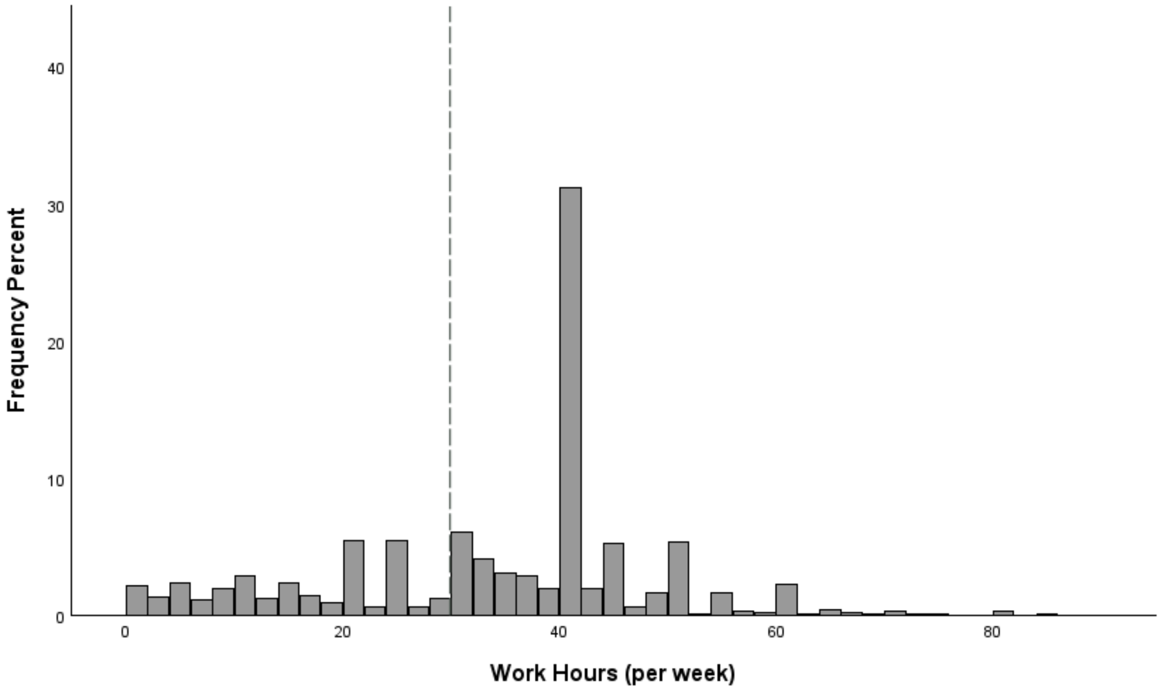
Descriptive Statistics for Covariate Variables (by Work/Retirement Status)

	Retired			Working			Total		
Variable	*n*	%	*Mdn* (*IQR*)	*n*	%	*Mdn* (*IQR*)	*n*	%	*Mdn* (*IQR*)
				Physical Health					
SF-12 PCS	1620		45.55 (35.30-53.01)	2892		50.67(42.7-55.05)	4512		49.15 (39.97-54.49)
Physical activity	1764			3037			4801		
Inactive	417	23.64		587	19.33		1004	20.91	
Active	1347	76.36		2450	80.67		3797	79.09	
Smoking status	1621			2776			4397		
Current	100	6.17		248	8.93		348	7.91	
Non-smoker	1521	93.83		2528	91.07		4049	92.09	
Comorbidities (count)	1774		3 (1-4)	3049		2 (1-3)	4823		2 (1-4)
				Mental Health					
Quality of life	1771			3046			4817		
Poor	95	5.36		85	2.79		180	3.74	
Not poor	1676	94.64		2961	97.21		4637	96.26	
SF-12 MCS	1620		53.09 (45.01-57.44)	2892		52.46 (44.62-56.63)	4512		52.58 (44.81-56.83)
				Employment					
Job Satisfaction				2833					
Dissatisfied				203	7.17				
Not Dissatisfied				2630	92.83				
Work hours (p/w)				2921		40.00 (24.00-40.00)			

Note. SF-12 PCS: Short Form Survey – 12 item physical component summary; SF-12 MCS: Short Form Survey – 12 item mental component summary; p/w: per week.

Figure 3

Histogram of Reported Weekly Work Hours for the Working Cohort (n=2921)



Note. The light grey vertical dashed line set at 30 hours indicates the generally accepted lower limit of fulltime work within NZ (Employment New Zealand, 2026).

Bivariate Analysis

Initially, several sleep variables were included to enable flexibility regarding which sleep characteristics would act as indicators of sleep disturbance for the focus of this study. Therefore, exploratory bivariate analysis was conducted to determine which sleep variables were most significantly and consistently associated with the independent variables pertaining to alcohol, after which analysis also checked correlation with the demographic variables.

Indicators of Sleep Disturbance

Analysis of the distribution between the categorical sleep variables and the (categorical) alcohol variables was conducted using chi-squares (see Table 7, the full set of the accompanying contingency tables can be found in Appendix B). Daytime sleepiness was not associated with alcohol for either cohort or for the total sample. This was due to lower than minimum cell counts (<5) for some categories in both the alcohol variables, and the generally low proportion of participants who reported experiencing frequent daytime sleepiness (1.8% or retirees, 3.9% of workers). Additionally, given that the non-drinkers baseline category for quantity was comprised of one participant from each cohort, it was deemed that the daytime sleepiness variable was unsuited for regression analysis, so it was removed from analysis at this time.

The association between alcohol and the remaining sleep variables were all significant for the working cohort. For retirees, alcohol frequency was not associated with any variables, and alcohol quantity was associated with everything except sleep satisfaction. Because all the Cramer's *V* values were within a similar range (below 0.2), dependent variable selection was mainly based around *p* values, but further analysis was conducted on demographic variables to ascertain potentially meaningful relationships.

Mann-Whitney U tests were used to examine how the categorical sleep variables (i.e. restless sleep, sleep satisfaction, and sleep problems) were associated with continuous demographic variables (see Table 8). Analysis of the continuous sleep variable (i.e. sleep duration) and categorical demographic and alcohol variables was conducted using the Kruskal-Wallis test. Analysis of two continuous variables (e.g. sleep duration and age) were conducted via bivariate correlation using Spearman's Rho (these results of tests can also be found in Table 8).

The results of these tests showed that the different definitions of sleep disturbance varied significantly by age and SES, and this variation was within a similar range. Restless sleep had slightly more significant associations with variables, however, the item in question used a frequency based 4-point Likert scale that was not very linear regarding the time distinctions across the range of the scale. While this is not grounds for immediate exclusion, given the general conceptual similarity to sleep problems and the similar rate of significant association, it was excluded in favour of using sleep problems and sleep satisfaction as categorical variables and using sleep duration as the only continuous linear variable.

Table 7

Chi-square Tests for Categorical Alcohol and Sleep Variables (by Work/Retirement Status)

		Retired				Working				Total			
Variable	*df*	*n*	X^2	*p*	*V*	*n*	X^2	*p*	*V*	*n*	X^2	*p*	*V*
Alcohol Frequency													
Restless Sleep	4	1748	1.49	.828	0.03	3014	18.76	**<.001**	0.08	4762	9.23	.056	0.04
Sleep Satisfaction	4	1762	3.19	.526	0.04	3027	15.58	**.004**	0.07	4789	4.65	.326	0.03
Sleep Problems	4	1741	2.89	.577	0.04	3000	30.22	**<.001**	0.10	4741	21.11	**<.001**	0.07
Daytime Sleepiness	4	1746	2.64	.620	.039	3009	3.625	.459	0.35	4755	1.735	.781	.019
Alcohol Quantity													
Restless Sleep	5	1504	17.16	**.004**	0.11	2662	12.74	**.026**	0.07	4166	24.74	**<.001**	0.08
Sleep Satisfaction	5	1515	9.00	.109	0.08	2670	15.41	**.009**	0.08	4185	17.84	**.003**	0.07
Sleep Problems	5	1496	13.79	**.017**	0.10	2649	26.95	**<.001**	0.10	4145	33.53	**<.001**	0.09
Daytime Sleepiness	5	1505	3.12	.681	0.46	2657	4.021	.546	0.39	4162	6.602	.252	0.04

Note. *p* values ≤.05 are bolded.

Table 8

Bivariate Analysis of Sleep Variables and Alcohol, Demographic, and Health Variables by Statistical Test (by Work/Retirement Status)

Variable	Retired			Working			Total		
Kruskal Wallis	*H*	*df*	*p*	*H*	*df*	*p*	*H*	*df*	*p*
Sleep duration									
Alcohol Frequency	2.462	4	.651	16.954	4	**.002**	14.861	4	**.005**
Alcohol Quantity	2.698	5	.746	9.314	5	.097	14.84	5	**.011**
Gender	11.186	2	**.004**	1.545	1	.214	7.855	2	**.020**
Ethnicity	8.901	4	.064	13.866	4	**.008**	22.752	4	**<.001**
Spearman Correlation	*ρ*	*n*	*p*	*ρ*	*n*	*p*	*ρ*	*n*	*p*
Sleep Duration									
Age	0.044	1729	.065	0.031	2990	.093	0.088	4719	**<.001**
ELSI-SF	0.065	1691	**.007**	0.089	2934	**<.001**	0.081	4625	**<.001**
Mann-Whittney U	*U*	*z*	*p*	*U*	*z*	*p*	*U*	*z*	*p*
Restless Sleep									
Age	320645.5	-2.94	**.003**	923364.5	-5.04	**<.001**	2384720	-4.63	**<.001**
ELSI -SF	245641.5	-9.09	**<.001**	786910.5	-9.66	**<.001**	1912562	-13.19	**<.001**
Sleep Satisfaction									
Age	250930	-3.10	**.002**	793292.5	-5.55	**<.001**	1921135	-6.79	**<.001**
ELSI -SF	221961	-5.00	**<.001**	735926.5	-7.00	**<.001**	1771035	-8.62	**<.001**
Sleep Problems									
Age	341298.5	-0.85	.395	913588.5	-2.61	**.009**	2472228	-0.44	.661
ELSI -SF	230042.5	-10.58	**<.001**	644867.5	-13.7	**<.001**	1649875	-17.28	**<.001**

Note. ELSI-SF: Economic Living Standard Index – Short Form. *p* values ≤.05 are bolded.

Work/Retirement Status

Further bivariate analysis was conducted on the remaining included variables to examine the distribution and direction of associations between variables and retirees and workers. Continuous variables were examined using Mann-Whitney U tests, and categorical variables were examined using chi-squares and contingency tables to explore how the observed distributions and proportions differed from expected values.

Mann-Whitney U Tests

Mann Whitney-U tests of key continuous variables stratified by cohort showed that, while the retired group had slightly higher SES status than workers, this was not significantly different between groups (see Table 9). Retirees had significantly worse physical health than their working counterparts (indicated by the SF-12 PCS). Compared to workers, the retired cohort was significantly older, slept significantly longer, had significantly worse SF-12 physical health scores, significantly more diagnosed comorbid conditions, and had significantly better SF-12 mental health scores.

Table 9

Mann Whittney U Tests (Continuous Variables) Comparing Differences in Distribution and Central Tendency Between Retirees and Workers

			M Rank			
Variable	*U*	*Z*	Retired	Working	Δ [a]	*p*
Sleep Duration	2282909	-6.886	2534.64	2259.01	275.63	**<.001**
Age	710927	-42.804	3535.75	1758.17	1777.58	**<.001**
ELSI-SF	2577949	-0.239	2367.72	2357.9	9.82	.811
SF-12 PCS	1751968	-14.07	1891.96	2460.7	-568.74	**<.001**
Comorbidities	2208835	-10.788	2691.38	2249.45	441.93	**<.001**
SF-12 MCS	2238356	-2.482	2320.8	2220.48	100.32	**.013**

[a] Mean rank change was calculated by [Retired Mean Rank] - [Working Mean Rank] = Δ, meaning positive values indicate the retired cohort had higher average scores. *p* values ≤.05 are bolded.

Chi Square Distribution Tests

All categorical variables were significantly associated with work/retirement status (see Table 10 for chi-square test results, the full list of the accompanying contingency tables can be found in Appendix C). While all the effect sizes were weak (>.1), using standardised residuals (SRs) can highlight where the associations lie within interactions between the variables. A SR of >1.96 (95% CI) shows observed results significantly different from expected.

Table 10

Chi Square Tests Comparing Categorical Variables and Work/Retirement Status

Variable	*df*	*n*	X^2	*p*	ϕ	*V*
Sleep Satisfaction	1	4806	9.674	**.002**	-.045	
Sleep Problems	1	4764	8.552	**.003**	.042	
Gender	1	4818	4.965	**.026**	-.032	
Binary Ethnicity	1	4747	49.524	**<.001**	-.102	
Alcohol Quantity	5	4196	68.512	**<.001**		.128
Alcohol Frequency	4	4800	30.157	**<.001**		.079
Physical Activity	1	4801	12.54	**<.001**	. 051	
Smoking Status	1	4397	10.733	**.001**	-.049	
Quality of Life	1	4817	20.62	**<.001**	.065	

Note. p values ≤.05 are bolded.

Examining SRs shows that less retirees reported being dissatisfied with their sleep than expected. For ethnicity, Māori were significantly less likely to be in the retired group compared to non-Māori. Regarding alcohol quantity, retirees were significantly more prevalent in the 1-2 drinks category, and significantly less prevent in the 3-4 and 5-6 drink categories. Workers were significantly less prevalent in the 1-2 drink category, and more present in the 3-4 and 5-6 drink categories. For alcohol frequency, retirees were significantly more likely to never drink (inversely, workers were significantly more likely to *not* never drink). Retirees were also significantly less prevalent in the 2-4 times per month and 2-3 times per week categories. Retirees were significantly more likely to be inactive when compared to expected results. They were also more likely to report not currently smoking. Regarding quality of life, retires were significantly more prevalent in the poor quality of life category, and workers were significantly less prevalent in the same category. Sleep problems and gender both had no values that were significantly different from expected.

Multivariate Regression Analysis

Examination of the relationship between sleep and alcohol was conducted using three sets of regression analysis for both retired and working groups (whilst controlling for demographic and physical health, mental health and work-based covariates). Given the variable type, sleep duration was examined using hierarchical multiple linear regression, while sleep satisfaction and sleep problems were examined using hierarchical binary single-level logistic regression models. For all models, variables were entered into the models in blocks (see Table 11), categorised by variable types and relevant areas of health to allow for the examination of goodness-of-fit changes throughout the process. Additionally, to avoid issues in analysis, covariates relating to employment were further isolated only for the working cohort, meaning the final models for retirees and workers would be for blocks 3 and 4, respectively.

Table 11

Organisation of Hierarchical Blocks in Regression Analysis

Block	Categorisation	Variables
1	Demographics and Alcohol	Age, gender, ethnicity, ELSI-SF, alcohol quantity, alcohol frequency
2	Physical Health	SF-12 PCS, physical activity, current smoking status, comorbidities (count)
3	Mental Health	Quality of life, SF-12 MCS
4	Employment [a]	Job Satisfaction, work hours (weekly)

[a] Block 4 was only applied to the working cohort.

Sleep Duration

The results of hierarchical linear regression for sleep duration can be found in Table 12 for retirees (models 1 to 3), and Table 13a and b for workers (models 1 to 4).

Alcohol. For retirees, drinking 3-4 drinks on a typical occasions when drinking was negatively associated with sleep duration, indicating shorter sleep duration in this group compared to the baseline group (i.e. those who never drank), and this became significant after controlling for physical and mental health characteristics (the B value of 0.55 indicates this was 33 minutes shorter than for those who never drank). However, alcohol frequency was not associated with sleep duration for retirees.

For workers, drinking once a month or less was negatively associated with sleep duration, meaning participants who drank less regularly had shorter sleep (by approximately 17 minutes) than those who never drank and those who drank more. None of the other alcohol variables were significantly associated with sleep duration for either cohort.

Table 12

Hierarchical Linear Regression Models for Sleep Duration (Retired Cohort (n=1208) – Models 1-3)

	Model 1					Model 2					Model 3				
Variables	*B*	95% CI	*SE*	β	*p*	*B*	95% CI	*SE*	β	*p*	*B*	95% CI	*SE*	β	*p*
Constant	6.84	[5.74, 7.95]	0.56		**<.001**	7.58	[6.32, 8.83]	0.64		**<.001**	7.42	[6.06, 8.79]	0.69		**<.001**
Age	0.01	[-0.01, 0.02]	0.01	0.04	.201	0.01	[-0.01, 0.02]	0.01	0.02	.456	0.00	[-0.01, 0.02]	0.01	0.02	.527
Gender (male)	0.21	[0.03, 0.39]	0.09	0.07	**.020**	0.23	[0.05, 0.40]	0.09	0.08	**.011**	0.22	[0.05, 0.4]	0.09	0.07	**.013**
Ethnicity (Māori)	-0.02	[-0.22, 0.19]	0.10	0.00	.887	-0.05	[-0.25, 0.16]	0.10	-0.01	.651	-0.05	[-0.25, 0.16]	0.10	-0.01	.651
ELSI-SF	0.01	[-0.01, 0.03]	0.01	0.04	.173	0.02	[0.00, 0.04]	0.01	0.07	**.028**	0.02	[0.00, 0.04]	0.01	0.06	.073
AQ (1-2)	-0.38	[-0.87, 0.11]	0.25	-0.11	.127	-0.35	[-0.84, 0.14]	0.25	-0.10	.160	-0.36	[-0.84, 0.13]	0.25	-0.10	.154
AQ (3-4)	-0.54	[-1.09, 0.01]	0.28	-0.12	.127	-0.54	[-1.08, 0.01]	0.28	-0.12	.054	-0.55	[-1.09, 0.00]	0.28	-0.12	**.050**
AQ (5-6)	-0.40	[-1.09, 0.29]	0.35	-0.05	.127	-0.44	[-1.13, 0.25]	0.35	-0.05	.215	-0.44	[-1.13, 0.25]	0.35	-0.05	.216
AQ (7-9)	0.20	[-0.59, 1.00]	0.40	0.02	.127	0.15	[-0.65, 0.95]	0.41	0.01	.708	0.15	[-0.66, 0.95]	0.41	0.01	.719
AQ (≥10)	-0.61	[-1.40, 0.17]	0.40	-0.05	.127	-0.65	[-1.44, 0.13]	0.40	-0.06	.101	-0.64	[-1.43, 0.14]	0.40	-0.05	.107
AF (≤1 time p/m)	0.27	[-0.09, 0.63]	0.18	0.07	.127	0.26	[-0.10, 0.61]	0.18	0.07	.163	0.26	[-0.1, 0.61]	0.18	0.07	.162
AF (2-4 times p/m)	0.11	[-0.26, 0.49]	0.19	0.03	.127	0.12	[-0.25, 0.50]	0.19	0.03	.517	0.14	[-0.24, 0.51]	0.19	0.03	.481
AF (2-3 times p/w)	0.03	[-0.33, 0.39]	0.18	0.01	.127	0.03	[-0.34, 0.39]	0.19	0.01	.893	0.04	[-0.33, 0.4]	0.19	0.01	.849
AF (≥4 times p/w)	0.23	[-0.12, 0.59]	0.18	0.07	.127	0.23	[-0.13, 0.59]	0.18	0.07	.203	0.24	[-0.12, 0.59]	0.18	0.07	.194
SF-12 PCS						-0.01	[-0.02, 0.00]	0.01	-0.11	**.005**	-0.01	[-0.02, 0.00]	0.01	-0.11	**.005**
PA (inactive)						-0.02	[-0.26, 0.23]	0.12	-0.01	.892	0.02	[-0.23, 0.27]	0.13	0.00	.900
Smoking (current)						0.48	[0.09, 0.88]	0.2	0.07	**.017**	0.50	[0.10, 0.90]	0.20	0.07	**.014**
Comorbidities (n)						-0.04	[-0.09, 0.01]	0.03	-0.05	.134	-0.03	[-0.09, 0.02]	0.03	-0.04	.212
QOL (poor)											-0.07	[-0.54, 0.40]	0.24	-0.01	.765
SF-12 MCS											0.01	[-0.01, 0.02]	0.01	0.03	.316
Fit	R^2= .02, p= .061					R^2= .03, ΔR^2= .01, p= **.004**					R^2= .03, ΔR^2= 0, p= .516				

Note. ELSI-SF: Economic Living Standard Index – Short Form; AQ: alcohol quantity; AF: alcohol frequency; p/month: per month; p/week: per week; Short Form Survey – 12 item physical component summary; PA: physical activity; QOL: quality of life; SF-12 MCS: Short Form Survey – 12 item mental component summary. *p* values ≤.05 are bolded.

Table 13a

Hierarchical Linear Regression Models for Sleep Duration (Working Cohort (n=2014) – Models 1-2)

	Model 1					Model 2				
Variables	*B*	95% CI	*SE*	β	*p*	*B*	95% CI	*SE*	β	*p*
Constant	7.39	[6.51, 8.27]	0.45		**<.001**	7.30	[6.32, 8.28]	0.5		**<.001**
Age	0.00	[-0.01, 0.01]	0.01	-0.01	.800	0.00	[-0.01, 0.01]	0.01	0.00	.854
Gender (male)	-0.01	[-0.13, 0.11]	0.06	-0.01	.833	-0.01	[-0.13, 0.11]	0.06	0.00	.911
Ethnicity (Māori)	0.07	[-0.06, 0.19]	0.06	0.03	.293	0.08	[-0.04, 0.21]	0.07	0.03	.195
ELSI-SF	0.01	[0.00, 0.02]	0.01	0.04	.083	0.01	[-0.01, 0.02]	0.01	0.02	.336
AQ (1-2)	0.01	[-0.36, 0.38]	0.19	0.00	.955	0.03	[-0.34, 0.40]	0.19	0.01	.877
AQ (3-4)	-0.18	[-0.57, 0.21]	0.20	-0.05	.373	-0.16	[-0.56, 0.23]	0.20	-0.05	.417
AQ (5-6)	-0.34	[-0.75, 0.08]	0.21	-0.07	.116	-0.31	[-0.73, 0.11]	0.21	-0.06	.148
AQ (7-9)	-0.24	[-0.76, 0.28]	0.27	-0.03	.359	-0.19	[-0.71, 0.33]	0.27	-0.02	.477
AQ (≥10)	-0.16	[-0.70, 0.39]	0.28	-0.02	.578	-0.12	[-0.67, 0.44]	0.28	-0.01	.679
AF (≤1 time p/m)	-0.32	[-0.58, -0.06]	0.13	-0.10	**.014**	-0.32	[-0.57, -0.06]	0.13	-0.10	**.017**
AF (2-4 times p/m)	-0.2	[-0.46, 0.06]	0.13	-0.06	.133	-0.21	[-0.47, 0.05]	0.13	-0.07	.109
AF (2-3 times p/w)	-0.15	[-0.40, 0.10]	0.13	-0.05	.245	-0.17	[-0.42, 0.09]	0.13	-0.06	.200
AF (≥4 times p/w)	-0.09	[-0.35, 0.17]	0.13	-0.03	.508	-0.10	[-0.36, 0.16]	0.13	-0.03	.462
SF-12 PCS						0.00	[-0.01, 0.01]	0.00	0.02	.549
PA (inactive)						0.03	[-0.13, 0.18]	0.08	0.01	.754
Smoking (current)						0.08	[-0.14, 0.30]	0.11	0.02	.479
Comorbidities (n)						-0.06	[-0.09, -0.02]	0.02	-0.08	**.003**
QOL (poor)										
SF-12 MCS										
Job Satis. (dissatis.)										
Work Hours (p/w)										
Fit	R^2= .01, *p*= **.009**					R^2= .02, ΔR^2.01, *p*= **.013**				

Table 13b

Hierarchical Linear Regression Models for Sleep Duration (Working Cohort (n=2014) – Models 3-4)

	Model 3					Model 4				
Variables	*B*	95% CI	*SE*	β	*p*	*B*	95% CI	***SE* (*B*)**	β	*p*
Constant	6.96	[5.93, 7.98]	0.52		**<.001**	7.96	[6.87, 9.05]	0.56		**<.001**
Age	0.00	[-0.01, 0.01]	0.01	0.00	.958	-0.01	[-0.03, 0.00]	0.01	-0.04	.088
Gender (male)	-0.02	[-0.14, 0.11]	0.06	-0.01	.803	0.08	[-0.05, 0.20]	0.06	0.03	.229
Ethnicity (Māori)	0.08	[-0.05, 0.21]	0.07	0.03	.221	0.11	[-0.02, 0.23]	0.06	0.04	.096
ELSI-SF	0.00	[-0.01, 0.01]	0.01	0.01	.827	0.00	[-0.01, 0.02]	0.01	0.01	.636
AQ (1-2)	0.03	[-0.34, 0.40]	0.19	0.01	.870	-0.01	[-0.38, 0.36]	0.19	0.00	.971
AQ (3-4)	-0.16	[-0.55, 0.24]	0.20	-0.05	.434	-0.19	[-0.58, 0.20]	0.20	-0.06	.347
AQ (5-6)	-0.30	[-0.72, 0.12]	0.21	-0.06	.159	-0.31	[-0.73, 0.11]	0.21	-0.06	.145
AQ (7-9)	-0.18	[-0.70, 0.35]	0.27	-0.02	.506	-0.22	[-0.74, 0.30]	0.27	-0.03	.404
AQ (≥10)	-0.11	[-0.66, 0.44]	0.28	-0.01	.694	-0.08	[-0.63, 0.47]	0.28	-0.01	.774
AF (≤1 time p/m)	-0.32	[-0.57, -0.06]	0.13	-0.10	**.017**	-0.29	[-0.55, -0.04]	0.13	-0.09	**.024**
AF (2-4 times p/m)	-0.21	[-0.47, 0.05]	0.13	-0.07	.111	-0.20	[-0.46, 0.06]	0.13	-0.06	.134
AF (2-3 times p/w)	-0.17	[-0.42, 0.09]	0.13	-0.06	.200	-0.15	[-0.40, 0.10]	0.13	-0.05	.250
AF (≥4 times p/w)	-0.09	[-0.36, 0.17]	0.13	-0.03	.494	-0.08	[-0.34, 0.18]	0.13	-0.03	.554
SF-12 PCS	0.00	[0.00, 0.01]	0.00	0.03	.347	0.00	[0.00, 0.01]	0.00	0.03	.291
PA (inactive)	0.06	[-0.10, 0.22]	0.08	0.02	.480	0.08	[-0.08, 0.24]	0.08	0.02	.324
Smoking (current)	0.08	[-0.14, 0.31]	0.11	0.02	.454	0.07	[-0.15, 0.29]	0.11	0.02	.518
Comorbidities (n)	-0.05	[-0.09, -0.01]	0.02	-0.06	**.011**	-0.05	[-0.09, -0.01]	0.02	-0.07	**.008**
QOL (poor)	0.10	[-0.30, 0.49]	0.20	0.01	.631	0.09	[-0.30, 0.48]	0.20	0.01	.656
SF-12 MCS	0.01	[0.00, 0.02]	0.00	0.06	**.012**	0.01	[0.00, 0.02]	0.00	0.06	**.010**
Job Satis. (dissatis.)						0.00	[-0.23, 0.23]	0.12	0.00	.987
Work Hours (p/w)						-0.01	[-0.02, -0.01]	0.00	-0.13	**<.001**
Fit	R^2= .02, ΔR^2= 0, *p*= **.041**					R^2= .04, ΔR^2= .01, *p*= **<.001**				

Note. ELSI-SF: Economic Living Standard Index – Short Form; AQ: alcohol quantity; AF: alcohol frequency; p/month: per month; p/week: per week; Short Form Survey – 12 item physical component summary; PA: physical activity; QOL: quality of life; SF-12 MCS: Short Form Survey – 12 item mental component summary; Job Satis. (dissatis.): job satisfaction (dissatisfied). *p* values ≤.05 are bolded.

Controlled Variables. Covariate variables related to sleep duration in retirement were being male (13 minutes more sleep than females), better self-rated physical health (SF-12 PCS, 36 seconds less for every 1% increase in score), and currently smoking (30 minutes longer sleep duration than non-smokers). The association with gender was significant at the 95% threshold throughout all three models, though it was most significant after controlling for physical health and lost some significance after controlling for mental health. SES (ELSI-SF) was significant when controlling for physical health but lost this association after controlling for mental health variables. Smoking increased in association after controlling for mental health.

During employment, no demographic variables were associated with sleep duration. Having more diagnosed comorbid conditions was associated with shorter sleep duration (3 minutes less per condition), and this association was stronger after controlling for aspects of mental health status. Better self-rated mental health scores were related to longer sleep duration (36 seconds more per 1% increase in health), and each one hour increased in work per week associated with more hour per week was associated with 36 seconds less sleep. This association was extremely significant, even if the reduction was relatively small. However, it should be noted that if working a full 40-hour week, this could potentially be associated with 24 less minutes of sleep. No other variables were independently associated with sleep duration for either cohort.

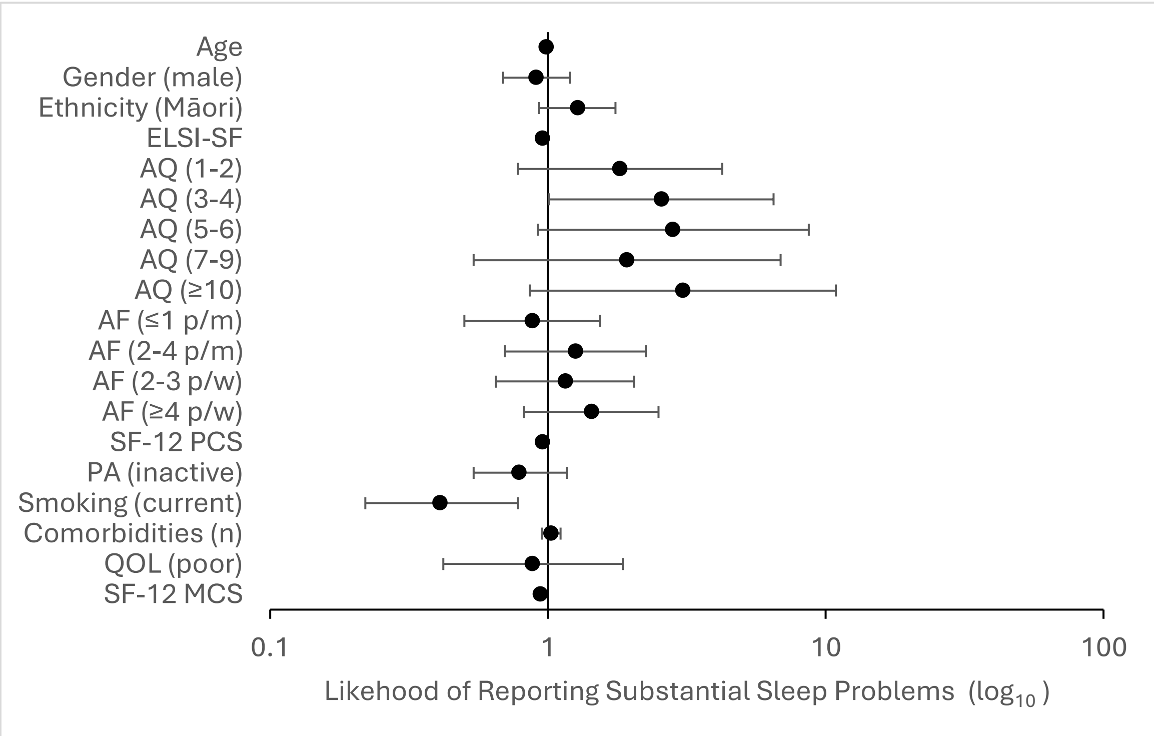
Model Fit. However, the context of the linear regression model must be considered. The R^2 values for the final model were extremely low meaning that at least 97-98% of the variation within the total hours participants' reported sleeping could not be explained by the model itself. This limits the notability of all the associations found within the model, even when associations were statistically significant, because the practical significance of these associations may be limited.

Sleep Problems

The results of regression analysis for sleep problems can be found in Table 14 for retirees (models 1 to 3) and Table 15a and b for workers (models 1 to 4). Odds ratios for retirees and workers is visualised in forest plots (Figure 4 and Figure 5, respectively).

Figure 4

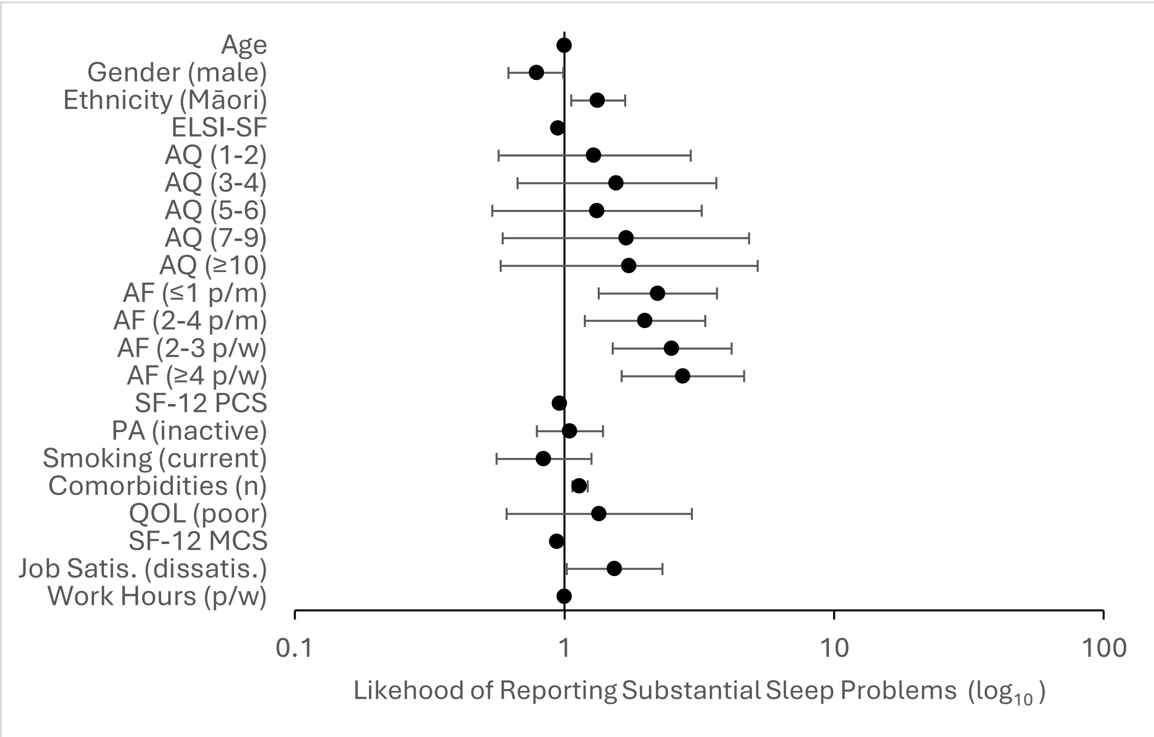
Forest Plot Showing Odds Ratios for Sleep Problems for Retired Cohort (n=1220)



Note. Visualization of odds of exposure group (noted in brackets) reporting substantial sleep problems during retirement, compared to baseline. Whisker bars indicate 95% CI range for odds ratios. ELSI-SF: Economic Living Standard Index – Short Form; AQ: alcohol quantity; AF: alcohol frequency; SF-12 PCS: Short Form Survey – 12 item physical component summary; PA: physical activity level; QOL: quality of life; SF-12 MCS: Short Form Survey – 12 item mental component summary; p/m: per month; p/w: per week.

Figure 5

Forest Plot Showing Odds Ratios for Sleep Problems for Working Cohort (n=2021)



Note. Visualization of odds of exposure group (noted in brackets) reporting substantial sleep problems during employment, compared to baseline. Whisker bars indicate 95% CI range for odds ratios. ELSI-SF: Economic Living Standard Index – Short Form; AQ: alcohol quantity; AF: alcohol frequency; SF-12 PCS: Short Form Survey – 12 item physical component summary; PA: physical activity level; QOL: quality of life; SF-12 MCS: Short Form Survey – 12 item mental component summary; p/m: per month; p/w: per week.; Job satis. (dissatis.): job satisfaction (dissatisfied), p/m: per month, p/w: per week.

Table 14

Hierarchical Binary Logistic Regression Models for Factors Relating to Sleep Problems (Retired Cohort (n=1220) – Models 1-3)

	Model 1					Model 2					Model 3				
Variable	*B*	*SE*	*p*	Exp(*B*)	95% CI	*B*	*SE*	*p*	Exp(*B*)	95% CI	*B*	*SE*	*p*	Exp(*B*)	95% CI
Age	0.01	0.01	.517	1.01	[0.99, 1.03]	-0.01	0.01	.296	0.99	[0.97, 1.01]	-0.01	0.01	.495	0.99	[0.97, 1.01]
Gender (male)	-0.19	0.13	.161	0.83	[0.64, 1.08]	-0.17	0.14	.207	0.84	[0.64, 1.10]	-0.1	0.14	.494	0.91	[0.69, 1.20]
Ethnicity (Māori)	0.28	0.15	.064	1.32	[0.99, 1.76]	0.24	0.15	.124	1.27	[0.94, 1.72]	0.24	0.16	.129	1.28	[0.93, 1.75]
ELSI-SF	-0.10	0.01	**<.001**	0.90	[0.88, 0.93]	-0.07	0.01	**<.001**	0.93	[0.91, 0.96]	-0.04	0.01	**.002**	0.96	[0.93, 0.98]
AQ (1-2)	0.56	0.4	.156	1.76	[0.81, 3.82]	0.48	0.41	.240	1.62	[0.72, 3.63]	0.6	0.43	.167	1.82	[0.78, 4.24]
AQ (3-4)	0.86	0.44	**.047**	2.37	[1.01, 5.57]	0.78	0.45	.082	2.19	[0.91, 5.31]	0.94	0.47	**.047**	2.57	[1.01, 6.49]
AQ (5-6)	0.99	0.52	.058	2.70	[0.97, 7.54]	1.00	0.54	.066	2.72	[0.94, 7.87]	1.04	0.57	.070	2.82	[0.92, 8.69]
AQ (7-9)	0.85	0.60	.154	2.34	[0.73, 7.49]	0.6	0.62	.334	1.82	[0.54, 6.13]	0.66	0.65	.312	1.93	[0.54, 6.88]
AQ (≥10)	1.13	0.59	.056	3.08	[0.97, 9.78]	1.08	0.62	.082	2.94	[0.87, 9.89]	1.12	0.65	.084	3.06	[0.86, 10.88]
AF (≤1 time p/m)	-0.17	0.27	.530	0.85	[0.50, 1.43]	-0.12	0.28	.663	0.89	[0.52, 1.52]	-0.13	0.29	.648	0.88	[0.50, 1.54]
AF (2-4 times p/m)	0.21	0.28	.443	1.24	[0.72, 2.13]	0.35	0.29	.224	1.41	[0.81, 2.47]	0.23	0.3	.439	1.26	[0.70, 2.25]
AF (2-3 times p/w)	0.01	0.27	.984	1.01	[0.59, 1.70]	0.26	0.28	.356	1.29	[0.75, 2.23]	0.14	0.29	.621	1.16	[0.65, 2.04]
AF (≥4 times p/w)	0.23	0.26	.391	1.25	[0.75, 2.10]	0.41	0.27	.131	1.51	[0.89, 2.57]	0.36	0.28	.201	1.44	[0.82, 2.50]
SF-12 PCS	0.70	0.84	.408	2.00		-0.04	0.01	**<.001**	0.96	[0.95, 0.98]	-0.04	0.01	**<.001**	0.96	[0.95, 0.97]
PA (inactive)						0.15	0.18	.419	1.16	[0.81, 1.65]	-0.23	0.2	.239	0.79	[0.54, 1.17]
Smoking (current)						-0.65	0.31	**.034**	0.52	[0.28, 0.95]	-0.89	0.33	**.006**	0.41	[0.22, 0.78]
Comorbidities (n)						0.10	0.04	**.015**	1.10	[1.02, 1.19]	0.03	0.04	.543	1.03	[0.95, 1.11]
QOL (poor)											-0.12	0.38	.744	0.88	[0.42, 1.86]
SF-12 MCS											-0.07	0.01	**<.001**	0.94	[0.92, 0.95]
Constant	0.7	0.84	.408	2.00		2.43	0.97	**.012**	11.41		5.19	1.1	**<.001**	179.07	

Note. Degrees of freedom for all variables =1. Values for Model 0: B=0.7 (SE=0.06), *p*=<.001, Exp(B)= 0.5. *p* values ≤.05 are bolded.

Table 15a

Hierarchical Binary Logistic Regression Models for Factors Relating to Sleep Problems (Working Cohort (n=2021) – Models 1-2)

	Model 1					Model 2				
Variable	*B*	*SE*	*p*	Exp(*B*)	95% CI	*B*	*SE*	*p*	Exp(*B*)	95% CI
Age	-0.01	0.01	.636	1.00	[0.97, 1.02]	-0.02	0.01	.074	0.98	[0.96, 1.00]
Gender (male)	-0.23	0.11	**.030**	0.79	[0.64, 0.98]	-0.27	0.11	**.017**	0.77	[0.62, 0.95]
Ethnicity (Māori)	0.32	0.11	**.003**	1.38	[1.11, 1.71]	0.22	0.11	.054	1.25	[1.00, 1.56]
ELSI-SF	-0.11	0.01	**<.001**	0.90	[0.88, 0.91]	-0.09	0.01	**<.001**	0.92	[0.90, 0.94]
AQ (1-2)	0.48	0.40	.227	1.62	[0.74, 3.54]	0.31	0.41	.442	1.37	[0.62, 3.05]
AQ (3-4)	0.67	0.41	.105	1.95	[0.87, 4.39]	0.51	0.42	.229	1.66	[0.73, 3.81]
AQ (5-6)	0.65	0.43	.131	1.92	[0.82, 4.47]	0.43	0.44	.335	1.53	[0.64, 3.64]
AQ (7-9)	0.97	0.50	.053	2.63	[0.99, 7.03]	0.62	0.52	.228	1.86	[0.68, 5.13]
AQ (≥10)	1.02	0.52	**.049**	2.77	[1.01, 7.62]	0.73	0.53	.171	2.07	[0.73, 5.88]
AF (≤1 time p/m)	0.70	0.24	**.004**	2.01	[1.26, 3.21]	0.73	0.25	**.003**	2.07	[1.28, 3.36]
AF (2-4 times p/m)	0.45	0.24	.066	1.56	[0.97, 2.52]	0.62	0.25	**.014**	1.85	[1.13, 3.04]
AF (2-3 times p/w)	0.64	0.24	**.007**	1.89	[1.19, 3.02]	0.82	0.25	**<.001**	2.27	[1.40, 3.69]
AF (≥4 times p/w)	0.81	0.25	**<.001**	2.25	[1.39, 3.64]	0.98	0.25	**<.001**	2.66	[1.61, 4.38]
SF-12 PCS						-0.03	0.01	**<.001**	0.97	[0.96, 0.98]
PA (inactive)						0.27	0.14	**.050**	1.30	[1.00, 1.70]
Smoking (current)						-0.17	0.20	.399	0.85	[0.58, 1.24]
Comorbidities (n)						0.18	0.03	**<.001**	1.20	[1.12, 1.28]
Quality of life (poor)										
SF-12 MCS										
Job Satis. (dissatis.)										
Work Hours (p/w)										
Constant	1.04	0.81	.200	2.83		2.63	0.92	**.004**	13.93	

Note. Degrees of freedom for all variables =1. Values for Model 0: B=-0.84 (SE=0.05), *p*=<0.001, Exp(B)=0.43. *p* values ≤.05 are bolded.

Table 15b

Hierarchical Binary Logistic Regression Models for Sleep Problems (Working Cohort (n=2021) – Models 3-4)

	Model 3					Model 4				
Variable	B	S.E.	p	Exp(B)	95% C.I.	B	S.E.	p	Exp(B)	95% C.I.
Age	-0.01	0.01	.454	0.99	[0.97, 1.02]	0.00	0.01	.737	1.00	[0.97, 1.02]
Gender (male)	-0.21	0.11	.063	0.81	[0.65, 1.01]	-0.24	0.12	**.043**	0.79	[0.62, 0.99]
Ethnicity (Māori)	0.29	0.12	**.013**	1.34	[1.06, 1.69]	0.29	0.12	**.015**	1.33	[1.06, 1.68]
ELSI-SF	-0.06	0.01	**<.001**	0.94	[0.92, 0.97]	-0.06	0.01	**<.001**	0.95	[0.93, 0.97]
AQ (1-2)	0.28	0.42	.511	1.32	[0.58, 3.01]	0.26	0.42	.543	1.29	[0.57, 2.94]
AQ (3-4)	0.47	0.44	.287	1.59	[0.68, 3.74]	0.45	0.44	.307	1.56	[0.67, 3.66]
AQ (5-6)	0.32	0.46	.492	1.37	[0.56, 3.36]	0.28	0.46	.544	1.32	[0.54, 3.23]
AQ (7-9)	0.55	0.53	.304	1.73	[0.61, 4.93]	0.53	0.54	.324	1.70	[0.59, 4.84]
AQ (≥10)	0.57	0.56	.308	1.77	[0.59, 5.32]	0.55	0.56	.326	1.74	[0.58, 5.21]
AF (≤1 time p/m)	0.81	0.26	**.002**	2.25	[1.36, 3.73]	0.80	0.26	**.002**	2.22	[1.34, 3.68]
AF (2-4 times p/m)	0.69	0.26	**.009**	1.99	[1.19, 3.33]	0.69	0.26	**.009**	1.99	[1.19, 3.33]
AF (2-3 times p/w)	0.92	0.26	**<.001**	2.50	[1.51, 4.16]	0.92	0.26	**<.001**	2.51	[1.51, 4.17]
AF (≥4 times p/w)	1.02	0.27	**<.001**	2.76	[1.64, 4.65]	1.01	0.27	**<.001**	2.75	[1.63, 4.64]
SF-12 PCS	-0.04	0.01	**<.001**	0.96	[0.95, 0.97]	-0.04	0.01	**<.001**	0.96	[0.95, 0.97]
PA (inactive)	0.06	0.14	.701	1.06	[0.80, 1.40]	0.05	0.14	.741	1.05	[0.79, 1.39]
Smoking (current)	-0.19	0.20	.347	0.83	[0.55, 1.23]	-0.17	0.20	.400	0.84	[0.56, 1.26]
Comorbidities (n)	0.13	0.03	**<.001**	1.14	[1.07, 1.22]	0.13	0.03	**<.001**	1.14	[1.07, 1.22]
Quality of life (poor)	0.32	0.40	.425	1.38	[0.63, 3.02]	0.30	0.40	.458	1.35	[0.61, 2.97]
SF-12 MCS	-0.06	0.01	**<.001**	0.94	[0.93, 0.95]	-0.06	0.01	**<.001**	0.94	[0.93, 0.95]
Job Satis. (dissatis.)						0.43	0.21	**.038**	1.54	[1.02, 2.31]
Work Hours (p/w)						0.00	0.00	.378	1.00	[1.00, 1.01]
Constant	4.74	0.99	**<.001**	114.36		4.20	1.06	**<.001**	66.35	

Note. Degrees of freedom for all variables =1. Values for Model 0: B=-0.84 (SE=0.05), *p*=<0.001, Exp(B)=0.43. ELSI-SF: Economic Living Standard Index – Short Form; AQ: alcohol quantity; AF: alcohol frequency; p/month: per month; p/week: per week; Short Form Survey – 12 item physical component summary; PA: physical activity; QOL: quality of life; SF-12 MCS: Short Form Survey – 12 item mental component summary; Job Satis. (dissatis.): job satisfaction (dissatisfied). *p* values ≤.05 are bolded.

Alcohol. During retirement, typically drinking three to four standard drinks per occasion was independently significantly positively associated with reporting substantial sleep problems (157% increase compared to non-drinkers), but no other consumption quantity was significant, nor was the frequency of days spent drinking throughout the month/week.

For workers, consuming alcohol at any frequency was significantly associated with self-reported sleep problems and drinking from twice a week up to more than four times per week were significant at >99.9% confidence threshold. Drinking at least once a month increased the likelihood of also reporting sleep problems by 122% compared to workers who never drank, two to four times per month increased odds by 99%, two to three times a month increased by 151%, and finally, working older adults who drank more than four times per week were 175% more likely to report substantial sleep problems than their peers who never drank. These relationships were significant after independently controlling for demographics, physical health status, mental health status, and employment characteristics (including the proportion of a week spend at work).

Controlled Variables. For workers, being male was associated with a 21% decrease in reported substantial sleep problems. Being Māori was associated with a

33% increase. Given the ELSI's unit range (0-31), every approximately 3% increase in SES score was associated with a 4% decrease in substantial sleep problems for retirees, and a 5% decrease for workers. For the SF-12, a PCS score increase of 1% (indicating better health) was associated with a 4% decrease in substantial sleep problems for both cohorts, and this was similar for the MCS (6% decrease for both cohorts). For retirees, the number of comorbid conditions a participant had been diagnosed with was not significant after controlling for mental health variables, however, for workers reporting a comorbid condition (as well as for each further additional condition) was associated with a 14% increase in substantial sleep problems. Currently smoking was associated with a 59% decrease in substantial sleep problems for retirees (no association for workers). Age and quality of life were not associated for either cohort. Being physically inactive was not associated with sleep problems for either cohort after controlling for mental health variables.

Model Fit. The logistic regression model for sleep problems was a good fit for the data (see Table 16). Every iteration of the -2 Log Likelihood (-2LL) ratio decreased from the previous iteration, and the changes in the -2LL were all significant, as indicated by the χ^2 statistic (see Table 17). Additionally, the large *p* values of the Hosmer and Lemeshow tests show the model is an adequate fit. Nagelkerke's pseudo R^2 values increased with each iteration, with the final values for both cohorts being above 0.2, suggesting a moderate relationship.

Table 16

Goodness-of-Fit Tests for the Logistic Regression Models (by Work/Retirement Status)

	Retired					Working				
	-2LL	Pseudo $R^{2\,a}$	H-L test			-2LL	Pseudo R^2	H-L test		
Model			χ^2	*df*	*p*			χ^2	*df*	*p*
0	1552.17					2475.35				
1	1446.02	0.12	11.75	8	.163	2282.52	0.13	5.7	8	.681
2	1384.76	0.18	10.87	8	.209	2182.64	0.19	6.29	8	.615
3	1311.27	0.25	8.52	8	.384	2073.97	0.26	8.64	8	.373
4						2068.88	0.26	10.26	8	.247

[a] Calculated using Nagelkerke's version.

Table 17

Chi-Square Goodness-of-Fit per Logistic Regression Model (by Work/Retirement Status)

	Retired						Working					
Model	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	*p*	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	*p*
1	106.148	13	**<.001**				192.834	13	**<.001**			
2	167.414	17	**<.001**	61.266	4	<.001	292.707	17	**<.001**	99.873	4	**<.001**
3	240.9	19	**<.001**	73.486	2	<.001	401.384	19	**<.001**	108.677	2	**<.001**
4							406.475	21	**<.001**	5.09	2	0.078

Note. *p* values ≤.05 are bolded.

Sleep Satisfaction

After running hierarchical logistic regression, it was found that sleep satisfaction was less statistically significantly associated with alcohol compared to sleep problems, so it was not explored further as the scope of this study was limited. While this association was less significant, like sleep problems alcohol frequency was similarly associated with sleep dissatisfaction in workers but not retirees. This potentially indicates a relationship between aspects of sleep quality and alcohol frequency in employment that differs in retirement. Most of the covariate relationships were also similar. However, for transparency, the complete hierarchical binary logistic regression table for sleep satisfaction can be found in Appendix D.

Discussion

This study aimed to examine the effects that alcohol consumption may have on the sleep health of older New Zealanders, and whether these effects differ between groups based on whether they were retirees or workers. This was achieved through cross-sectional analysis of a large cohort of retired and working older New Zealanders, providing the first analyses of its kind to focus on sleep and alcohol in older NZ adults. This is important because as older adults are living longer and spending more time in retirement, there is increasing research showing that alcohol is harmful for sleep health (He et al., 2019; Leger et al., 2022; Park et al., 2015; Stein & Friedmann, 2006), as well as overall health (White et al., 2023; World Health Organization, 2023, 2024). Good sleep health can serve as a protective factor during ageing (Amidi et al., 2024), and promote healthy ageing (Ravyts & Dzierzewski, 2024). Inversely, poor sleep health is associated with increased negative health outcomes (Amidi et al., 2024; Ravyts & Dzierzewski, 2024). There was a gap in the literature within NZ on how alcohol impacts the sleep health of older adults, making this a needed area of study especially as increased information on how alcohol impacts sleep health status is useful for expanding public awareness of the impacts of alcohol on sleep, enabling informed health decision-making, and making improvements to public health policy and health education.

A priori hypotheses were that poor sleep status would be more likely among participants who were working compared to those who were retired, that the post retiree group would have less alcohol consumption than the working group, that high frequency and high quantity drinking would be independently associated with poor sleep status, and that the profile of poor sleep and alcohol would differ between retirement status with regards to indicators of stress, and poor physical or mental health status.

Regarding sleep health during retirement, moderate quantity drinking (3-4 drinks) was linked to shorter sleep duration and reporting more substantial sleep problems. No other alcohol quantity or frequency was associated with either sleep outcome for retirees. While drinking monthly or less while employed was linked to shorter sleep duration, all other alcohol frequency variable levels that indicated consuming alcohol more frequently than monthly were not significantly associated with sleep duration. Most notably, workers who consumed alcohol of any frequency were at least 99% more likely to report substantial sleep problems compared to those who did not drink. The quantity of drinks consumed was not linked to significant differences in sleep duration or an increase in substantial sleep problems for workers.

The following sections will give an assessment of whether the results aligned with hypotheses, alongside discussion of why this may be. Interpretation of these findings will compare to existing literature on alcohol, ageing, and sleep health. Potential mechanisms and explanations of the findings will further explore existing literature, particularly in regard to sleep health, alcohol physiology and metabolism (including normative changes to sleep health and alcohol metabolism during ageing), the influence of social factors on health, sleep, and drinking behaviours, differences between the context of employment and retirement, current NZ policy on recommended alcohol intake in older adults, and current NZ policy regarding retirement. Finally, consideration will be given to the potential strengths and limitations of the present study, some implications of the present findings for future research in this area, and some recommendations of future public health policy and health promotion opportunities.

Findings

The first hypothesis that workers would have worse sleep than retirees was partly true, but only for some of the sleep health characteristics. Generally, both cohorts tended to sleep within the typical recommended 7-8 hours per night, and roughly two thirds of both retirees and workers identified as not having any substantial sleep problems. Bivariate analysis showed work/retirement status had significant associations with both sleep problems and sleep duration. Workers had significantly shorter sleep duration than retirees, with one hour difference in median values between cohorts. However, retirees reported significantly more substantial sleep problems, which was contrary to the hypothesis. Ageing is known to increase fragmentation and disrupt sleep quality (Amidi et al., 2024; Li et al., 2022; Ohayon et al., 2004) and given that the retirees tended to be older than the workers, it is possible that retirees were more likely to have more complaints about their sleep as the result of normative ageing.

Generally, workers tended to consume more alcohol on days that they drank. Within the cohort, significantly more than expected drank either 3-4 or 5-6 drinks per drinking session, and significantly less workers than expected were represented in the lower quantity categories (none or 1-2 drinks). Retirees had a larger portion of the cohort that identified as drinking either zero or 1-2 drinks (and significantly more retirees than expected drank 1-2 drinks compared to other quantity levels). However, regarding how often the participants drank, retirees were significantly less represented in the middle of the frequency spectrum (between 2-4 times per month to 2-3 times per week). This implies that while workers were more likely to be current drinkers and drank moderately regularly, there was a portion of retirees who reported drinking more regularly than workers, which was a more multifaceted result than was hypothesised. This finding is supported by existing research that has shown that older adults in NZ have variation in their drinking behaviour patterns (Szabo, Towers, Sheridan, et al., 2021), and that some older adults may tend to drink low quantities of alcohol at regular frequencies.

It was hypothesised that both high quantity and frequency of drinking would both be associated with poor sleep status, however the present analysis showed relationships that were significantly more nuanced. Initially, it is worth noting that there were few individuals who identified as drinking large amounts of alcohol. In NZ this is generally accepted as drinking ≥5 drinks for women or ≥6 drinks for men (Health New Zealand – Te Whatu Ora, 2022), and the present study found that 6.87% of retirees and 12.54% of workers reported drinking at least 5-6 drinks or more. Comparing these results to data obtained from the NZHS over a similar timeframe (the 2021/22 wave), these rates found in this present study were generally lower than what was found in the NZHS (21.4% of 55-64 year olds, 12.8% of 65-74 year olds, and 3.2% of those aged ≥75) (Ministry of Health – Manatū Hauora, 2025). However, the trend that 'younger' older adults tend to drink more (i.e. those still working, or those aged 55-64) was replicated in this study.

For both sleep problems and sleep duration, retirees who drank 3-4 drinks were associated with worse outcomes than other retirees who drank both more and less than 3-4 drinks. It is possible that this quantity was a threshold for how alcohol impacts sleep in retirement, especially given that participants in lower quantities did not appear to experience the same negative impact to their sleep health. Notably, drinking with any level of regularity while currently in paid employment was linked to reporting substantial sleep problems. This implies that how alcohol impacts sleep in ways that lead to sleep complaints or fragmentation is more related to how regular and habitually a worker drinks, and that this regularity matters more than how many drinks they tend to consume.

While this research found some weak associations between alcohol consumption patterns and the length of time participants slept, the general fit of the model was poor, and did not explain the majority of variance within the dataset. Despite this, the existence of associations significant at the >95% CI threshold means these relationships can be determined to almost certainly exist within the data, but their strength is uncertain due to large variance. Any conclusion drawn should acknowledge that the actual values of the relationships between duration and alcohol consumption will likely differ greatly from the values in the model, specifically regarding prediction, odds, and strength of association. This combination of significant associations and poor model fit often indicates that there are other external variables that mediate the relationship between the dependent variables and independent variables. For this study, this means that the relationships of significance found within the model (shorter sleep duration for retirees who drank 3-4 drinks, and workers who drank monthly or less) likely do exist within the dataset, and can be discussed and interpreted, with the understanding that covariate variables included in this study likely do not explain the entire relationship between sleep duration and drinking behaviour.

In alignment with hypotheses, the profiles of sleep, health status and alcohol consumption were different between cohorts. Retirees tended to be older, of non-Māori ethnicity, and have worse physical health (lower activity levels, more comorbid conditions, lower SF-12 PCS scores) compared to the workers. Determining mental health status was more complicated, retirees disproportionally reported lower QOL, although the majority of them were satisfied with their QOL. Retirees tended to have better SF-12 MCS scores than workers and were significantly less likely to smoke. Less than 10% of workers were dissatisfied with their jobs. Median SES was the same across cohorts, and there were no statistically significant differences in distribution.

The finding that smoking was associated with longer sleep duration and less substantial sleep problems during retirement was unexpected. Nicotine is a stimulant and has been found to disrupt sleep quality (Hayley et al., 2017), and this effect has been shown to be dose-dependent (Leger et al., 2022). The association between being a current smoker and not reporting substantial sleep problems may have been mediated by physical health status. Smoking cessation in older adulthood has been linked to worsening health status as a decline in physical health can trigger a desire to reduce nicotine intake (Cohen-Mansfield, 2016). This aligns with the fact that retirees were significantly less likely to smoke than their working counterparts. This also means it is possible that those who smoked had better physical health (i.e. had not been prompted to quit after a decline in health) and were more likely to experience less substantial sleep problems and have longer sleep duration.

Another potential mechanism is that retires differ from workers in how they smoked. The general public has been found to sometimes confuse time in bed with total sleep time (i.e. duration) (Lee & Ward, 2005), and older adults may be more likely to smoke in bed during retirement (Beideman et al., 2018; Duncanson, 2011). If retirees had less scheduled commitments than workers, and could spend more time in their bed smoking, it is possible that the longer sleep duration associated with smoking could be further explained as the result of conflating time in bed with sleep duration.

The relationship between alcohol and work status/work environment is complicated (Frone, 2016; Jay et al., 2017). Alcohol consumption is mediated by various individual and environmental factors, including physiology (Sharma & Kavuru, 2010; White et al., 2023), age (Blazer & Wu, 2009; Edgar et al., 2016; Stevenson et al., 2015), ethnicity (Hogarth & Rapata-Hanning, 2023), culture (Szabo, Towers, Sheridan, et al., 2021), attitudes and beliefs (Bareham et al., 2019; New Zealand Alcohol Beverages Council, 2019), marital status (Midorikawa et al., 2019), childhood experiences (Szabo, Towers, Newcombe, et al., 2021), SES (Szabo, Towers, Newcombe, et al., 2021), access to health services (Hogarth & Rapata-Hanning, 2023), and policy (Boumans et al., 2022). Whether an individual is employed or retired is only one of the potential factors that can influence alcohol consumption, which in turn is only one part of potential health behaviours that may influence sleep health status. However, as retirement status is underexplored regarding both alcohol and sleep health in NZ, the scope and findings of the present study aim to improve the knowledge-base and provide a foundation for future research.

Alcohol and Sleep

Alcohol has been found to be bidirectionally linked to sleep health outcomes (Nelson et al., 2024) through a complex relationship mediated by several other health domains and health behaviours (Midorikawa et al., 2019; Sabatier et al., 2024), which requires interpretation through a nuanced and holistic framework. A holistic conceptualisation of sleep health encapsulates a range of objective and subjective sleep health characteristics, and the context in which they occur (Buysse, 2014). Including this full range was outside the scope of this study, so it is acknowledged that self-reported sleep duration and sleep problems are each just singular aspects of sleep health and therefore cannot provide full understanding of the sleep health status of the participants.

With reference to Buysse's model (2014), the included variable of reported sleep problems is interesting because it potentially relates to the dimensions of sleep continuity, timings, and quality. Sleep quality is often considered a useful survey metric because it is uniquely measured only at the subjective level (Buysse, 2014). Because of this, sleep quality often includes an individual's assessment of their sleep that by nature will relate to various other aspects (e.g. duration, regularity, fragmentation, continuity etc). While 'sleep quality' was not directly included by name within the sleep variables in this research project, research has found that subjective assessments of sleep quality are often closely linked to sleep continuity (Åkerstedt et al., 1994; Della Monica et al., 2018; Keklund & Åkerstedt, 1997; Libman et al., 2016), and adequate proportions of REM sleep (Della Monica et al., 2018) and SWS (Keklund & Åkerstedt, 1997) throughout the night. Therefore, as the wording of the sleep problems item in the NZ-HWR study included references to long SOL times, WASO periods/fragmentation, and being unable to sleep in, it is conceptually related to the dimension of sleep continuity. This means reported sleep complaints can be linked to subjective sleep quality, making it a useful metric of how sleep has been influenced.

This relationship between sleep continuity and quality also highlights that several of the ways alcohol may impact sleep health may be noticeable without objective measurement and therefore impact self-report data (as compared to the notion that physiological impacts to sleep are best measured objectively). Research has found consuming alcohol to be associated with changes to circadian processes (Burgess et al., 2022; Burgess et al., 2024; He et al., 2019; Nelson et al., 2024) and sleep architecture (Burgess et al., 2022; Gardiner et al., 2025), including disruption to the total amount of REM sleep later in the night (Hussain et al., 2022), even at relatively low levels (Gardiner et al., 2025). High quantity and frequency drinking is known to disrupt entrainment to light time cues (Burgess et al., 2022) and disrupt sleep continuity (He et al., 2019) which can exacerbate normative physiological changes to sleep continuity and timings that occur during ageing (Li et al., 2022). Drinking has also been linked to insomnia (Burgess et al., 2024; He et al., 2019; Hussain et al., 2022; Morin et al., 2024), and reduced subjective sleep quality and satisfaction (Garcia et al., 2024; Hussain et al., 2022). Research on alcohol and aspects of sleep quality in older adults has linked high alcohol quantity and frequency to insomnia (Thorne et al., 2021), and high quantity to both sleep dissatisfaction (Hussain et al., 2022) and disrupted sleep continuity (Hayley et al., 2017; Zheng et al., 2024).

Sleep quality has been linked to how ‘refreshing’ sleep feels (Della Monica et al., 2018; Libman et al., 2016). While a survey cannot be expected to accurately assess sleep stages, disruptions to the amount of time spend in REM sleep can lead to sleep feeling like it is unrefreshing , which may influence assessments of quality (Della Monica et al., 2018). Given that even low doses of alcohol can reduce REM sleep (Gardiner et al., 2025; Hussain et al., 2022), this could explain why alcohol was found to be linked to higher rates of substantial sleep problems for some participants in this study. Alcohol consumption can fragment normal sleep and is associated with reports of increased sleep disruption (Hayley et al., 2017; He et al., 2019; Zheng et al., 2024), which could further explain why there were significant findings as the sleep problems variable included several aspects of poor sleep continuity.

Short sleep duration has been linked to various aspects of alcohol consumption in adults, including quantity (Chaput et al., 2012; Midorikawa et al., 2019; Zheng et al., 2024), frequency (Wang et al., 2023), and both quantity and frequency (Park et al., 2015). Generally, there is an association between higher rates of alcohol consumption and shorter sleep duration (Chaput et al., 2012; He et al., 2019; Park et al., 2015), but this relationship becomes more complicated in populations of older adults. Some research with older adults has found short sleep duration to be associated with alcohol quantity (Midorikawa et al., 2019; Zheng et al., 2024) and frequency (Wang et al., 2023), but some have found no relationship (Horvat Davey et al., 2024; Hussain et al., 2022; Leger et al., 2022).

This study found that retirees who drank 3-4 drinks had slept 33 minutes less than other retirees, and workers who drank at least monthly slept 17 minutes less than workers who did not drink. This shows that some aspects of drinking behaviour were linked to shorter sleep duration, however this relationship was not consistent with linear increases in quantity or frequency (for example, workers who drank more than monthly did not have significant changes in their sleep duration).

Normative ageing is generally associated with a decrease in sleep duration (Li et al., 2022), but retirement is generally associated with an increase in sleep duration

(Myllyntausta & Stenholm, 2018). During ageing the nighttime sleep period has been identified as becoming more fragmented, and a higher proportion of the night is spent awake compared to younger adults. But this is often balanced by an increase in the amount of time spent napping during the day. Literature on how alcohol influences sleep duration is mixed (Horvat Davey et al., 2024; Hussain et al., 2022; Leger et al., 2022; Midorikawa et al., 2019; Zheng et al., 2024), as is NZ research on the prevalence of short sleep duration in older NZ adults (Gibson et al., 2023; Lee & Sibley, 2019), but it is generally accepted that alcohol reduces sleep quality and increases fragmentation, leading to reductions in sleep duration.

The sleep duration variable was sourced from a question that included nap times within the total amount of sleep per day, so it is possible that results for sleep duration were less significant because potential reduction in total sufficient sleep duration over the nighttime period was 'rectified' or 'caught up' by any napping periods during the day that were reported as part of the total hours slept. Some research indicates that the normative reduction in sleep duration associated with ageing plateaus around 60 years of age (Li et al., 2022). Other research has found that increases in sleep duration after retirement are larger for those who drink higher amounts of alcohol (Myllyntausta & Stenholm, 2018). This means that the level to which alcohol impacts sleep duration may depend on whether someone is above or below 60 years old, or that the length of time spent in retirement could influence their reported length of sleep duration.

It is also possible that workers whose sleep was impacted by their employment (i.e. shift work, evening chronotype with early starts, flexible hours, etc) were more likely to use alcohol as a sleep aid (He et al., 2019) to combat the negative impacts of employment structure. Evidence for this mechanism is supported by the finding that more total work hours per week was associated with less sleep duration for workers. However, the complexity of the relationship between alcohol and sleep health makes it difficult to ascertain the direction of this relationship. Alcohol is known to disrupt sleep quality and contribute to more fragmentation and wakings later on in the night (Gardiner et al., 2025). If participants were experiencing more fragmented sleep from using alcohol as a sleep aid, the tendency of the general public to conflate time in bed with total sleep time (Lee & Ward, 2005) could have impacted their self-reported sleep duration, as they may have been less aware of the proportion of their time in bed spent not sleeping.

A further potential explanation of why this research had different results compared to some literature is the variation in operational definitions of alcohol consumption and the inclusion of alcohol quantity and frequency as independent variables. As noted in the literature review, there have been several studies that have utilised similar methodology to the present study (i.e. data from representative national surveys to investigate alcohol and sleep in older adults) (Hayley et al., 2017; Horvat Davey et al., 2024; Hussain et al., 2022; Hwang et al., 2024; Leger et al., 2022; Midorikawa et al., 2019; Thorne et al., 2021; Wang et al., 2023; Zheng et al., 2024). In these studies, alcohol consumption was conceptualised in a variety of ways. Several utilised quantity (Hayley et al., 2017; Leger et al., 2022; Zheng et al., 2024), or quantity and frequency as metrics of alcohol consumption (Hussain et al., 2022; Hwang et al., 2024; Midorikawa et al., 2019; Thorne et al., 2021). Some used current drinking as an indicator of consuming alcohol with any frequency (Hayley et al., 2017; Wang et al., 2023). There was only one that focused specifically on alcohol frequency without including alcohol quantity (Horvat Davey et al., 2024). Of those that included both alcohol quantity and frequency, two utilised the exact same categories as the present study (assumedly also sourced from the AUDIT-C items) (Hwang et al., 2024; Thorne et al., 2021). However, in the majority of studies using the same or similar quantity and frequency metrics, a final crossover quantity-frequency metric (e.g. heavy drinking, at-risk drinking, AUDIT score) was typically utilised to categorise alcohol consumption (Hussain et al., 2022; Midorikawa et al., 2019; Thorne et al., 2021), and only Hwang and colleagues (2024) included quantity and frequency as separate components of alcohol behaviour patterns.

This means that majority of the existing literature that examines sleep and alcohol in older adults tends to focus on quantity as a metric of drinking behaviour or utilises quantity and frequency in ways that are less comparable to the present study. This study found that quantity was not a significant indicator of sleep duration or sleep problems for workers. Moderate quantity was relevant for retirees, but this association was isolated and existed only at 3-4 standard drinks, which is consistent with the finding that dose-dependent linear relationships between alcohol and sleep become less robust during ageing (Hwang et al., 2024). Linear patterns of high quantity and high frequency (or inversely, low quantity and low frequency drinking) do not account for the total range of drinking behaviour patterns found within older New Zealanders, and there are patterns that include some disparate matches of quantity and frequency (e.g. moderately frequency but low quantity, etc) (Szabo, Towers, Newcombe, et al., 2021). This was found in the retired cohort, who did not engage in traditionally heavy quantities of alcohol (i.e. 6 to >10 drinks) but were either low frequency or high frequency, with significantly lower rates of moderate frequency.

Therefore, while there is a large volume of literature on how alcohol can impact sleep duration or sleep quality in older adults, literature that can explicitly corroborate the finding of frequency (and not quantity) being associated with sleep problems during employment is sparse, with the exception that employment has been linked to high-risk drinking (i.e. high quantity and frequency) (Midorikawa et al., 2019). Patterns of drinking behaviour in NZ older adults have been shown to be non-linear, and the levels of quantity and frequency of alcohol consumption can be somewhat independent of each other (Szabo, Towers, Sheridan, et al., 2021). Therefore, given that the present study was the first of its kind to focus on alcohol and sleep health in older New Zealanders, it is noteworthy that the findings were non-linear, and that some aspects of quantity or frequency were only significant for either workers or retirees and that these relationships occurred independently. Given that these results are slightly different from existing studies, further discussion of potential underlying mechanisms will be drawn from aspects of studies that touch on relevant components of the present research.

Social-ecological Interactions

Referring back to Grandner's Social-ecological model of sleep health (2019), it emphasises that sleep health and related behaviours are mediated through factors at the individual, social, and societal levels of influence. Further interpretation of potential mechanisms and discussion of related factors will be guided by this framework.

The fact that sleep is bidirectionally linked with other areas of health is conceptually central to the findings of this study (Buysse, 2014; Nelson et al., 2024). Individual level physiological changes to sleep health and the metabolism of alcohol may explain some of the findings. Also at the individual level, the attitudes and beliefs that older adults have surrounding alcohol and sleep health are strong influencers of their health behaviour, meaning that perception and attitudes can have significant impacts on both the sleep health of individuals, and their patterns of alcohol consumption. As both alcohol (Herbert et al., 2017) and sleep (Crestani et al., 2022) are mediated socially, individual level attitudes and behaviours that are influenced by social factors and relationships can mediate drinking patterns and sleep health. Retirement status and employment status are also significant social level factors, and each will be explored further in relation to the findings of this study. The impact of daily routine, socialisation, and the timings of drinking throughout the day (and whether it is utilised as a sleep aid) will also be discussed further. Finally, the context of public health promotion regarding alcohol, the accessibility of this educational information among older adults, and how policy impacts SES and loneliness during retirement will also be explored.

Ageing

Genetic and physiological changes during normative ageing are known to impact sleep physiology (Dzierzewski et al., 2018; Li et al., 2022). Furthermore, ageing is associated with a higher likelihood of disrupted and fragmented sleep (Li et al., 2022), meaning that older adults may be more inclined to use sleep aids (Morin et al., 2024), especially if they are having sleep issues during the retirement transition.

As mentioned in the previous section, consuming alcohol impacts sleep in established ways that can lead to worse quality and subjective experience of sleep for older adults. Ageing is also associated with a decline in overall health (Dzierzewski et al., 2018; Li et al., 2022), meaning that alcohol consumption may be mediated by health status, as well as the perceptions and beliefs that individuals hold over prioritisation of health domains in regard to other aspects of life. It is also possible that the significant results for sleep problems, and the inconclusive results for sleep duration, are related to the way that sleep health is conceptualised by the general public, as well as the ways that alcohol impacts sleep physiologically. Therefore, exploration of the current guidelines on alcohol consumption for older adults will also be included as part of the discussion of metabolic and physiological changes during ageing within the following section.

Metabolism During Ageing. Normative ageing involves changes to physiology, including how alcohol is metabolised, and how it impacts the body. Between 60-65 years of age, it has been estimated that the percentage of total water within the body tends to decrease (Lu et al., 2023; White et al., 2023). This reduction in water volume within the body has been interpreted to mean that, compared to younger adults, drinking the same amount of alcohol when ageing can lead to higher blood alcohol concentration (BAC) levels, and higher levels of intoxication (Stevenson et al., 2015; White et al., 2023). Additionally, such effects may be further exacerbated by muscle atonia that is characteristic of normative ageing, as well as slowed metabolism, causing a standard drink to 'last longer' in the blood stream than it would have in younger years (White et al., 2023).

Alcohol Guidelines for Older Adults. At the societal level, policy and national perceptions and attitudes towards health and sleep are factors that influence health and health behaviours for older adults. Particularly, policy regarding alcohol recommendations and guidelines on safe drinking can have a large impact on how older adults interact with alcohol.

Health New Zealand – Te Whatu Ora has guidelines on recommended limits for alcohol consumption for New Zealanders. The current guidelines that allow healthy adults to "reduce their long-term health risks" from drinking alcohol are that women should drink no more than two standard drinks per day, and for men, no more than three (Health New Zealand – Te Whatu Ora, 2025b). The recommended total drinks per week are 10 and 15 for women and men, respectively. It is also recommended that adults abstain from alcohol at least two full days a week to avoid long term health impacts (Health New Zealand – Te Whatu Ora, 2025b). Advice for older adults is less specific (Health New Zealand – Te Whatu Ora, 2025a), but clarifies that the aforementioned guidelines are for adults generally (i.e. middle aged), and that older adults should "…be careful using these guidelines because they are likely to be too high for [older adults] as [they] get older" (p. 20).

For the retired cohort, which had a median age of 71 (nine years higher than their working counterparts) drinking 3-4 drinks per occasion was associated with both shorter sleep duration and reporting substantial sleep problems. It is possible that because the quantity category of 3-4 drinks partially includes and exceeds the 2-3 drink recommendations, it was at this level where notable effects started to appear for retirees.

Retirement: A Context or a Variable

At the social level, changes to routine and social environments can influence sleep and alcohol consumption during ageing (Edgar et al., 2016; Kuerbis & Sacco, 2012). A central hypothesised mechanism for differences in sleep health and alcohol consumption patterns between workers and retirees includes differences in daily structure and routine. Compared to during employment, the retirement transition theoretically allows older adults to have significantly more freedom in deciding their daily structure and routine (Olds et al., 2018; Pond et al., 2010). However, some older adults may experience less drastic changes in their amount of leisure time as they may have commitments to family (Tunney et al., 2023; Wright-St Clair et al., 2017), caregiving (Tunney et al., 2023; Wright-St Clair et al., 2017), housekeeping, or volunteer work (Wanka, 2020). Leisure opportunities can also be mediated by physical activity level, social opportunities, and individual level priorities. In NZ, cultural differences have been found between Māori and non-Māori regarding prioritised activities during retirement (Wright-St Clair et al., 2017). Māori were found to prioritise leisure, household/domestic activities, spiritual activities, and interpersonal connections. Non-Māori were found to prioritise leisure, self-care, sleep, domestic activities, work, and learning.

A thematic analysis considering how older adults view alcohol found that alcohol is often seen as an activity associated with "relaxation", and that retirement can lead to increases in the amount of context in which older adults can relax and drink socially, thereby increasing consumption (Bareham et al., 2019). Further research corroborates that alcohol consumption does increase during retirement (Zins et al., 2011), while some have only found this effect in men (Wang et al., 2014). Another potential mechanism is that employment often acts as a deterrent for drinking, due to routine schedules and early starts, and having a lack of employment the following day could mean older adults have less constraints on when it is acceptable to drink (Zins et al., 2011).

A review on literature on alcohol and retirement has suggested that retirement itself does not directly impact alcohol consumption, and instead individuals have latent predispositions and history that can influence drinking patterns during the retirement transition (Kuerbis & Sacco, 2012). This suggests that any drinking behaviour changes after retirement have less to do with retirement itself, and more that the changes that retirement causes allow some individuals to drink more, given they already tended to drink higher amounts of alcohol. Inversely, individuals who prefer to abstain from alcohol may be more likely to reduce alcohol intake after retirement, especially if conscious of health impacts. Additionally, the workplace context pre-retirement can have a large impact on drinking after retirement, and involuntary retirement can increase drinking (Kuerbis & Sacco, 2012). In the present study, while the retired cohort tended to consume lower quantities of alcohol, there were some that drank at greater frequencies than workers. These findings imply that retirement may cause some retirees to lower their total consumption of alcohol and may cause others to drink lower amounts of alcohol far more often. Future research could further explore changes in drinking patterns, through questions that take retrospective reports of drinking behaviour before retirement, or indicators of alcohol quantity or frequency increasing or decreasing in the last year/since retirement etc. It could also benefit from using a longitudinal within-subject design to explore how an individual’s sleep health and alcohol consumption change before and after retirement (while this type of analysis is possible with the NZ-HWR study dataset, it would involve analysing multiple waves which was outside the scope of this study).

The large variation in the sleep duration regression model indicated a potential external variable relating to time use and scheduling during older age that mediates the relationship between alcohol and sleep duration. Retirement is often a significant transition for older adults (Myllyntausta & Stenholm, 2018). Employment is typically routine and imparts structure on daily schedules, and the change of leaving employment can lead to a degradation in normal daytime structure (Myllyntausta & Stenholm, 2018).

Some studies have found that retirement is associated with a delay to sleep phase, changing where sleep is positioned within the 24-hour day, meaning that retirees may wake later in the morning and go to bed later in the evening after leaving the workforce (Hagen et al., 2016). The NZ-HWR study had no items that focused on what part of the day they typically scheduled their activities (e.g. sleep, meals, socialisation, physical activity, etc). Given that sleep duration is an aspect of sleep that is directly related to daily schedule and the total amount of available hours within the day, the lack of data in this sample about the differences between timings and routine for workers and retirees means that it is entirely possible that daily schedule mediates the relationship between sleep duration and alcohol. Therefore, it is recommended that future research include a metric that captures time usage throughout the day, and typical structure to enable better understanding of how alcohol may impact sleep duration during retirement.

How long an older adult has been retired has also been related to health and wellbeing (Kim & Moen, 2002). Some report retirement and the associated increase in leisure time as morale boosting, and for some it can be isolating and monotonous (An et al., 2023). Older adults with low morale regarding retirement have been found to experience worse mental health outcomes in the latter years following the transition (Kim & Moen, 2002). Future research focused on expanding the available data in this area would therefore benefit from including information on retirement length and cause as it could be associated with drinking patterns and health outcomes. Because alcohol is often associated with social settings, there is also a relationship between alcohol consumption and prevalence of loneliness in older adults (Boumans et al., 2022). This could also mean that future research would benefit from examining the contexts in which people drink (social, alone, etc), and the times of day they typically drink. This increased exploration of social contexts could also include how retirement villages influence alcohol consumption and sleep health status in older adults.

Employment Status

The lack of association between quantity of alcohol consumed (on average drinking occasion) and sleep health could also be additionally explained by attending to how employment impacts behaviour at the individual and social level. High quantities of alcohol consumption have been found to be associated with higher rates of unemployment as well as difficulty sustaining employment (Jørgensen et al., 2019). So, it is possible that the inherent requirement that this sample include employed older adults means that participants were more likely to drink alcohol in ways that do not affect their ability to maintain their employment. Plainly, the methodology of this study could mean that participants who regularly drank high quantities of alcohol were more likely to be unemployed and therefore removed during data processing or that they could even be less likely to participate in the initial survey data collection process.

Timing of Alcohol Consumption: Working versus Retirement

Regarding the finding of frequency being associated with sleep problems for workers, applying the socio-ecological model of sleep health (Grandner, 2019), specifically the social level, enables a better understanding of potential mechanisms that could explain the results found in this study. Workers who drank alcohol with any level of frequency/regularity had a large increase in their likelihood of reporting more substantial sleep problems (ranging from a 99% to a 175% increase). As established, a key difference between pre- and post-retirement could be the increase in freedom that some individuals have around planning their daily time usage and schedule. This allows for some retirees to have more choice around when they wake, eat, drink, socialise, and go to bed. Employment within Western societies is typically associated with a 9-5 workday, and, given it is generally socially unacceptable to consume alcohol during the workday, those currently employed are more likely to drink outside work hours (typically after 5pm). This means that, compared to retirees, they could be more likely to consume alcoholic beverages much closer to when they begin to sleep.

Drinking alcohol close to bedtime and the subsequent onset of sleep is known to disrupt normal sleep physiology throughout the night (Gardiner et al., 2025; Stein & Friedmann, 2006), especially later on after peak BAC levels wear off partway through sleep (Gardiner et al., 2025). Worse subjective sleep quality has been linked to consuming alcohol daily (Chueh et al., 2019) and higher ‘alcohol problem’ severity

(Chueh et al., 2009; Hartwell et al., 2015), and more reported sleep difficulty has been linked to higher frequency drinking (Hwang et al., 2024). It is also established that this impact to sleep physiology can occur even at relatively low doses (Gardiner et al., 2025; Zheng et al., 2024). If the structure of employment within society means that workers (compared to retirees) have less hours in a day to freely decide their schedule, it is possible that alcohol consumption would occur more regularly after work hours. This potentially explains why frequency was so significant for workers reporting substantial sleep problems. Furthermore, the fact that sleep disruption occurs at relatively low dosages of alcohol may also explain why quantity was not associated with sleep problems, because regardless of the amount consumed, the daily schedule constraints of employment mean that drinking any amount of alcohol after work could result in alcohol being present in the body during sleep onset. Aside from the included frequency variable, the NZ-HWR study had no items on typical routine associated with drinking, and no items on when drinking typically occurred within participants' schedule. Therefore, future research could benefit from the inclusion of questions asking when and how participants typically consume alcohol (i.e. time of day, in social settings, with dinner, on weekends, etc).

Alcohol as a Sleep Aid

It is noteworthy that the methods of analysis utilised within this study do not allow for interpretation of the directions of relationships, only the strength of associations. This means it is possible that the inverse is true: that workers are more likely to have sleep problems, and therefore more likely to drink alcohol to help them sleep or to self-medicate disturbed or problematic sleep. The use of alcohol as a sleep aid is well established as a phenomenon (Leger et al., 2022; Midorikawa et al., 2019; Moskal et al., 2025). Literature in this area specifically on older adults suggests that alcohol may be used as a sleep aid to counteract sleep complaints associated with ageing (Leger et al., 2022), and that older males are more likely to choose alcohol over other sleep aids (e.g. medication) (Morin et al., 2024).

The relationship between sleep disorders and alcohol usage later in life can also be increased by the prevalence of childhood sleep problems (Sabatier et al., 2024), meaning that attending to wider health context and health status is important when researching this dynamic. Subjective reports of insomnia features have been shown to correlate with more frequent drinking (Burgess et al., 2024). Because of the notoriety of alcohol as a sleep aid, public perception may have yet to catch up on the fact that research shows that the potentially beneficial aspects of alcohol (i.e. sedation, shorter SOL times) are vastly outweighed by the numerous ways it harms sleep health (Gardiner et al., 2025; Leger et al., 2022), and some research has found that the beneficial aspects of alcohol sedation quickly loose potency with even a few days of continuous usage (Stein & Friedmann, 2006).

In NZ, there is limited-service usage and availability of treatment for insomnia, meaning that some older adults may need to self-manage symptoms with over-the-counter sleep aids, or alcohol. The health sector lacks a systematic pathway for diagnosing insomnia (Sleep/Wake Research Centre, 2019), and sectors relating to insomnia treatment tends to be underfunded (O'Keeffe et al., 2012). Globally, the sleep health education of health professionals is often insufficient (Meaklim et al., 2020), and lack of appropriate sleep health knowledge has also been reported within NZ (Meaklim et al., 2020; O'Keeffe et al., 2012). The status of medication containing melatonin to treat insomnia was recently updated and is now available without a prescription for up to 30-days for adults. For older adults with insomnia, melatonin has been available in 13 week increments since 2019, but this requires consultation with a pharmacist (Medsafe, 2019, 2025). While these changes acknowledge how older adults tend to have higher prevalence of insomnia symptoms, melatonin is typically not funded in adults (Medsafe, 2025).

This combination of a general lack of good quality information on sleep health among the general population (Meaklim et al., 2020) and the common misconception that alcohol is an effective sleep aid (Leger et al., 2022) may cause older adults to use alcohol to treat symptoms of insomnia, without realising the harm it cause to their sleep health. It is also possible that some adults self-medicate symptoms without acknowledging or fully knowing they had symptoms of insomnia. Furthermore, the aforementioned context of inaccessible insomnia diagnostic pathways in NZ also means that older adults who want to try improving their sleep health may struggle to access the services they need and may need to turn to other options to manage their symptoms.

Socioeconomic Status

A factor relating to alcohol policy and societal perception is SES. SES has been linked to drinking patterns in NZ, and wealthier individuals have been found to be more likely to drink more alcohol and drink more hazardously (Towers et al., 2017; Towers et al., 2011). Research has found that attitudes and belief in claims about the positive benefits that low alcohol consumption can have on health are often linked to higher

SES (Petticrew et al., 2025), and the WHO advises that richer drinkers are more likely to have the perception that alcohol is less harmful (World Health Organization, 2023). This is noteworthy because if higher SES is associated with numerous other protective factors for health and wellbeing (World Health Organization, 2023), it means individuals with a higher standard of living may be drinking higher quantities of alcohol, with the belief that their drinking is less harmful than it actually is. This is especially true if the harm they are experiencing is impacting them in a chronic manner rather than an acute manner (e.g. increasing risk of cancer without causing acute hospitalisations).

The participants in this study were generally likely to have a relatively high standard of living, with the median scores of the ELSI-SF for retirees, workers, and both cohorts situated in the “good” material standard of living category (and the lower limit of the IQR for each cohort as well as overall was situated within the “comfortable” range). This reflects the tendency for survey respondents to be of higher than average SES (i.e. wealthier) (Cohen & Duffy, 2002). While there were less participants who drank extremely high quantities of alcohol, there was a substantial portion that reported drinking more than the recommended limits, and a portion of retirees and workers who drank very frequently. Additionally, if alcohol is typically underreported in surveys, it is possible that participants were drinking higher quantities and frequencies than was shown in the data, and that the true portion of participants who drink over the guidelines for healthy adults is higher than was reported here.

Alcohol: Health Information and Policy

As previously mentioned, the NZ recommended guidelines on alcohol intake for men is three drinks per day (15 per week) and for women, two drinks per day (total 10 per week) (Health New Zealand – Te Whatu Ora, 2025b). Guidelines for older adults are not as specific, and simply state that older adults may need to drink less than this to avoid harmful impacts on their health because of changes to physiology during ageing (Health New Zealand – Te Whatu Ora, 2025a). The present study found that relatively moderate dosages of alcohol affected sleep for retirees, and that any level of regular drinking was associated with sleep problems for older adult workers. This could indicate that the public health environment surrounding alcohol in NZ is not up to date with how alcohol can impact health during ageing.

The alcohol industry has been known to influence public health perception and research around the health impacts of alcohol (Petticrew et al., 2025; Stockwell et al., 2024), and NZ is no exception (Towers et al., 2025). Historically, public perception of alcohol has included claims around how low alcohol consumption is linked to longevity and improved health outcomes (Stockwell et al., 2024). However, in recent years, numerous studies have begun debunking this and highlighting how any consumption of alcohol can impact health outcomes (Stockwell et al., 2024; World Health Organization, 2023). Additionally, methodological issues have been found within several of the studies that link alcohol and longevity (Petticrew et al., 2025; World Health Organization, 2023). Even nowadays, there is a global trend where information on drinking often warns against excessive alcohol consumption, while subtly implying that “non-excessive” consumption may be unharmful (Petticrew et al., 2025).

The NZ recommended guidelines state they are specifically catered towards reducing long term harm from alcohol (Health New Zealand – Te Whatu Ora, 2025a, 2025b), and do clarify that even when drinking within the recommended limits, that this does not mean there is no risk to health: "… [this is] advice to reduce long-term health risks. Low risk is not no risk."(Health New Zealand – Te Whatu Ora, 2025a, p. 21). However, it is possible that these guidelines could be more direct. In 2023, the World Health Organisation published a statement stating "no level of alcohol consumption is safe for our health" (World Health Organization, 2023), further explaining that there have been no concrete studies that demonstrate that the potential benefit from drinking alcohol outweighs the harm to health and the established causal relationship between drinking and cancers.

Recent survey data from NZ adults shows that adults are generally aware of alcohol being linked to worse health outcomes, but that there are definite areas for improvement in public health information and policy (Peniamina et al., 2023). As of 2024, NZ began reviewing potential revisions of the lower recommended limits of alcohol consumption (Towers et al., 2025). The current NZ guidelines discuss risk, without explicitly stating that there is no safe level of alcohol consumption and lack explicit information on increased cancer risk (Towers et al., 2025). However, lobbying from the alcohol industry has delayed this process significantly and contributed to information about these revision being less accessible to the public (Alcohol Healthwatch – Whakatūpato Waipiro, 2025, July 16; Towers et al., 2025), including removing the acknowledgement of the outdated guidelines and the ongoing review process from the *Te Whatu Ora* webpage on alcohol limits (Alcohol Healthwatch – Whakatūpato Waipiro, 2025, July 16). This obfuscation of information is concerning as research suggests that increased awareness of the harmful impacts of alcohol is positively connected to a NZ adult's support for improvement in policy (Peniamina et al., 2023). As of February 2026, the official guidelines have not been updated since 2011.

There is data to suggest that the amount of young people who drank alcohol is decreasing over the last 5 years (Ministry of Health – Manatū Hauora, 2025; New Zealand Alcohol Beverages Council, 2025), and that younger people are drinking with more moderation than past generations (New Zealand Alcohol Beverages Council, 2025, 2026). Additionally, it seems a higher proportion of younger people drink low alcohol (i.e. low ABV) beverages than previous generations (New Zealand Alcohol Beverages Council, 2026). This possibly indicates that younger adults have different access to education on the harm that alcohol causes to health and wellbeing. This potential imbalance in access to health information is especially pertinent as the risk of harm from drinking increases with age (Bareham & Seddon, 2022).

Ageing is associated with changes to coordination and balance meaning that the physiological effects of alcohol can exacerbate the existing increased risk of falls and related injuries. Additionally, older adults are more likely to have more comorbid diagnoses (e.g. cardiovascular conditions, diabetes, etc) that can further increase the risk of harm that drinking causes (Bareham & Seddon, 2022), and these conditions may require treatment that can result in medication interactions with alcohol (Boumans et al., 2022; Health New Zealand – Te Whatu Ora, 2025a). Older adults also take longer to recover from alcohol related harm, meaning that the increased risk could continue to impact their health and wellbeing for a longer period than their younger counterparts (Bareham & Seddon, 2022).

Considerations

When interpreting the findings of this research, there are several important considerations. This study utilised survey data meaning it is subject to the bias and recall influences that is typical of subjective reports (Schmier & Halpern, 2004), particularly in areas of alcohol consumption and sleeping which can be subject to impaired recall and social biases (Landry et al., 2015; Livingston & Callinan, 2015). Relating to the employed survey methodology are the fact that a comprehensive validated sleep measure was not included in its entirety, and that the AUDIT-C/Q-F had some technical limitations. Finally, research protocols and scope can influence the populations that are able to be observed, and therefore also the populations that remain invisible within the data. These hidden populations may have experiences of sleep and alcohol that differ from the findings in this study, and care should be taken to interpret findings with this context. Further detail on each of these considerations will be covered within the following sections.

Self-report Surveys

The NZ-HWR study is a strong data set using surveys every two years among over 4,000 participants. However, data is subject to reliability and validity issues due to the limitations of self-report and retrospective recall (Schmier & Halpern, 2004). For example, alcohol consumption is often underreported in surveys (Stevenson et al., 2015), potentially due to the memory inhibitory impacts of alcohol (Blazer & Wu, 2009; Stevenson et al., 2015), or because the stigmatisation of alcohol within culture may contribute to underreporting of hazardous or frequent drinking (Blazer & Wu, 2009). However, this trend is not always uniform across demographic groups or alcohol consumption categories (Livingston & Callinan, 2015), meaning that the full severity and impact of underreporting bias on data accuracy is not fully predictable or understood. Additionally, if alcohol is often underreported, it is possible that retirees who reported drinking a little above the recommended level of alcohol were actually drinking more than a little above the recommendation (2-3 drinks) (Health New Zealand – Te Whatu Ora, 2025a, 2025b), and this could further explain why alcohol impacted sleep at this threshold.

The act of falling and being asleep is a process of amnesia and unconsciousness, so subjective sleep health characteristics are often also impacted by memory and reporting issues (Cudney et al., 2022). Subjective survey data can be poor at identifying the way that sleep may be fragmented or disrupted throughout the night, contributing to differences in measures of sleep quality and sleep efficiency (Cudney et al., 2022; Landry et al., 2015). Sleep duration is similarly inconsistent across subjective and objective measures (Benz et al., 2023; Gaiduk et al., 2020).

When considering sleep health, sleeping should be framed as a process occurring within the 24-hour day, not as an isolated event (Matricciani et al., 2018). Other behaviours and events throughout the day can impact the sleep health of individuals (Matricciani et al., 2018). Subjective measures of sleep phenomena and sleep health characteristics are an important aspect of sleep health (Buysse, 2014), and the scope of objective measurement is often limited by funding and labour costs, and typically involves much smaller sample size (Rundo & Downey, 2019). This means that as that the sleep health variables included in this study were discussed within the parameters of subjective sleep health, their potential inconsistency with objective data is not necessarily a limitation, and more a byproduct of the methodology used. Subjective measures are beneficial when considering the impact of alcohol consumption on sleep health as they improve understanding of perception and opinion, which are important factors of health behaviour.

When examining health behaviours through questionnaires that use retrospective recall, there are some methods to potentially reduce the likelihood of recall bias (Schmier & Halpern, 2004). These include using clear and precise language (i.e. common terms, avoiding scientific 'jargon'), defining specific time frames (e.g. "over the past 30 days...", etc), and framing concepts objectively (Schmier & Halpern, 2004). Majority of the included variables specified relevant timeframes, defined key terms, or provided clarifying examples within the item (e.g. the definition of 'difficulty' in the sleep problems item, examples of various activities indicative of moderate or vigorous physical activity, stating sleep duration included 'all naps and sleeps', etc.). This demonstrates the care taken in selecting questions for the NZ-HWR study, and reflects the fact that, at time of data collection in 2022, the NZ-HWR study had been running for 16 years. Furthermore, all items included in the original 2022 survey were drawn from academic sources, including research, validated measures, or expert recommendations (Health and Ageing Research Team, 2022).

Comprehensive Validated Sleep Measures

A full, comprehensive and validated sleep scale was not included in the 2022 NZ-HWR survey (Health and Ageing Research Team, 2022) and therefore could not be administered to the participants. Some of the included sleep health variables were single items sourced from validated sleep health scales (Health and Ageing Research

Team, 2022). In other cases, the sleep health variables were taken from scales measuring other aspects of health (e.g. screening for depression which included aspects of insomnia, screening for frailty which included aspects of fatigue, etc). Single items are generally psychometrically weaker than full measures (Cuvillier et al., 2021), however, further context should be taken into account.

Sleep health characteristics are best examined through validated comprehensive measures that understand the holistic nature of sleep health (Buysse, 2014), and generally it is best practise to utilise full comprehensive sleep health measures. However, in surveys that focus on many aspects of health and wellbeing (like the NZ-HWR study), it is often not feasible to include validated measures in their entirety, out of respect to the time burden on participations and the logistics and costs of survey administration. When examining health behaviours and mood, single items have been shown to have generally acceptable correlation with multi-item measures (Verster et al., 2021). Some research has found that using single items from validated sleep health measures were equivalently valid to using the full measure, especially when research insomnia (Snyder et al., 2018). Single-item scales are beneficial when examining singular constructs, especially when a screening score or calculated subscale score not the focus on the study (Verster et al., 2021).

The present study aimed to explore the relationship between alcohol and sleep health in older adults through single item indicators of sleep disturbances. Therefore, provided the extracted sleep health items were used solely for the purpose of evaluating sleep health characteristics, extracting a single item relating to sleep health from an existing measure to be used only for the purpose of sleep health would likely not impact the validity of the data (i.e. extracting an item on insomnia from a depression scale would not impact analysis as the insomnia item relates to a single sleep health contract and the focus on the study was not on depression). Care was also taken to avoid issues with confounding and collinearity; after extracting a potential sleep health item, the original full measure was considered removed from the list of potential variables and would not be available for further analysis (i.e. using an insomnia screening item from a depression scale meant no other part of the depression scale was used in analysis).

The holistic model of sleep health emphasises that subjective reports of sleep health characteristics are an important part of sleep health, and that sleep quality is best suited to single item questions that enquire on perceived experiences of sleep quality (Buysse, 2014). Therefore, it seems that the methodology of the present study that focused on sleep problems as a characteristic of sleep quality was appropriate given the survey data collection methods.

Alcohol Quantity: Cohort Size

Another potential limitation is the fact that there were varying rates of reported quantity and frequency of alcohol consumption. In this sample consuming higher amounts of alcohol was rare, with only 10.5% of the total sample reporting typically drinking at least five drinks when they drank. While this was a large sample, and 10.5% constitutes a significant number of participants, it is notable that this was comparatively lower than most other alcohol variables categories in this study. For example, every alcohol frequency category across both cohorts had on average 20% of participants in each category (*SD*=2.92), indicating the distribution was more consistent than in the alcohol quantity variable. This could mean that the trend of drinking lower quantities of alcohol meant that there was less association between alcohol quantity and sleep health characteristics, because the majority drank low amounts, meaning that trends could be impacted by this uneven distribution of data.

Flaws of the AUDIT-C/Q-F. It is worth noting that the way the NZ-HWR items were ordered meant that participants who had drunk alcohol at some point in their lives would answer the AUDIT-C quantity question, without indication of the recency of this drinking behaviour. While this was assumedly a small sub-section of participants as most were likely screened out through the creation of a custom 'non-drinker' category as a baseline for the quantity variable, there was a portion of participants for whom it was not possible to determine whether they drank recently or not, and they were not able to be identified for removal during data cleaning. Future work in this area would benefit from more careful distinction around recency of alcohol consumption, for example, whether this behaviour is "new" or "chronic".

Hidden Populations

A notable strength of the methodology of the NZ-HWR study was the oversampling of Māori older adults, enabling improved information on their experience of ageing and retirement (Towers, 2007). This highlights the HART team's ethical duty to uphold principles of Te Tiriti o Waitangi, and their recognition of how culture can contribute to inequalities around opportunities to participate in research.

While some (aforementioned) aspects of sleep health and alcohol behaviour were not included in the content 2022 wave, the NZ-HWR survey is comprehensive, covering a variety of aspects of health and ageing including (but not limited to) financial situation, living standards, employment, retirement, various indicators of physical and psychological health status (diagnoses, mental health measures, cognition, etc), experiences and frequency of various of health service usage, housing, and factors associated with injury during ageing (falls, hospitalisations, etc) (Health and Ageing Research Team, 2022). A survey of this depth often imparts a significant time burden on participants, and it is possible that older adults with poorer health status were less able to participate (or complete their participation) (Cohen & Duffy, 2002). Additionally, due to restrictions on logistics, funding, and scope, the 2022 wave could not feasibly provide alternative versions of the survey as accommodations for those with worse health (e.g. telephone interviews, audio recording of the survey, braille transcript of the survey, etc). As sleep is bidirectionally linked to health status (Buysse, 2014), it is possible that older adults with poorer health status or disabilities differ in their experiences of sleep health from the included population, and findings should be interpreted with the understanding that participants were at a level of health or ability that did not inhibit their ability to participate in a long research survey. Even in this reasonably healthy and wealthy population, the proportion of those who reported substantial sleep problems was around one third, and these rates would likely be exacerbated within these hidden populations.

This study was novel in its approach to differentiate populations of older New Zealanders by work and retirement status while research sleep health and alcohol. This was aided by the NZ-HWR study's in depth focus on experiences of retirement. However, this methodology excluded data from participants who were unemployed, homemakers, students, or otherwise unable to work. However, it is possible that the stratification of work/retirement status and the exclusion of participants who were not employed pre-retirement contributed to the lower than expected rates of Māori within each cohort, as Māori are more likely to experience inequalities around employment opportunities (Hogarth & Rapata-Hanning, 2023). It also meant that data on alcohol consumption while not employed pre-retirement could not be analysed, potentially marginalising the experiences of sleep health for those who drank alcohol in ways that impacted their employment status or ability to maintain work (i.e. heavy drinkers or those with AUD (Jørgensen et al., 2019)). Future work could benefit from utilising a longitudinal within-subject design that track changes in sleep and alcohol consumption per individual pre- and post-retirement (this type of analysis would be possible using the longitudinal NZ-HWR dataset).

As noted previously, participants generally reported a good standard of living. This standard of living potentially reflects how those with higher SES are more likely to participate in research and those with lower SES are more likely to not respond or be lost to contact (Cohen & Duffy, 2002). As higher SES is associated with an increased likelihood of protective health factors and better access to healthcare opportunities (World Health Organization, 2023), it is possible that experiences of alcohol related harm and those with poorer sleep health status may be not be visible within the findings of this study. However, it is notable that alcohol consumption is associated with a financial cost, and that higher SES can been linked to increased drinking in NZ (Szabo, Towers, Newcombe, et al., 2021; Szabo, Towers, Sheridan, et al., 2021), potentially meaning that this data encapsulates an adequate scope of alcohol consumption in older adults.

Future Directions

Recommendations for Research

Sleep duration and sleep problems are only two aspects of sleep health, and the multi-faceted nature of sleep health (Buysse, 2014), alongside its bidirectional relationship with most other areas of health and health behaviour, means that future studies could further investigate whether relationships differ in other sleep health characteristics pre- and post-retirement, partially regarding the timings of alcohol consumption and the position of sleep within the 24-hour day. Research could also benefit from longitudinal within-subject analysis that explores how sleep and alcohol change per person throughout the retirement transition, and this could provide richer data and enable better understanding of individuals' experiences. Some additional recommendations for future research have been included throughout this discussion when interpreting the present research findings and the limitations of the project.

To summarise, these include incorporation of daily time use metrics regarding evening schedule for workers and daily schedules for retirees, indicators of whether alcohol quantity and frequency increased or decreased after the retirement transition, inclusion of a variable regarding how long individuals have been retired to assess the impact of latter retirement years on drinking and health, and improved information on the contexts in which older adults consume alcohol (e.g. social occasions, weekends, with dinner, etc).

Particularly, data on daily scheduling and time usage would have improved the quality of the findings, especially considering that the poor fit of the sleep duration regression model implies there were other variables relating to time usage that better explained the relationship between alcohol consumption and sleep duration in older adults. Potential methods to explore daily schedule could include more questions on typical daily structure or use diaries to explore daily usage and routine. Information on typical sleep schedule could be explored through sleep diaries or through objective measures such as actigraphy (wrist worn device that calculates sleep periods through activity/movement data).

Finally, as previously mentioned, a large flaw in this study and its related data collection process was the inability to determine the recency of alcohol consumption for the quantity variable, while the sleep health items included clearly defined time periods. Future work in this area could benefit from examination of how recent reported alcohol behaviours are or investigate how the recency of alcohol consumption is related to sleep health in older adults in NZ.

Recommendations for Health Promotion and Education

The present study found that the quantity of alcohol consumed per typical drinking occasion was associated with indicators of worse sleep health during retirement and that the frequency of alcohol consumption was associated with more substantial sleep problems while working. Interpreting these findings within the local NZ context (regarding accessibility of public health information and education on alcohol) suggests that current policy for older adults could benefit from improved detail on how alcohol harms health during ageing. The retirement transition is associated with changes to sleep and mood, but further information on how these vary over the whole retirement period for NZ older adults would be beneficial when planning interventions.

A systematic review of literature focusing on interventions for alcohol harm found that effective interventions involve three main aspects (Boumans et al., 2022). Firstly, it is important to provide accurate information on the dangers of drinking during ageing and associated harms and risk. Secondly, efforts should demonstrate an awareness of how loneliness is associated with ageing and drinking (and how drinking can provide social interactions that help ease isolation during ageing/retirement) and should provide sober connection opportunities for older adults. Finally, that it is beneficial to encourage personalised advice from practitioners on alcohol consumption (Boumans et al., 2022). As acknowledged by the authors, two of these are focused on increasing awareness and accessibility of information (Boumans et al., 2022).

Individual agency is important for health, and people should be able to make choices without stigmatisation. The present study has tried to balance the fact that alcohol is associated with worse health outcomes and that good sleep health is important during ageing alongside the fact that individual agency in choosing health behaviours is important for wellbeing. However, it is still worthwhile to aim to improve education and accessibility of information so people can make *informed* decisions about their health and wellbeing. While it is generally known that drinking large amounts of alcohol is associated with negative health impacts, it is lesser known that drinking any alcohol is associated with risks to long term health, and that even low quantity or frequency consumption of alcohol can impair healthy sleep, which is important for ageing well and maintaining wellbeing during later years of life. The vagueness of the NZ guidelines on alcohol for older adults, as well as the findings relating to the drinking behaviour patterns of the participants in this study and the impact of this on their sleep health, demonstrate the need for improved alcohol policy in NZ. The projected portion of older adults within the population is predicted to increase in coming years (Stats NZ – Tatauranga Aotearoa, 2022). Therefore, unless the impact that alcohol has on health and sleep is readily available and known, older adults may continue to drink alcohol without being appropriately informed of the ways it can harm their sleep and health.

Another opportunity from this research regarding health promotion is how this could influence social perceptions of drinking. Alcohol composition is linked to social interactions in two main ways: the contexts in which alcohol is often consumed are typically social and there is an expectation of drinking during social events in NZ (New Zealand Alcohol Beverages Council, 2019); and, that stereotypes and attitudes surrounding alcohol are replicated though social channels (Herbert et al., 2017). Therefore, interventions need to acknowledge the social aspects of drinking as well as promoting healthy sleep behaviours. Potential suggestions are providing spaces for older adults to socialise that are sober or not centred around alcohol and drinking (Boumans et al., 2022), improving information on alcohol related harm so older adults can make informed choices about their choice to drink, and safe alcohol consumption as a part of social and cultural leadership while ageing (Herbert et al., 2017). Implementing these improvements in public health education would enable older adults to make informed decisions regarding their alcohol consumption and have greater understanding of how drinking can impact sleep health and wellbeing during ageing.

Conclusion

This study was the first of its kind to explore the relationship between alcohol usage and sleep among older working and retired New Zealanders. Alcohol was found to impact sleep health in different ways both during employment and after retirement. Drinking alcohol with any level of regularity while employed was associated with >99% increase in reported substantial sleep problems. Hypothesised mechanisms include how employment discourages workers from consuming alcohol during the workday and thereby influences workers who drink to consume alcohol significantly closer to bedtime which disrupts normal sleep physiology and structure. It is also possible that factors relating to employment are associated with sleep problems, meaning that the commitment to employment causes higher frequencies of using alcohol as a sleep aid, which is known to be harmful to sleep health. Retirees who drank who typically drank 3-4 drinks on days they consumed alcohol had shorter sleep duration and higher rates of substantial sleep problems than their peers who drank other quantities of alcohol. This is potentially related to the physiological changes to the metabolism of alcohol, as well as metabolic changes that occur normally during ageing. It is also possible that retirement acts as a context that enables retirees who drink to consumer lower and more frequent quantities of alcohol throughout their day, meaning that the direct impacts on sleep are less noticeable than was seen in workers.

This study found that alcohol impacted sleep even when participants were drinking less than weekly or were drinking moderate amounts of alcohol without binge drinking (i.e. not consuming >6 drinks on one occasion). This supports research that has found that even low amounts of alcohol can impact sleep health (Gardiner et al., 2025), and this may potentially call for public health policy within NZ to acknowledge that the consumption patterns of alcohol in older adults are not without negative impact, meaning that public health efforts should work to raise awareness so that older adults can make informed choices regarding their sleep health during ageing.

References

Åkerstedt, T., Discacciati, A., Miley-Åkerstedt, A., & Westerlund, H. (2018). Aging and the change in fatigue and sleep - a longitudinal study across 8 years in three age groups. *Front Psychol*, *9*, 234. https://doi.org/10.3389/fpsyg.2018.00234

Åkerstedt, T., Hume, K., Minors, D., & Waterhouse, J. (1994). The meaning of good sleep: A longitudinal study of polysomnography and subjective sleep quality. *J Sleep Res*, *3*(3), 152-158. https://doi.org/10.1111/j.1365-2869.1994.tb00122.x

Alcohol Healthwatch – Whakatūpato Waipiro. (2025, July 16). *Media release: New low-risk drinking guidelines challenge outdated advice* https://www.ahw.org.nz/Portals/5/Resources/media/2025/Media%20Release%20-%20Low%20risk%20drinking%20guidelines%20media%20release%2016_7_25%20Updated%20V3.pdf

Alnawwar, M. A., Alraddadi, M. I., Algethmi, R. A., Salem, G. A., Salem, M. A., & Alharbi, A. A. (2023). The effect of physical activity on sleep quality and sleep disorder: A systematic review. *Cureus*, *15*(8), e43595.

Amidi, A., Buskbjerg, C. D. R., Christensen, D. S., Wu, L. M., & Zachariae, R. (2024). Sleep and mental health in the ageing population. In G. Kaur & S. I. S. Rattan (Eds.), *Brain and mental health in ageing* (pp. 395-417). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-68513-2_19

An, J., Payne, L. L., Lee, M., & Janke, M. C. (2023). Understanding boredom and leisure in later life: A systematic review. *Innov Aging*, *7*(8), igad109. https://doi.org/10.1093/geroni/igad109

Andresen, E. M., Malmgren, J. A., Carter, W. B., & Patrick, D. L. (1994). Screening for depression in well older adults: Evaluation of a short form of the ces-d (center for epidemiologic studies depression scale). *Am J Prev Med*, *10*(2), 77-84.

Antonaglia, C., Fabozzi, A., Steffanina, A., Ture, R., Palange, P., & Confalonieri, M. (2025). Walking the fine line between osa and aging. *Sleep Breath*, *29*(3), 195. https://doi.org/10.1007/s11325-025-03343-x

Babor, T. F., Higgins-Biddle, J. C., Saunders, J. B., & Monteiro, M. G. (2001). *AUDIT: The alcohol use disorders identification test: Guidelines for use in primary health care (2nd ed.)*. https://iris.who.int/handle/10665/67205

Bacharach, S., Bamberger, P., Biron, M., & Horowitz-Rozen, M. (2008). Perceived agency in retirement and retiree drinking behavior: Job satisfaction as a moderator. *J Vocat Behav*, *73*(3), 376-386. https://doi.org/10.1016/j.jvb.2008.07.007

Bailey, S. M. (2026). Timing matters: Circadian rhythm disruption in alcohol-associated peripheral organ pathophysiology. *Function*, *7*(1), e099-2025. https://doi.org/10.1152/function.099.2025

Bareham, B., & Seddon, J. (2022). Alcohol use: Its meaning and impact in older age. In T. Thurnell-Read & L. Fenton (Eds.), *Alcohol, age, generation and the life course* (pp. 275-295). Springer International Publishing. https://doi.org/10.1007/978-3-031-04017-7_12

Bareham, B. K., Kaner, E., Spencer, L. P., & Hanratty, B. (2019). Drinking in later life: A systematic review and thematic synthesis of qualitative studies exploring older people's perceptions and experiences. *Age Ageing*, *48*(1), 134-146. https://doi.org/10.1093/ageing/afy069

Barnes, G. M., & Welte, J. W. (1990). Prediction of adults' drinking patterns from the drinking of their parents. *Journal of Studies on Alcohol*, *51*(6), 523-527. https://doi.org/10.15288/jsa.1990.51.523

Beideman, J., Kulak, J. A., & Watt, C. A. (2018). Legislation governing tobacco use in ontario’s retirement homes. *Journal of Aging & Social Policy*, *30*(2), 141-154. https://doi.org/10.1080/08959420.2017.1407215

Benz, F., Riemann, D., Domschke, K., Spiegelhalder, K., Johann, A. F., Marshall, N. S., & Feige, B. (2023). How many hours do you sleep? A comparison of subjective and objective sleep duration measures in a sample of insomnia patients and good sleepers. *Journal of Sleep Research*, *32*(2), e13802. https://doi.org/https://doi.org/10.1111/jsr.13802

Blazer, D. G., & Wu, L. T. (2009). The epidemiology of at-risk and binge drinking among middle-aged and elderly community adults: National survey on drug use and health. *Am J Psychiatry*, *166*(10), 1162-1169. https://doi.org/10.1176/appi.ajp.2009.09010016

Borbély, A. (2022). The two-process model of sleep regulation: Beginnings and outlook. *Journal of Sleep Research*, *31*(4), e13598. https://doi.org/https://doi.org/10.1111/jsr.13598

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

Borbély, A. A., Daan, S., Wirz-Justice, A., & Deboer, T. (2016). The two-process model of sleep regulation: A reappraisal. *Journal of Sleep Research*, *25*(2), 131-143. https://doi.org/https://doi.org/10.1111/jsr.12371

Boumans, J., van de Mheen, D., Crutzen, R., Dupont, H., Bovens, R., & Rozema, A. (2022). Understanding how and why alcohol interventions prevent and reduce problematic alcohol consumption among older adults: A systematic review. *International Journal of Environmental Research and Public Health*, *19*(6), 3188. https://www.mdpi.com/1660-4601/19/6/3188

https://pmc.ncbi.nlm.nih.gov/articles/PMC8953167/

Breheny, M., Ross, I., Ladyman, C., Signal, L., Gibson, R., & Dew, K. (2023). “It's just [complicated] sleep”: Discourses of sleep and aging in the media [Article]. *Gerontologist*, *63*(10), 1591-1601-1601. https://doi.org/10.1093/geront/gnad058

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American Psychologist*, *32*(7), 513-531. https://doi.org/10.1037/0003-066X.32.7.513

Burgess, H. J., Rizvydeen, M., Kikyo, F., Kebbeh, N., Tan, M., Roecklein, K. A., Hasler, B. P., King, A. C., & Cao, D. (2022). Sleep and circadian differences between light and heavy adult alcohol drinkers. *Alcoholism: Clinical & Experimental Research*, *46*(7), 1181-1191. https://doi.org/10.1111/acer.14872

Burgess, H. J., Troost, J. P., Rizvydeen, M., Kikyo, F., Kebbeh, N., Tan, M., Roecklein, K. A., King, A. C., & Hasler, B. P. (2024). Do sleep and circadian characteristics predict alcohol use in adult drinkers? *Alcohol, Clinical & Experimental Research*, *48*(4), 680-691. https://doi.org/10.1111/acer.15280

Burman, D., & Muzumdar, H. (2020). Sleep architecture and physiology. In *Management of sleep disorders in psychiatry*. (pp. 12-22).

Bush, K., Kivlahan, D. R., McDonell, M. B., Fihn, S. D., & Bradley, K. A. (1998). The AUDIT alcohol consumption questions (AUDIT-c): An effective brief screening test for problem drinking. Ambulatory care quality improvement project (acquip). Alcohol use disorders identification test. *Arch Intern Med*, *158*(16), 1789-1795. https://doi.org/10.1001/archinte.158.16.1789

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

Buysse, D. J., Reynolds, C. F., 3rd, Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Res*, *28*(2), 193-213. https://doi.org/10.1016/0165-1781(89)90047-4

Carter, M. A. T., & Cook, K. (1995). *Adaptation to retirement: Role changes and psychological resources* (0889-4019). (Career Development Quarterly, Issue. https://research.ebsco.com/linkprocessor/plink?id=d5b248ef-6085-3554-be68-247943039dd8

Chaput, J.-P., McNeil, J., Després, J.-P., Bouchard, C., & Tremblay, A. (2012). Short sleep duration is associated with greater alcohol consumption in adults. *Appetite*, *59*(3), 650-655. https://doi.org/https://doi.org/10.1016/j.appet.2012.07.012

Chueh, K.-H., Guilleminault, C., & Lin, C.-M. (2019). Alcohol consumption as a moderator of anxiety and sleep quality. *Journal of Nursing Research*, *27*(3). https://journals.lww.com/jnr-twna/fulltext/2019/06000/alcohol_consumption_as_a_moderator_of_anxiety_and.5.aspx

Chueh, K.-H., Yang, M.-S., Chen, C.-S., & Chiou, S.-M. (2009). Poor sleep quality and alcohol use problems among elderly taiwanese aboriginal women. *International Psychogeriatrics*, *21*(3), 593-599. https://doi.org/10.1017/S1041610209008850

Cohen-Mansfield, J. (2016). Predictors of smoking cessation in old-old age. *Nicotine Tob Res*, *18*(7), 1675-1679. https://doi.org/10.1093/ntr/ntw011

Cohen, G., & Duffy, J. C. (2002). Are nonrespondents to health surveys less healthy than respondents? *Journal of Official Statistics*, *18*(1), 13.

Crestani, F., Williams, G., Gander, P., Gibson, R., Breheny, M., Tupara, H., & Cunningham, C. (2022). Sleep health in later life: Interviews exploring experiences, attitudes and behaviours of older people [Article]. *Ageing and Society*. https://doi.org/10.1017/S0144686X22000447

Cudney, L. E., Frey, B. N., McCabe, R. E., & Green, S. M. (2022). Investigating the relationship between objective measures of sleep and self-report sleep quality in healthy adults: A review. *J Clin Sleep Med*, *18*(3), 927-936. https://doi.org/10.5664/jcsm.9708

Cuvillier, M., Léger, P.-M., & Sénécal, S. (2021). Quantity over quality: Do single-item scales reflect what users truly experienced? *Computers in Human Behavior Reports*, *4*, 100097. https://doi.org/https://doi.org/10.1016/j.chbr.2021.100097

Della Monica, C., Johnsen, S., Atzori, G., Groeger, J. A., & Dijk, D. J. (2018). Rapid eye movement sleep, sleep continuity and slow wave sleep as predictors of cognition, mood, and subjective sleep quality in healthy men and women, aged 20-84 years. *Front Psychiatry*, *9*, 255. https://doi.org/10.3389/fpsyt.2018.00255

Desai, D., Momin, A., Hirpara, P., Jha, H., Thaker, R., & Patel, J. (2024). Exploring the role of circadian rhythms in sleep and recovery: A review article. *Cureus*, *16*(6), e61568. https://doi.org/10.7759/cureus.61568

Duncanson, M. J. (2011). *Unintentional domestic injury from fire and flame in Aotearoa New Zealand* [Doctoral Thesis, University of Otago].

Dzierzewski, J. M., Dautovich, N., & Ravyts, S. (2018). Sleep and cognition in older adults. *Sleep Med Clin*, *13*(1), 93-106. https://doi.org/10.1016/j.jsmc.2017.09.009

Edgar, F., Nicholson, D., Duffy, T., Seaman, P., Bell, K., & Gilhooly, M. (2016). Alcohol use across retirement: A qualitative study into drinking in later life. *Glasgow: Glasgow Centre for Population Health*.

Ellis, J. G., Perlis, M. L., & Posner, D. (2021). Insomnia. In *Handbook of cognitive behavioral therapy: Applications, vol. 2* (pp. 291-329). American Psychological Association. https://doi.org/10.1037/0000219-009

Employment New Zealand. (2026). *Understanding types of workers*. Ministry of Business, Innovation and Employment – Hikina Whakatutuki. https://www.employment.govt.nz/starting-employment/types-of-worker/understanding-types-of-workers

Endeshaw, Y. W. (2015). Do sleep complaints predict persistent fatigue in older adults? *Journal of the American Geriatrics Society*, *63*(4), 716-721.

Fergusson, D. M., Hong, B., Horwood, J., Jensen, J., & Travers, P. D. (2001). *Living standards of older new zealanders: A technical account*. Ministry of Social Policy.

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). SAGE Publications. https://books.google.co.nz/books?id=a6FLF1YOqtsC

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

Frone, M. R. (2016). Work stress and alcohol use: Developing and testing a biphasic self-medication model. *Work Stress*, *30*(4), 374-394. https://doi.org/10.1080/02678373.2016.1252971

Gaiduk, M., Seepold, R., Ortega, J. A., & Madrid, N. M. (2020). Comparison of sleep characteristics measurements: A case study with a population aged 65 and above. *Procedia Computer Science*, *176*, 2341-2349. https://doi.org/https://doi.org/10.1016/j.procs.2020.09.297

Garcia, C. C., Richards, D. K., Tuchman, F. R., Hallgren, K. A., Kranzler, H. R., Aubin, H.-J., O'Malley, S. S., Mann, K., Aldridge, A., Hoffman, M., Anton, R. F., & Witkiewitz, K. (2024). Reductions in world health organization risk drinking level are associated with improvements in sleep problems among individuals with alcohol use disorder. *Alcohol & Alcoholism*, *59*(3), 1-8. https://doi.org/10.1093/alcalc/agae022

Gardiner, C., Weakley, J., Burke, L. M., Roach, G. D., Sargent, C., Maniar, N., Huynh, M., Miller, D. J., Townshend, A., & Halson, S. L. (2025). The effect of alcohol on subsequent sleep in healthy adults: A systematic review and meta-analysis. *Sleep Medicine Reviews*, *80*. https://doi.org/10.1016/j.smrv.2024.102030

Garrouste, C., & Perdrix, E. (2022). Is there a consensus on the health consequences of retirement? A literature review. *Journal of Economic Surveys*, *36*(4), 841-879. https://doi.org/https://doi.org/10.1111/joes.12466

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. *J Gerontol A Biol Sci Med Sci*, *78*(10), 1908-1918. 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., Kepa, M., Dyall, L., Moyes, S., & Kerse, N. (2016). Sleep of māori and non-māori of advanced age. *The New Zealand medical journal*, *129*, 52-61.

Goheer, A., Holzhauer, K., Martinez, J., Woolf, T., Coughlin, J. W., Martin, L., Zhao, D., Lehmann, H., Clark, J. M., & Bennett, W. L. (2021). What influences the "when" of eating and sleeping?A qualitative interview study. *Appetite*, *156*, 104980. https://doi.org/https://doi.org/10.1016/j.appet.2020.104980

Grandner, M. A. (2019). Chapter 5 - social-ecological model of sleep health. In M. A. Grandner (Ed.), *Sleep and health* (pp. 45-53). Academic Press. https://doi.org/https://doi.org/10.1016/B978-0-12-815373-4.00005-8

Greenhaus, J., Parasuraman, S., & Wormley, W. (1990). Effects of race on organizational experiences, job performance evaluations, and career outcomes. *Academy of Management Journal*, *33*, 64-86. https://doi.org/10.2307/256352

Grigoriou, I., Kotoulas, S.-C., Porpodis, K., Spyratos, D., Papagiouvanni, I., Tsantos, A., Michailidou, A., Mourelatos, C., Mouratidou, C., Alevroudis, I., Marneri, A., & Pataka, A. (2024). The interactions between smoking and sleep. *Biomedicines*, *12*(8), 1765. https://www.mdpi.com/2227-9059/12/8/1765

Hagen, E. W., Barnet, J. H., Hale, L., & Peppard, P. E. (2016). Changes in sleep duration and sleep timing associated with retirement transitions. *Sleep*, *39*(3), 665-673. https://doi.org/10.5665/sleep.5548

Hale, L., Singer, L., Barnet, J. H., Peppard, P. E., & Hagen, E. W. (2017). Associations between midlife insomnia symptoms and earlier retirement. *Sleep Health*, *3*(3), 170-177. https://doi.org/https://doi.org/10.1016/j.sleh.2017.03.003

Hartwell, E. E., Bujarski, S., Glasner-Edwards, S., & Ray, L. A. (2015). The association of alcohol severity and sleep quality in problem drinkers. *Alcohol and Alcoholism*, *50*(5), 536-541. https://doi.org/10.1093/alcalc/agv046

Hastings, M. H., Maywood, E. S., & Brancaccio, M. (2018). Generation of circadian rhythms in the suprachiasmatic nucleus. *Nature Reviews Neuroscience*, *19*(8), 453-469. https://doi.org/10.1038/s41583-018-0026-z

Hayley, A. C., Stough, C., & Downey, L. A. (2017). Dsm-5 tobacco use disorder and sleep disturbance: Findings from the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III). *Substance Use & Misuse*, *52*(14), 1859-1870. https://doi.org/10.1080/10826084.2017.1316508

He, S., Hasler, B. P., & Chakravorty, S. (2019). Alcohol and sleep-related problems. *Curr Opin Psychol*, *30*, 117-122. https://doi.org/10.1016/j.copsyc.2019.03.007

Health and Ageing Research Team. (2022). *2022 Health, Work & Retirement survey content inventory*. https://www.massey.ac.nz/documents/1417/2022_content_inventory_V1.0.pdf

Health New Zealand – Te Whatu Ora. (2022). *Standard drinks and legal limits*. https://www.alcohol.org.nz/help-and-support/advice/standard-drinks-and-legal-limits

Health New Zealand – Te Whatu Ora. (2025a). Alcohol and older people. In.

Health New Zealand – Te Whatu Ora. (2025b). *Drinking responsibly*. https://info.health.nz/health-topics/mental-health/alcohol-and-drug-addiction/drinking-responsibly

Henry, J. R. (2023). *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* [Masters Thesis, Massey University]. https://mro.massey.ac.nz/server/api/core/bitstreams/ccb55bcf-ac19-466c-b49b-de2be099c1ab/content

Herbert, S., Forster, M., McCreanor, T., & Stephens, C. (2017). The social context of alcohol use among māori in Aotearoa/New Zealand: Reflections of life experiences of alcohol use by older māori. *International Journal of Indigenous Health*, *12*(1), 57-74.

Hogarth, K., & Rapata-Hanning, M. (2023). Māori health in Aotearoa new zealand. In J. A. Craft, C. J. Gordon, S. E. Huether, K. L. McCance, & V. L. Brashers (Eds.), *Understanding pathophysiology* (4th, Australia and New Zealand ed., pp. 1179-1197).

Horvat Davey, C., Griggs, S., Duwadi, D., Martin, S., & Hickman, R. L., Jr. (2024). Mental health, substance use, and a composite of sleep health in adults, 2018 ohio behavioral risk factor surveillance system. *Sleep Medicine*, *124*, 254-259. https://doi.org/10.1016/j.sleep.2024.09.010

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. *Clin Gerontol*, *41*(2), 145-157. https://doi.org/10.1080/07317115.2017.1408734

Hussain, J., Ling, L., Alonzo, R. T., Rodrigues, R., Nicholson, K., Stranges, S., & Anderson, K. K. (2022). Associations between sleep patterns, smoking, and alcohol use among older adults in canada: Insights from the canadian longitudinal study on aging (clsa). *Addictive Behaviors*, *132*. https://doi.org/10.1016/j.addbeh.2022.107345

Hwang, H.-F., Liang, W.-M., Chiu, Y.-N., & Lin, M.-R. (2003). Suitability of the whoqol-bref for community-dwelling older people in taiwan. *Age and Ageing*, *32*(6), 593-600. https://doi.org/10.1093/ageing/afg102

Hwang, I. C., Park, Y., Ahn, H. Y., Kim, K. J., & Park, S.-J. (2024). Association between alcohol consumption and sleep difficulty in a nationwide korean survey. *Journal of Research in Medical Sciences*, *29*, 1-6. https://doi.org/10.4103/jrms.jrms_805_23

Iao, S. I., Jansen, E., Shedden, K., O'Brien, L. M., Chervin, R. D., Knutson, K. L., & Dunietz, G. L. (2022). Associations between bedtime eating or drinking, sleep duration and wake after sleep onset: Findings from the american time use survey. *Br J Nutr*, *127*(12), 1888-1897. https://doi.org/10.1017/s0007114521003597

Institute of Medicine, Committee on Sleep Medicine and Research, & Board on Health Sciences Policy. (2006). *Sleep disorders and sleep deprivation: An unmet public health problem* (H. R. Colten & B. M. Altevogt, Eds.). The National Academies Press. https://doi.org/doi:10.17226/11617

Ishida, M., Sakai, C., Kobayashi, Y., & Ishida, T. (2024). Cigarette smoking and atherosclerotic cardiovascular disease. *Journal of Atherosclerosis and Thrombosis*, *31*(3), 189-200. https://doi.org/10.5551/jat.RV22015

Jason, K. J., Carr, D. C., Washington, T. R., Hilliard, T. S., & Mingo, C. A. (2015). Multiple chronic conditions, resilience, and workforce transitions in later life: A socio-ecological model. *The Gerontologist*, *57*(2), 269-281. https://doi.org/10.1093/geront/gnv101

Jay, S. M., Gander, P. H., Eng, A., Cheng, S., Douwes, J., Ellison-Loschmann, L., McLean, D., Pearce, N., & 'tMannetje, A. (2017). New zealanders working non-standard hours also have greater exposure to other workplace hazards. *Chronobiology International*, *34*(4), 519-526. https://doi.org/10.1080/07420528.2017.1307850

Jensen, J., Spittal, M., Crichton, S., Sathiyandra, S., & Krishnan, V. (2002). Direct measurement of living standards: The New Zealand elsi scale. *Wellington: Ministry of Social Development*.

Jensen, J., Spittal, M., & Krishnan, V. (2005). *Elsi short form: User manual for a direct measure of living standards*. Ministry of Social Development Wellington, New Zealand.

Johnson, D. A., Jackson, C. L., Williams, N. J., & Alcántara, C. (2019). Are sleep patterns influenced by race/ethnicity - a marker of relative advantage or disadvantage? Evidence to date. *Nat Sci Sleep*, *11*, 79-95. https://doi.org/10.2147/nss.S169312

Jones, C. J. (2022). *Profiles of sleep status among older adults in New Zealand: The association between alcohol use and other health and lifestyle factors.* [Masters Thesis, Massey University]. Wellington, New Zealand. https://research.ebsco.com/linkprocessor/plink?id=0ea74592-67ad-3927-ba3a-3d8724cffd9b

Jørgensen, M. B., Pedersen, J., Thygesen, L. C., Lau, C. J., Christensen, A. I., Becker, U., & Tolstrup, J. S. (2019). Alcohol consumption and labour market participation: A prospective cohort study of transitions between work, unemployment, sickness absence, and social benefits. *Eur J Epidemiol*, *34*(4), 397-407. https://doi.org/10.1007/s10654-018-0476-7

Joyce, L. R., Forman, E., Hlavac, A., Cleland, L., Crossin, R., & Foulds, J. (2024). Changes in alcohol-related emergency department presentations—a comparison of three waves in 2013, 2017 and 2022. *New Zealand Medical Journal*, *137*(1593), 56-67. https://doi.org/10.26635/6965.6375

Keklund, G., & Åkerstedt, T. (1997). Objective components of individual differences in subjective sleep quality. *Journal of Sleep Research*, *6*(4), 217-220. https://doi.org/https://doi.org/10.1111/j.1365-2869.1997.00217.x

Kim, J. E., & Moen, P. (2002). Retirement transitions, gender, and psychological well-being: A life-course, ecological model. *The Journals of Gerontology: Series B*, *57*(3), P212-P222. https://doi.org/10.1093/geronb/57.3.P212

Kontturi, M., Virtanen, M., Myllyntausta, S., Prakash, K. C., Pentti, J., Vahtera, J., & Stenholm, S. (2024). Are changes in sleep problems associated with changes in life satisfaction during the retirement transition? *Eur J Ageing*, *21*(1), 7. https://doi.org/10.1007/s10433-024-00802-4

Kuerbis, A., & Sacco, P. (2012). The impact of retirement on the drinking patterns of older adults: A review. *Addictive Behaviors*, *37*(5), 587-595. https://doi.org/https://doi.org/10.1016/j.addbeh.2012.01.022

Landry, G. J., Best, J. R., & Liu-Ambrose, T. (2015). Measuring sleep quality in older adults: A comparison using subjective and objective methods. *Front Aging Neurosci*, *7,* 166. https://doi.org/10.3389/fnagi.2015.00166

Lavidor, M., Weller, A., & Babkoff, H. (2003). How sleep is related to fatigue. *British Journal of Health Psychology*, *8*(1), 95-105. https://doi.org/https://doi.org/10.1348/135910703762879237

Lee, C. H. J., & Sibley, C. G. (2019). Sleep duration and psychological well-being among new zealanders. *Sleep Health: Journal of the National Sleep Foundation*, *5*(6), 606-614. https://doi.org/10.1016/j.sleh.2019.06.008

Lee, K. A., & Ward, T. M. (2005). Critical components of a sleep assessment for clinical practice settings. *Issues in Mental Health Nursing*, *26*(7), 739-750.

Leger, D., Collin, O., Chennaoui, M., Metlaine, A., Andler, R., Richard, J. B., & Nguyen-Thanh, V. (2022). Sleep, substance misuse and addictions: A nationwide observational survey on smoking, alcohol, cannabis and sleep in 12,637 adults. *Journal of Sleep Research*, *31*(5). https://doi.org/10.1111/jsr.13553

León-Barriera, R., Chaplin, M. M., Kaur, J., & Modesto-Lowe, V. (2025). Insomnia in older adults: A review of treatment options. *Cleveland Clinic Journal of Medicine*, *92*(1), 43-50. https://doi.org/10.3949/ccjm.92a.24073

Leota, J., Presby, D. M., Le, F., Czeisler, M. É., Mascaro, L., Capodilupo, E. R., Wiley, J. F., Drummond, S. P. A., Rajaratnam, S. M. W., & Facer-Childs, E. R. (2025). Doseresponse relationship between evening exercise and sleep. *Nature Communications*, *16*(1), 3297. https://doi.org/10.1038/s41467-025-58271-x

Li, J., Vitiello, M. V., & Gooneratne, N. S. (2022). Sleep in normal aging. *Sleep Medicine Clinics*, *17*(2), 161-171. https://doi.org/https://doi.org/10.1016/j.jsmc.2022.02.007

Libman, E., Fichten, C., Creti, L., Conrod, K., Tran, D.-L., Grad, R., Jorgensen, M., Amsel, R., Rizzo, D., Baltzan, M., Pavilanis, A., & Bailes, S. (2016). Refreshing sleep and sleep continuity determine perceived sleep quality. *Sleep Disorders*, *2016*(1), 7170610. https://doi.org/https://doi.org/10.1155/2016/7170610

Livingston, M., & Callinan, S. (2015). Underreporting in alcohol surveys: Whose drinking is underestimated? *Journal of Studies on Alcohol and Drugs*, *76*(1), 158-164. https://doi.org/10.15288/jsad.2015.76.158

Lu, H., Ayers, E., Patel, P., & Mattoo, T. K. (2023). Body water percentage from childhood to old age. *Kidney Res Clin Pract*, *42*(3), 340-348. https://doi.org/10.23876/j.krcp.22.062

Martinčeková, L., & Škrobáková, Ž. (2019). Transition from work to retirement: Theoretical models and factors of adaptation. *Individual & Society / Clovek a Spolocnost*, *22*(1), 1-15. https://doi.org/10.31577/cas.2019.01.549

Matricciani, L., Bin, Y. S., Lallukka, T., Kronholm, E., Wake, M., Paquet, C., Dumuid, D., & Olds, T. (2018). Rethinking the sleep-health link. *Sleep Health*, *4*(4), 339-348. https://doi.org/10.1016/j.sleh.2018.05.004

McHill, A. W., & Butler, M. P. (2024). Eating around the clock: Circadian rhythms of eating and metabolism. *Annu Rev Nutr*, *44*(1), 25-50. https://doi.org/10.1146/annurev-nutr-062122-014528

McMillan, A., & Morrell, M. J. (2016). Sleep disordered breathing at the extremes of age: The elderly. *Breathe*, *12*(1), 50-60. https://doi.org/10.1183/20734735.003216

Meaklim, H., Jackson, M. L., Bartlett, D., Saini, B., Falloon, K., Junge, M., Slater, J., Rehm, I. C., & Meltzer, L. J. (2020). Sleep education for healthcare providers: Addressing deficient sleep in australia and New Zealand. *Sleep Health*, *6*(5), 636-650. https://doi.org/https://doi.org/10.1016/j.sleh.2020.01.012

Medsafe. (2019). *Medicines classification update*. Ministry of Health – Manatū Hauora. https://www.medsafe.govt.nz/profs/PUArticles/September2019/Medicines-classification-update.htm

Medsafe. (2025). *Melatonin without a prescription*. Ministry of Health – Manatū Hauora. https://www.medsafe.govt.nz/profs/class/ReclassificationOfMelatonin2025.asp

Midorikawa, H., Tachikawa, H., Aiba, M., Arai, T., Watanabe, T., & Tamiya, N. (2019). Factors associated with high-risk drinking in older adults: Evidence from a national survey in Japan. *Geriatrics & Gerontology International*, *19*(12), 1260-1267. https://doi.org/https://doi.org/10.1111/ggi.13808

Ministry of Health – Manatū Hauora. (2025). *New Zealand health survey annual data explorer*. Ministry of Health. https://minhealthnz.shinyapps.io/nz-health-survey-

2024-25-annual-data-explorer/_w_d50352be6f3d49cfb66cc519a8a12250/#!/explore-indicators

Morin, C. M., Vézina-Im, L.-A., Chen, S.-J., Ivers, H., Carney, C. E., Chaput, J.-P., Dang-Vu, T. T., Davidson, J. R., Belleville, G., Lorrain, D., Horn, O., & Robillard, R. (2024). Prevalence of insomnia and use of sleep aids among adults in canada. *Sleep Medicine*, *124*, 338-345. https://doi.org/10.1016/j.sleep.2024.09.044

Moskal, K. R., Miller, M. B., Shoemaker, S. D., Trull, T. J., & Wycoff, A. M. (2025). Sleep quality and duration as predictors of alcohol and cannabis use motives in daily life. *Addictive Behaviors*, *163*. https://doi.org/10.1016/j.addbeh.2024.108237

Mukherjee, S. (2013). Alcoholism and its effects on the central nervous system. *Curr Neurovasc Res*, *10*(3), 256-262. https://doi.org/10.2174/15672026113109990004

Myllyntausta, S., & Stenholm, S. (2018). Sleep before and after retirement. *Curr Sleep Med Rep*, *4*(4), 278-283. https://doi.org/10.1007/s40675-018-0132-5

Natsky, A. N., Vakulin, A., Coetzer, C. L. C., McEvoy, R. D., Adams, R. J., & Kaambwa, B. (2021). Economic evaluation of diagnostic sleep studies for obstructive sleep apnoea: A systematic review protocol. *Syst Rev*, *10*(1), 104. https://doi.org/10.1186/s13643-021-01651-3

Nelson, M. J., Soliman, P. S., Rhew, R., Cassidy, R. N., & Haass-Koffler, C. L. (2024). Disruption of circadian rhythms promotes alcohol use: A systematic review. *Alcohol & Alcoholism*, *59*(2), 1-9. https://doi.org/10.1093/alcalc/agad083

New Zealand Alcohol Beverages Council. (2019). *New zealander's attitudes to alcohol*. https://nzabc.org.nz/wp-content/uploads/2020/07/NZABC-Research_New-Zealanders-attitudes-to-alcohol_December-2019.pdf

New Zealand Alcohol Beverages Council. (2025, 19 November). *The NZ health survey shows we are drinking less and drinking better with the move to moderation* [Media Release]. https://nzabc.org.nz/the-nz-health-survey-shows-we-are-drinking-less-and-drinking-better-with-the-move-to-moderation/

New Zealand Alcohol Beverages Council. (2026, 28 January). *Gen z is increasingly choosing moderation with beer, wine and spirits consumption* [Media Release]. https://nzabc.org.nz/gen-z-is-increasingly-choosing-moderation-with-beer-wine-and-spirits-consumption/

Noonan, R. J. (2024). Extrinsic goals benefit capitalism but not well-being. Rethinking the economy's goal for a healthier future. *Health Promotion International*, *39*(5). https://doi.org/10.1093/heapro/daae090

O'Keeffe, K. M., Gander, P. H., Scott, W. G., & Scott, H. M. (2012). Insomnia treatment in New Zealand. *N Z Med J*, *125*(1349), 46-59.

Ohayon, M. M., Carskadon, M. A., Guilleminault, C., & Vitiello, M. V. (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. https://doi.org/10.1093/sleep/27.7.1255

Olds, T., Burton, N. W., Sprod, J., Maher, C., Ferrar, K., Brown, W. J., van Uffelen, J., & Dumuid, D. (2018). One day you'll wake up and won't have to go to work: The impact of changes in time use on mental health following retirement. *PLOS ONE*, *13*(6), e0199605. https://doi.org/10.1371/journal.pone.0199605

Paine, S. J., Gander, P. H., Harris, R. B., & Reid, P. (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), 22-28. https://onlinelibrary.wiley.com/doi/10.1111/j.1467-842x.2005.tb00743.x

Park, S. Y., Oh, M. K., Lee, B. S., Kim, H. G., Lee, W. J., Lee, J. H., Lim, J. T., & Kim, J. Y. (2015). The effects of alcohol on quality of sleep. *Korean J Fam Med*, *36*(6), 294-299. https://doi.org/10.4082/kjfm.2015.36.6.294

Patel, A. K., Reddy, V., Shumway, K. R., & Araujo, J. F. (2024). Physiology, sleep stages. In *Statpearls [internet]*. StatPearls Publishing.

Pearson, D. (2011). *Ethnic inequalities – occupation and education*. Te Ara – the Encyclopedia of New Zealand. https://teara.govt.nz/en/ethnic-inequalities/page-6

Peniamina, R., McNoe, B., & Signal, L. (2023). *Public awareness of cancer risk factors & support for prevention policies in Aotearoa New Zealand: A focus on alcohol and diet*.

Petticrew, M., van Schalkwyk, M. C. I., & Knai, C. (2025). *Alcohol industry conflicts of interest: The pollution pathway from misinformation to alcohol harms* (2514-

6645). (Future Healthcare Journal, Issue. https://www.sciencedirect.com/science/article/pii/S2514664525000499

https://pmc.ncbi.nlm.nih.gov/articles/PMC12277470/

Phillips, H. (2023). *2022 Health, Work and Retirement (HWR) Survey.* [Technical report for the Health, Work and Retirement Study]. Massey University.

Pond, R., Stephens, C., & Alpass, F. (2010). How health affects retirement decisions: Three pathways taken by middle-older aged new zealanders. *Ageing & Society*, *30*(3), 527-545. https://doi.org/10.1017/S0144686X09990523

Quante, M., Mariani, S., Weng, J., Marinac, C. R., Kaplan, E. R., Rueschman, M., Mitchell, J. A., James, P., Hipp, J. A., Cespedes Feliciano, E. M., Wang, R., & Redline, S. (2019). Zeitgebers and their association with rest-activity patterns. *Chronobiol Int*, *36*(2), 203-213. https://doi.org/10.1080/07420528.2018.1527347

Ravyts, S. G., & Dzierzewski, J. M. (2024). Sleep and healthy aging: A systematic review and path forward. *Clinical Gerontologist*, *47*(3), 367-379. https://doi.org/10.1080/07317115.2022.2064789

Reid, P., Cormack, D., & Paine, S. J. (2019). Colonial histories, racism and health—the experience of māori and indigenous peoples. *Public Health*, *172*, 119-124. https://doi.org/https://doi.org/10.1016/j.puhe.2019.03.027

Roehrs, T., & Roth, T. (2001). Sleep, sleepiness, and alcohol use. *Alcohol Res Health*, *25*(2), 101-109. https://pmc.ncbi.nlm.nih.gov/articles/PMC6707127/

Rosenkoetter, M. M., & Garris, J. M. (1998). Psychosocial changes following retirement. *Journal of advanced nursing*, *27*(5), 966-976. https://doi.org/10.1046/j.1365-2648.1998.t01-1-00569.x

Ross, I., Signal, L., Tassell-Matamua, N., Meadows, R., & Gibson, R. (2024). Sleep as a social and cultural practice in Aotearoa: A scoping review. *Kōtuitui: New Zealand Journal of Social Sciences Online*, 1-30. https://doi.org/10.1080/1177083X.2024.2403654

Rundo, J. V., & Downey, R. (2019). Polysonmography. In K. H. Levin & P. Chauvel (Eds.), *Handbook of clinical neurology* (Vol. 160, pp. 381-392). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-444-64032-1.00025-4

Sabatier, T., Gomajee, R., Barry, K. M., Melchior, M., Mary-Krause, M., & Kousignian, I. (2024). Sleep disturbances during childhood can predict adult alcohol consumption: A longitudinal cohort study. *Substance Use and Misuse*. https://doi.org/10.1080/10826084.2024.2434674

Saha, P., Salmela, J., Lallukka, T., & Aho, A. L. (2023). Functioning changes in varying ways after retirement: A scoping review. *INQUIRY: The Journal of Health Care Organization, Provision, and Financing*, *60*, 00469580221142477. https://doi.org/10.1177/00469580221142477

Saunders, J. B., Aasland, O. G., Babor, T. F., de la Fuente, J. R., & Grant, M. (1993). Development of the alcohol use disorders identification test (AUDIT): Who collaborative project on early detection of persons with harmful alcohol consumption--ii. *Addiction*, *88*(6), 791-804. https://doi.org/10.1111/j.1360-0443.1993.tb02093.x

Schmier, J., & Halpern, M. T. (2004). Patient recall and recall bias of health state and health status. *Expert Review of Pharmacoeconomics and Outcomes Research*, *4*(2), 159-163. https://doi.org/10.1586/14737167.4.2.159

Sharma, S., & Kavuru, M. (2010). Sleep and metabolism: An overview. *Int J Endocrinol*, *2010*. https://doi.org/10.1155/2010/270832

Skevington, S. M., Lotfy, M., & O'Connell, K. A. (2004). The world health organization's whoqol-bref quality of life assessment: Psychometric properties and results of the international field trial. A report from the whoqol group. *Quality of life Research*, *13*(2), 299-310. https://link.springer.com/article/10.1023/B:QURE.0000018486.91360.00

Sleep/Wake Research Centre. (2019). *Adult sleep disorders and sleep services*. https://www.sleepwake.ac.nz/projects/adult-sleep-disorders-and-sleep-services/

Snyder, E., Cai, B., DeMuro, C., Morrison, M. F., & Ball, W. (2018). A new single-item sleep quality scale: Results of psychometric evaluation in patients with chronic primary insomnia and depression. *Journal of Clinical Sleep Medicine*, *14*(11), 1849-1857. https://doi.org/10.5664/jcsm.7478

Stats NZ – Tatauranga Aotearoa. (2022). *One million people aged 65+ by 2028: Stats NZ*. New Zealand Government. https://www.stats.govt.nz/news/one-million-people-aged-65-by-2028/

Stein, M. D., & Friedmann, P. D. (2006). Disturbed sleep and its relationship to alcohol use. *Substance Abuse*, *26*(1), 1-13. https://doi.org/10.1300/J465v26n01_01

Stevenson, B. S., Stephens, C., Dulin, P., Kostick, M., & Alpass, F. (2015). Alcohol consumption among older adults in Aotearoa/New Zealand: A comparison of ‘baby boomers’ and ‘over-65s’. *Health Psychology and Behavioral Medicine*, *3*(1), 366-378. https://doi.org/10.1080/21642850.2015.1082916

Stockwell, T., Zhao, J., Clay, J., Levesque, C., Sanger, N., Sherk, A., & Naimi, T. (2024). Why do only some cohort studies find health benefits from low-volume alcohol use? A systematic review and meta-analysis of study characteristics that may bias mortality risk estimates. *J Stud Alcohol Drugs*, *85*(4), 441-452. https://doi.org/10.15288/jsad.23-00283

Szabo, A., Towers, A., Newcombe, D., & Sheridan, J. (2021). Alcohol use trajectories across the life course: Influences of childhood predictors and consequences for late-life health. *Drug Alcohol Depend*, *224*, 108713. https://doi.org/10.1016/j.drugalcdep.2021.108713

Szabo, A., Towers, A., Sheridan, J., & Newcombe, D. (2021). Ten-year trajectories of alcohol consumption in older adult new zealanders. *J Gerontol B Psychol Sci Soc Sci*, *76*(3), 496-506. https://doi.org/10.1093/geronb/gbz143

Taylor, G. A., Brody, A., Coley, B. D., Dempsey, M., DiPietro, M., Hernanz-Schulman, M., & Ayyala, R. S. (2024). Transitions to retirement: Challenges and strategies. *Pediatric Radiology*, *54*(7), 1206-1211. https://doi.org/10.1007/s00247-024-05889-6

Te Ara Ahunga Ora Retirement Commission. (2019). *Work and the workforce*. https://retirement.govt.nz/policy-and-research/retirement-income-policy-review/2019-review-of-retirement-income-policies/work-and-the-workforce

Thorne, H. B., Rockloff, M. J., Ferguson, S. A., Vincent, G. E., & Browne, M. (2021). Gambling problems are associated with alcohol misuse and insomnia: Results from a representative national telephone survey. *Int J Environ Res Public Health*, *18*(13). https://doi.org/10.3390/ijerph18136683

Towers, A., Severinsen, C., Lyons, A., Ware, F., Newcombe, D., & Esekielu, M. (2025). *Reconsidering our low-risk alcohol advice: The dark influence of the alcohol industry* [Public Health Expert Briefing]. Public Health Communication Centre Aotearoa. https://www.phcc.org.nz/briefing/reconsidering-our-low-risk-alcohol-advice-dark-influence-alcohol-industry

Towers, A., Sheridan, J., & Newcombe, D. (2017). The drinking patterns of older new zealanders: National and international comparisons. In: Health promotion Agency.

Towers, A., Stephens, C., Dulin, P., Kostick, M., Noone, J., & Alpass, F. (2011). Estimating older hazardous and binge drinking prevalence using AUDIT-c and

AUDIT-3 thresholds specific to older adults. *Drug Alcohol Depend*, *117*(2-3), 211-218. https://doi.org/10.1016/j.drugalcdep.2011.02.008

Towers, A. J. (2007). Methodology. In *Health, Work and Retirement Survey: Summary report for the 2006 data wave*. Massey University,.

Tunney, O., Henkens, K., & van Solinge, H. (2023). A life of leisure? Investigating the differential impact of retirement on leisure activity. *J Gerontol B Psychol Sci Soc Sci*, *78*(10), 1775-1784. https://doi.org/10.1093/geronb/gbad097

Tyler, R. E., & Leggio, L. (2024). Biological basis of addiction and alcohol use disorder. *Clin Liver Dis (Hoboken)*, *23*(1), e0177. https://doi.org/10.1097/cld.0000000000000177

Varghese, J., & Dakhode, S. (2022). Effects of alcohol consumption on various systems of the human body: A systematic review. *Cureus*, *14*(10).

Verster, J. C., Sandalova, E., Garssen, J., & Bruce, G. (2021). The use of single-item ratings versus traditional multiple-item questionnaires to assess mood and health. *Eur J Investig Health Psychol Educ*, *11*(1), 183-198. https://doi.org/10.3390/ejihpe11010015

Wang, J., Wang, Y., Guo, Z., Lin, Z., Jin, X., Niu, H., Wu, Y., Tang, L., & Hou, H. (2023). Influence of lifestyle on suboptimal health: Insights from a national cross-sectional survey in China. *Journal of Global Health*, *13*, 1-10. https://doi.org/10.7189/jogh.13.04151

Wang, X., Steier, J. B., & Gallo, W. T. (2014). The effect of retirement on alcohol consumption: Results from the us health and retirement study. *European Journal of Public Health*, *24*(3), 485-489. https://doi.org/10.1093/eurpub/cku027

Wanka, A. (2020). Continuity and change in the transition to retirement: How time allocation, leisure practices and lifestyles evolve when work vanishes in later life. *Eur J Ageing*, *17*(1), 81-93. https://doi.org/10.1007/s10433-019-00526-w

Ware, J. E., Kosinski, M., Turner-Bowker, D. M., & Gandek, B. (2005). *How to score version 2 of the sf-12 health survey (with a supplement documenting version 1)*. Quality Metric Incorporated Lincoln, RI.

Waterhouse, J., Fukuda, Y., & Morita, T. (2012). Daily rhythms of the sleep-wake cycle. *Journal of Physiological Anthropology*, *31*(1), 5. https://doi.org/10.1186/1880-6805-31-5

White, A. M., Orosz, A., Powell, P. A., & Koob, G. F. (2023). Alcohol and aging – an area of increasing concern. *Alcohol*, *107*, 19-27. https://doi.org/https://doi.org/10.1016/j.alcohol.2022.07.005

Work and Income – Te Hiranga Tangata. (2024a). *How much you can get for NZ super*. https://www.workandincome.govt.nz/eligibility/seniors/superannuation/how-much-you-can-get.html

Work and Income – Te Hiranga Tangata. (2024b). *Who can get NZ super*. https://www.workandincome.govt.nz/eligibility/seniors/superannuation/who-can-get-it/index.html

World Health Organization. (2006). *Who sage survey manual: The who study on global ageing and adult health (sage)* (Geneva: World Health Organization, Issue.

World Health Organization. (2023, 4 January). *No level of alcohol consumption is safe for our health* [New Release]. https://www.who.int/europe/news/item/04-01-2023-no-level-of-alcohol-consumption-is-safe-for-our-health

World Health Organization. (2024). *Alcohol* [Fact Sheet]. https://www.who.int/en/news-room/fact-sheets/detail/alcohol

Wright-St Clair, V. A., Rapson, A., Kepa, M., Connolly, M., Keeling, S., Rolleston, A., Teh, R., Broad, J. B., Dyall, L., Jatrana, S., Wiles, J., Pillai, A., Garrett, N., & Kerse, N. (2017). Ethnic and gender differences in preferred activities among māori and non-māori of advanced age in New Zealand. *J Cross Cult Gerontol*, *32*(4), 433-446. https://doi.org/10.1007/s10823-017-9324-6

Yanbaeva, D. G., Dentener, M. A., Creutzberg, E. C., Wesseling, G., & Wouters, E. F. M. (2007). Systemic effects of smoking. *Chest*, *131*(5), 1557-1566. https://doi.org/https://doi.org/10.1378/chest.06-2179

Yang, E., Ismail, A., Kim, Y., Erdogmus, E., Boron, J., Goldstein, F., DuBose, J., & Zimring, C. (2022). Multidimensional environmental factors and sleep health for aging adults: A focused narrative review. *International Journal of Environmental Research and Public Health*, *19*(23).

Yeatts, S. D., & Martin, R. H. (2015). What is missing from my missing data plan? *Stroke*, *46*(6), e130-132. https://doi.org/10.1161/strokeaha.115.007984

Yildiz, D. (2004). Nicotine, its metabolism and an overview of its biological effects. *Toxicon*, *43*(6), 619-632. https://www.sciencedirect.com/science/article/abs/pii/S0041010104000911?via%3Dihub

Yuan, B. (2024). How the interplay of late retirement, health care, economic insecurity, and electronic social contact affects the mental health amongst older workers? *Stress & Health: Journal of the International Society for the Investigation of Stress*, *40*(2), 1-16. https://doi.org/10.1002/smi.3309

Zakhari, S. (2006). Overview: How is alcohol metabolized by the body? *Alcohol Res Health*, *29*(4), 245-254.

Zheng, J.-W., Ai, S.-Z., Chang, S.-H., Meng, S.-Q., Shi, L., Deng, J.-H., Di, T.-Q., Liu, W.-Y., Chang, X.-W., Yue, J.-L., Yang, X.-Q., Zeng, N., Bao, Y.-P., Sun, Y., Lu, L., & Shi, J. (2024). Association between alcohol consumption and sleep traits: Observational and mendelian randomization studies in the uk biobank. *Molecular Psychiatry*, *29*(3), 838-846. https://doi.org/10.1038/s41380-023-02375-7

Zins, M., Guéguen, A., Kivimaki, M., Singh-Manoux, A., Leclerc, A., Vahtera, J., Westerlund, H., Ferrie, J. E., & Goldberg, M. (2011). Effect of retirement on alcohol consumption: Longitudinal evidence from the french gazel cohort study. *PLOS ONE*, *6*(10), e26531. https://doi.org/10.1371/journal.pone.0026531

Appendices

Appendix A

Missing Value Analysis for All Variables

Table A1

Proportion of Missing Values for All Variables (Stratified by Cohort)

	Retired			Working			Total		
Variable	N	Missing	%	N	Missing	%	N	Missing	%
Age	1774	0	0.0	3049	0	0.0	4823	0	0.0
Gender	1769	5	0.3	3049	0	0.0	4818	5	0.1
Ethnicity	1742	32	1.8	3005	44	1.4	4747	76	1.6
ELSI	1731	43	2.4	2991	58	1.9	4722	101	2.1
Sleep Duration	1729	45	2.5	2990	59	1.9	4719	104	2.2
Restless Sleep	1759	15	0.8	3026	23	0.8	4785	38	0.8
Sleep Satisfaction	1771	3	0.2	3035	14	0.5	4806	17	0.4
Sleep Problems	1752	22	1.2	3012	37	1.2	4764	59	1.2
Daytime Sleepiness	1755	19	1.0	3017	32	1.0	4772	51	1.0
Alcohol Quantity	1516	258	14.5	2680	369	12.1	4196	627	13.0
Alcohol Frequency	1763	11	0.6	3037	12	0.4	4800	23	0.5
SF-12 PCS	1620	154	8.7	2892	157	5.1	4512	311	6.4
Physical Activity	1764	10	0.6	3037	12	0.4	4801	22	0.5
Smoking	1621	153	8.6	2776	273	9.0	4397	426	8.8
Comorbid Conditions	1774	0	0.0	3049	0	0.0	4823	0	0.0
QOL	1771	3	0.2	3046	3	0.1	4817	6	0.1
SF-12 MCS	1620	154	8.7	2892	157	5.1	4512	311	6.4
Job Satisfaction	1774	0	0.0	2833	216	7.1	4607	216	4.5
Work Hours	1774	0	0.0	2921	128	4.2	4695	128	2.7

Appendix B

Bivariate Analysis Contingency Tables for Sleep and Alcohol Variables

This appendix contains the contingency tables that accompany the chi-square tests generated while refining which sleep variables should be used as indicators of sleep disturbance during multivariate analysis. The tables contain the distribution of participants within each sleep health variable against each alcohol variable.

Table B1

Contingency Table for Restless Sleep and Alcohol Quantity (For Retirees, Workers, and Combined)

	Restless Sleep					
	Frequently		Infrequently		Total	
Alcohol Quantity	*n*	%	*n*	%	*n*	%
			Retired			
Non-Drinkers	23	4.60	50	5.00	73	4.90
1-2	344	68.10	767	76.80	1111	73.90
3-4	94	18.60	122	12.20	216	14.40
5-6	23	4.60	32	3.20	55	3.70
7-9	10	2.00	16	1.60	26	1.70
≥10	11	2.20	12	1.20	23	1.50
Total	505	100.00	999	100.00	1504	100.00
			Working			
Non-Drinkers	26	2.90	69	3.90	95	3.60
1-2	555	61.20	1146	65.30	1701	63.90
3-4	209	23.00	323	18.40	532	20.00
5-6	68	7.50	144	8.20	212	8.00
7-9	31	3.40	42	2.40	73	2.70
≥10	18	2.00	31	1.80	49	1.80
Total	907	100.00	1755	100.00	2662	100.00
			Combined			
Non-Drinkers	49	3.50	119	4.30	168	4.00
1-2	899	63.70	1913	69.50	2812	67.50
3-4	303	21.50	445	16.20	748	18.00
5-6	91	6.40	176	6.40	267	6.40
7-9	41	2.90	58	2.10	99	2.40
≥10	29	2.10	43	1.60	72	1.70
Total	1412	100.00	2754	100.00	4166	100.00

Table B2

Contingency Table for Restless Sleep and Alcohol Frequency (For Retirees, Workers, and Combined)

	Restless Sleep					
	Frequently		Infrequently		Total	
Alcohol Frequency	*n*	%	*n*	%	*n*	%
			Retired			
Never	121	20.00	203	17.80	324	18.50
Monthly or less	123	20.30	241	21.10	364	20.80
Two to four times per month	94	15.50	182	15.90	276	15.80
Two to three times per week	125	20.70	234	20.50	359	20.50
Four or more times a week	142	23.50	283	24.80	425	24.30
Total	605	100.00	1143	100.00	1748	100.00
			Working			
Never	132	12.60	301	15.30	433	14.40
Monthly or less	253	24.20	381	19.40	634	21.00
Two to four times per month	174	16.60	400	20.30	574	19.00
Two to three times per week	247	23.60	489	24.80	736	24.40
Four or more times a week	240	22.90	397	20.20	637	21.10
Total	1046	100.00	1968	100.00	3014	100.00
			Combined			
Never	253	15.30	504	16.20	757	15.90
Monthly or less	376	22.80	622	20.00	998	21.00
Two to four times per month	268	16.20	582	18.70	850	17.80
Two to three times per week	372	22.50	723	23.20	1095	23.00
Four or more times a week	382	23.10	680	21.90	1062	22.30
Total	1651	100.00	3111	100.00	4762	100.00

Table B3

Contingency Table for Sleep Satisfaction and Alcohol Quantity (For Retirees, Workers, and Combined)

	Sleep Satisfaction					
	Dissatisfied		Not Dissatisfied		Total	
Alcohol Quantity	*n*	%	*n*	%	*n*	%
			Retired			
Non-Drinkers	15	4.40	59	5.00	74	4.90
1-2	239	70.70	881	74.90	1120	73.90
3-4	56	16.60	161	13.70	217	14.30
5-6	19	5.60	36	3.10	55	3.60
7-9	3	0.90	23	2.00	26	1.70
≥10	6	1.80	17	1.40	23	1.50
Total	338	100.00	1177	100.00	1515	100.00
			Working			
Non-Drinkers	18	2.50	75	3.90	93	3.50
1-2	445	60.80	1264	65.20	1709	64.00
3-4	171	23.40	361	18.60	532	19.90
5-6	54	7.40	159	8.20	213	8.00
7-9	26	3.60	47	2.40	73	2.70
≥10	18	2.50	32	1.70	50	1.90
Total	732	100.00	1938	100.00	2670	100.00
			Combined			
Non-Drinkers	33	3.10	134	4.30	167	4.00
1-2	684	63.90	2145	68.90	2829	67.60
3-4	227	21.20	522	16.80	749	17.90
5-6	73	6.80	195	6.30	268	6.40
7-9	29	2.70	70	2.20	99	2.40
≥10	24	2.20	49	1.60	73	1.70
Total	1070	100.00	3115	100.00	4185	100.00

Table B4

Contingency Table for Sleep Satisfaction and Alcohol Frequency (For Retirees, Workers, and Combined)

	Sleep Satisfaction					
	Dissatisfied		Not Dissatisfied		Total	
Alcohol Frequency	*n*	%	*n*	%	*n*	%
			Retired			
Never	85	20.90	242	17.90	327	18.60
Monthly or less	75	18.40	293	21.60	368	20.90
Two to four times per month	64	15.70	212	15.60	276	15.70
Two to three times per week	86	21.10	277	20.40	363	20.60
Four or more times a week	97	23.80	331	24.40	428	24.30
Total	407	100.00	1355	100.00	1762	100.00
			Working			
Never	98	11.90	336	15.30	434	14.30
Monthly or less	208	25.20	431	19.60	639	21.10
Two to four times per month	151	18.30	428	19.40	579	19.10
Two to three times per week	188	22.80	548	24.90	736	24.30
Four or more times a week	180	21.80	459	20.80	639	21.10
Total	825	100.00	2202	100.00	3027	100.00
			Combined			
Never	183	14.90	578	16.20	761	15.90
Monthly or less	283	23.00	724	20.40	1007	21.00
Two to four times per month	215	17.50	640	18.00	855	17.90
Two to three times per week	274	22.20	825	23.20	1099	22.90
Four or more times a week	277	22.50	790	22.20	1067	22.30
Total	1232	100.00	3557	100.00	4789	100.00

Table B5

Contingency Table for Sleep Problems and Alcohol Quantity (For Retirees, Workers, and Combined)

	Sleep Problems					
	Substantial		Not Substantial		Total	
Alcohol Quantity	*n*	%	*n*	%	*n*	%
			Retired			
Non-Drinkers	20	3.90	53	5.40	73	4.90
1-2	357	70.30	751	76.00	1108	74.10
3-4	82	16.10	130	13.20	212	14.20
5-6	25	4.90	29	2.90	54	3.60
7-9	12	2.40	14	1.40	26	1.70
≥10	12	2.40	11	1.10	23	1.50
Total	508	100.00	988	100.00	1496	100.00
			Working			
Non-Drinkers	15	1.90	80	4.40	95	3.60
1-2	494	61.00	1205	65.50	1699	64.10
3-4	180	22.20	346	18.80	526	19.90
5-6	68	8.40	141	7.70	209	7.90
7-9	35	4.30	38	2.10	73	2.80
≥10	18	2.20	29	1.60	47	1.80
Total	810	100.00	1839	100.00	2649	100.00
			Combined			
Non-Drinkers	35	2.70	133	4.70	168	4.10
1-2	851	64.60	1956	69.20	2807	67.70
3-4	262	19.90	476	16.80	738	17.80
5-6	93	7.10	170	6.00	263	6.30
7-9	47	3.60	52	1.80	99	2.40
≥10	30	2.30	40	1.40	70	1.70
Total	1318	100.00	2827	100.00	4145	100.00

Table B6

Contingency Table for Sleep Problems and Alcohol Frequency (For Retirees, Workers, and Combined)

	Sleep Problems					
	Substantial		Not substantial		Total	
Alcohol Frequency	*n*	%	*n*	%	*n*	%
			Retired			
Never	122	20.00	200	17.70	322	18.50
Monthly or less	132	21.60	232	20.50	364	20.90
Two to four times per month	94	15.40	180	15.90	274	15.70
Two to three times per week	114	18.70	242	21.40	356	20.40
Four or more times a week	148	24.30	277	24.50	425	24.40
Total	610	100.00	1131	100.00	1741	100.00
			Working			
Never	111	11.90	324	15.70	435	14.50
Monthly or less	247	26.50	384	18.60	631	21.00
Two to four times per month	158	17.00	414	20.00	572	19.10
Two to three times per week	212	22.70	515	24.90	727	24.20
Four or more times a week	204	21.90	431	20.80	635	21.20
Total	932	100.00	2068	100.00	3000	100.00
			Combined			
Never	233	15.10	524	16.40	757	16.00
Monthly or less	379	24.60	616	19.30	995	21.00
Two to four times per month	252	16.30	594	18.60	846	17.80
Two to three times per week	326	21.10	757	23.70	1083	22.80
Four or more times a week	352	22.80	708	22.10	1060	22.40
Total	1542	100.00	3199	100.00	4741	100.00

Table B7

Contingency Table for Daytime Sleepiness and Alcohol Quantity (For Retirees, Workers, and Combined)

	Daytime Sleepiness					
	Frequently		Infrequently		Total	
Alcohol Quantity	*n*	%	*n*	%	*n*	%
			Retired			
Non-Drinkers	1	3.80	72	4.90	73	4.90
1-2	17	65.40	1094	74.00	1111	73.80
3-4	4	15.40	213	14.40	217	14.40
5-6	2	7.70	53	3.60	55	3.70
7-9	1	3.80	25	1.70	26	1.70
≥10	1	3.80	22	1.50	23	1.50
Total	26	100.00	1479	100.00	1505	100.00
			Working			
Non-Drinkers	1	1.00	93	3.60	94	3.50
1-2	64	66.00	1636	63.90	1700	64.00
3-4	16	16.50	513	20.00	529	19.90
5-6	10	10.30	202	7.90	212	8.00
7-9	3	3.10	70	2.70	73	2.70
≥10	3	3.10	46	1.80	49	1.80
Total	97	100.00	2560	100.00	2657	100.00
			Combined			
Non-Drinkers	2	1.60	165	4.10	167	4.00
1-2	81	65.90	2730	67.60	2811	67.50
3-4	20	16.30	726	18.00	746	17.90
5-6	12	9.80	255	6.30	267	6.40
7-9	4	3.30	95	2.40	99	2.40
≥10	4	3.30	68	1.70	72	1.70
Total	123	100.00	4039	100.00	4162	100.00

Table B8

Contingency Table for Daytime Sleepiness and Alcohol Frequency (For Retirees, Workers, and Combined)

	Daytime Sleepiness					
	Frequently		Infrequently		Total	
Alcohol Frequency	*n*	%	*n*	%	*n*	%
			Retired			
Never	6	19.40	314	18.30	320	18.30
Monthly or less	7	22.60	356	20.80	363	20.80
Two to four times per month	2	6.50	274	16.00	276	15.80
Two to three times per week	6	19.40	355	20.70	361	20.70
Four or more times a week	10	32.30	416	24.30	426	24.40
Total	31	100.00	1715	100.00	1746	100.00
			Working			
Never	18	15.30	414	14.30	432	14.40
Monthly or less	26	22.00	604	20.90	630	20.90
Two to four times per month	29	24.60	547	18.90	576	19.10
Two to three times per week	23	19.50	713	24.70	736	24.50
Four or more times a week	22	18.60	613	21.20	635	21.10
Total	118	100.00	2891	100.00	3009	100.00
			Combined			
Never	24	16.10	728	15.80	752	15.80
Monthly or less	33	22.10	960	20.80	993	20.90
Two to four times per month	31	20.80	821	17.80	852	17.90
Two to three times per week	29	19.50	1068	23.20	1097	23.10
Four or more times a week	32	21.50	1029	22.30	1061	22.30
Total	149	100.00	4606	100.00	4755	100.00

Appendix C

Contingency Tables for All Variables and Work/Retirement Status

This appendix contains the contingency tables that accompany the chi-square tests generated while conducting bivariate analysis on the finalised set of variables. Each tables contains the distribution of retirees and workers across each variable, with standardised residuals (SR) to indicate where the observed disruption is significantly different from expected levels. SRs indicative of differences significant at the 95% confidence Interval threshold are bolded (i.e. either ≥1.96, or ≤ -1.96).

Table C1

Contingency Table of Sleep Satisfaction with Standardized Residuals (by Work/Retirement Status)

	Retired			Working			Total	
Sleep Satisfaction	N	%	SR	N	%	SR	N	%
Dissatisfied	410	23.2%	**-2.1**	826	27.2%	1.6	1236	25.7%
Not Dissatisfied	1361	76.8%	1.3	2209	72.8%	-1.0	3570	74.3%
Total	1771	100.0%		3035	100.0%		4806	100.0%

*Note. SR: s*tandardized residuals.

Table C2

Contingency Table of Sleep Problems with Standardized Residuals (by Work/Retirement Status)

	Retired			Working			Total	
Sleep Problems	N	%	SR	N	%	SR	N	%
Substantial	616	35.2%	1.9	935	31.0%	-1.5	1551	32.6%
Not Substantial	1136	64.8%	-1.3	2077	69.0%	1.0	3213	67.4%
Total	1752	100.0%		3012	100.0%		4764	100.0%

*Note. SR: s*tandardized residuals.

Table C3

Contingency Table of Gender with Standardized Residuals (by Work/Retirement Status)

	Retired			Working			Total	
Sleep Problems	N	%	SR	N	%	SR	N	%
Male/Tane	756	42.7%	-1.3	1404	46.0%	1.0	2160	44.8%
Female/Wahine	1013	57.3%	1.2	1645	54.0%	-.9	2658	55.2%
Total	1769	100.0%		3049	100.0%		4818	100.0%

Note. *SR: s*tandardized residuals.

Table C4

Contingency Table of Binary Ethnicity with Standardized Residuals (by Work/Retirement Status)

	Retired			Working			Total	
Ethnicity	N	%	SR	N	%	SR	N	%
Māori	490	28.1%	**-4.5**	1148	38.2%	**3.5**	1638	34.5%
Non-Māori	1252	71.9%	**3.3**	1857	61.8%	**-2.5**	3109	65.5%
Total	1742	100.0%		3005	100.0%		4747	100.0%

Note. *SR: s*tandardized residuals.

Table C5

Contingency Table of Alcohol Quantity with Standardized Residuals (by Work/Retirement Status)

	Retired			Working			Total	
Alcohol Quantity	N	%	SR	N	%	SR	N	%
Non-Drinkers	74	4.9%	1.6	96	3.6%	-1.2	170	4.1%
1-2	1121	73.9%	**3.0**	1714	64.0%	**-2.3**	2835	67.6%
3-4	217	14.3%	**-3.3**	534	19.9%	**2.5**	751	17.9%
5-6	55	3.6%	**-4.3**	213	7.9%	**3.2**	268	6.4%
7-9	26	1.7%	-1.6	73	2.7%	1.2	99	2.4%
≥10	23	1.5%	-.7	50	1.9%	.5	73	1.7%
Total	1516	100.0%		2680	100.0%		4196	100.0%

Note. *SR: s*tandardized residuals.

Table C6

Contingency Table of Alcohol Frequency with Standardized Residuals (by Work/Retirement Status)

	Retired			Working			Total	
Alcohol Frequency	N	%	SR	N	%	SR	N	%
Never	327	18.5%	**2.7**	439	14.5%	**-2.1**	766	16.0%
≥Monthly	368	20.9%	-.1	639	21.0%	.1	1007	21.0%
2-4 times p/month	277	15.7%	**-2.1**	579	19.1%	1.6	856	17.8%
2-3 times p/week	363	20.6%	**-2.0**	737	24.3%	1.6	1100	22.9%
≥4 times p/week	428	24.3%	1.7	643	21.2%	-1.3	1071	22.3%
Total	1763	100.0%		3037	100.0%		4800	100.0%

Note. *SR:* standardized residuals.

Table C7

Contingency Table of Physical Activity Level with Standardized Residuals (by Work/Retirement Status)

	Retired			Working			Total	
PA	N	%	SR	N	%	SR	N	%
Inactive	417	23.6%	**2.5**	587	19.3%	-1.9	1004	20.9%
Active	1347	76.4%	-1.3	2450	80.7%	1.0	3797	79.1%
Total	1764	100.0%		3037	100.0%		4801	100.0%

Note. PA: physical activity; *SR*: standardized residuals.

Table C8

Contingency Table of Smoking Status with Standardized Residuals (by Work/Retirement Status)

	Retired			Working			Total	
Smoking	N	%	SR	N	%	SR	N	%
Current	100	6.2%	**-2.5**	248	8.9%	1.9	348	7.9%
Non-Smoker	1521	93.8%	.7	2528	91.1%	-.6	4049	92.1%
Total	1621	100.0%		2776	100.0%		4397	100.0%

Note. *SR:* standardized residuals.

Table C9

Contingency Table of Quality of Life with Standardized Residuals (by Work/Retirement Status)

	Retired			Working			Total	
QOL	N	%	SR	N	%	SR	N	%
Poor	95	5.4%	**3.5**	85	2.8%	**-2.7**	180	3.7%
Not poor	1676	94.6%	-.7	2961	97.2%	.5	4637	96.3%
Total	1771	100.0%		3046	100.0%		4817	100.0%

Note. QOL: quality of life; *SR*: standardized residuals.

Appendix D

Hierarchical Binary Single-Level Logistic Regression Analysis for Sleep Satisfaction

Table D1

Hierarchical Binary Logistic Regression Models for Factors Relating to Sleep Satisfaction (Retired Cohort (n=1229) – Models 1-3)

	Model 1					Model 2					Model 3				
Variable	*B*	*SE*	*p*	Exp(*B*)	95% CI	*B*	*SE*	*p*	Exp(*B*)	95% CI	B	S.E.	*p*	Exp(B)	95% CI
Age	-0.03	0.01	0.013	0.97	[0.95, 0.99]	-0.04	0.01	<.001	0.96	[0.94, 0.98]	-0.04	0.01	0.002	0.96	[0.94, 0.99]
Gender (male)	-0.3	0.15	0.042	0.74	[0.56, 0.99]	-0.29	0.15	0.05	0.75	[0.56, 1]	-0.27	0.15	0.075	0.76	[0.57, 1.03]
Ethnicity (Māori)	0.11	0.16	0.511	1.11	[0.81, 1.53]	0.06	0.17	0.722	1.06	[0.76, 1.48]	0.05	0.17	0.757	1.05	[0.75, 1.47]
ELSI-SF	-0.05	0.01	<.001	0.95	[0.93, 0.97]	-0.03	0.01	0.068	0.98	[0.95, 1]	0.00	0.02	0.805	1.00	[0.97, 1.03]
AQ (1-2)	0.22	0.42	0.603	1.24	[0.55, 2.83]	0.17	0.43	0.697	1.18	[0.51, 2.72]	0.22	0.44	0.611	1.25	[0.53, 2.93]
AQ (3-4)	0.56	0.46	0.227	1.74	[0.71, 4.29]	0.5	0.47	0.291	1.64	[0.66, 4.11]	0.59	0.48	0.213	1.81	[0.71, 4.62]
AQ (5-6)	0.51	0.56	0.362	1.66	[0.56, 4.96]	0.49	0.57	0.387	1.64	[0.54, 5]	0.49	0.58	0.404	1.62	[0.52, 5.08]
AQ (7-9)	-0.38	0.74	0.602	0.68	[0.16, 2.89]	-0.55	0.76	0.468	0.58	[0.13, 2.55]	-0.50	0.77	0.519	0.61	[0.13, 2.76]
AQ (≥10)	0.37	0.62	0.549	1.45	[0.43, 4.93]	0.29	0.64	0.655	1.33	[0.38, 4.68]	0.22	0.66	0.742	1.24	[0.34, 4.55]
AF (≤1 time p/month)	-0.19	0.29	0.526	0.83	[0.47, 1.47]	-0.16	0.3	0.59	0.85	[0.48, 1.52]	-0.17	0.3	0.57	0.84	[0.47, 1.52]
AF (2-4 times p/month)	0.07	0.3	0.813	1.07	[0.6, 1.94]	0.16	0.31	0.612	1.17	[0.64, 2.12]	0.08	0.31	0.799	1.08	[0.59, 1.99]
AF (2-3 times p/week)	0.14	0.29	0.627	1.15	[0.65, 2.03]	0.30	0.3	0.311	1.35	[0.76, 2.4]	0.23	0.3	0.448	1.26	[0.7, 2.27]
AF (≥4 times p/week)	0.08	0.29	0.778	1.08	[0.62, 1.90]	0.18	0.29	0.535	1.20	[0.68, 2.12]	0.15	0.3	0.607	1.17	[0.65, 2.09]
SF-12 PCS						-0.03	0.01	<.001	0.97	[0.95, 0.98]	-0.03	0.01	<.001	0.97	[0.95, 0.98]
Physical Activity (inactive)						-0.07	0.2	0.717	0.93	[0.63, 1.37]	-0.34	0.21	0.106	0.71	[0.47, 1.08]
Smoking (current)						-0.2	0.32	0.544	0.82	[0.44, 1.54]	-0.28	0.33	0.384	0.75	[0.4, 1.43]
Comorbidities (count)						0.04	0.04	0.324	1.04	[0.96, 1.13]	-0.01	0.04	0.896	0.99	[0.91, 1.08]
Quality of life (poor)											0.58	0.34	0.087	1.78	[0.92, 3.43]
SF-12 MCS											-0.04	0.01	<.001	0.97	[0.95, 0.98]
Constant	1.79	0.92	0.052	5.98		3.38	1.05	0.001	29.46		4.44	1.15	<.001	84.44	

Note. Degrees of freedom for all variables =1. Values for Model 0: *B*=-1.26 (*SE*=0.07), *p*=<.001, Exp(*B*)=0.28.

Table D2a

Hierarchical Binary Logistic Regression Models for Factors Relating to Sleep Satisfaction (Working Cohort (n=2040) – Models 1-2)

	Model 1					Model 2				
Variable	*B*	*SE*	*p*	Exp(*B*)	95% CI	*B*	*SE*	*p*	Exp(*B*)	95% CI
Age	-0.05	0.01	<.001	0.95	[0.93, 0.97]	-0.06	0.01	<.001	0.94	[0.92, 0.96]
Gender (male)	-0.07	0.11	.533	0.94	[0.76, 1.15]	-0.07	0.11	.536	0.94	[0.76, 1.16]
Ethnicity (Māori)	0.16	0.11	.140	1.17	[0.95, 1.45]	0.07	0.11	.520	1.07	[0.86, 1.34]
ELSI-SF	-0.05	0.01	<.001	0.96	[0.94, 0.97]	-0.03	0.01	.007	0.97	[0.95, 0.99]
AQ (1-2)	0.12	0.37	.753	1.12	[0.55, 2.31]	0.01	0.37	.989	1.01	[0.48, 2.09]
AQ (3-4)	0.36	0.38	.347	1.43	[0.68, 3.03]	0.26	0.39	.507	1.30	[0.60, 2.78]
AQ (5-6)	0.08	0.41	.852	1.08	[0.49, 2.39]	-0.09	0.41	.822	0.91	[0.41, 2.05]
AQ (7-9)	0.69	0.47	.145	1.98	[0.79, 4.98]	0.41	0.48	.399	1.50	[0.58, 3.86]
AQ (≥10)	0.46	0.49	.350	1.59	[0.6, 4.16]	0.21	0.51	.679	1.23	[0.46, 3.32]
AF (≤1 time p/m)	0.48	0.24	.045	1.61	[1.01, 2.57]	0.48	0.24	.049	1.62	[1.00, 2.60]
AF (2-4 times p/m)	0.39	0.24	.103	1.48	[0.92, 2.36]	0.53	0.25	.032	1.69	[1.05, 2.74]
AF (2-3 times p/w)	0.35	0.24	.141	1.42	[0.89, 2.25]	0.49	0.24	.043	1.64	[1.02, 2.63]
AF (≥4 times p/w)	0.41	0.24	.091	1.51	[0.94, 2.44]	0.51	0.25	.041	1.67	[1.02, 2.72]
SF-12 PCS						-0.01	0.01	.241	0.99	[0.98, 1.01]
PA (inactive)						0.31	0.13	.018	1.37	[1.06, 1.78]
Smoking (current)						-0.16	0.19	.416	0.86	[0.59, 1.25]
Comorbidities (n)						0.21	0.03	<.001	1.23	[1.15, 1.31]
Quality of life (poor)										
SF-12 MCS										
Job Satis. (dissatis.)										
Work Hours (p/w)										
Constant	2.65	0.82	.001	14.09		2.91	0.91	.001	18.37	

Note. Degrees of freedom for all variables =1. Values for Model 0: *B*=-0.95 (*SE*=0.05), *p*=<.001, Exp(*B*)=0.39.

Table D2b

Hierarchical Binary Logistic Regression Models for Factors Relating to Sleep Satisfaction (Working Cohort (n=2040) – Models 3-4)

	Model 3					Model 4				
Variable	*B*	*SE*	*p*	Exp(*B*)	95% CI	*B*	*SE*	*p*	Exp(*B*)	95% CI
Age	-0.05	0.01	<.001	0.95	[0.93, 0.97]	-0.04	0.01	<.001	0.96	[0.93, 0.98]
Gender (male)	-0.01	0.11	.906	0.99	[0.80, 1.23]	-0.09	0.12	.458	0.92	[0.73, 1.15]
Ethnicity (Māori)	0.12	0.11	.280	1.13	[0.90, 1.41]	0.11	0.12	.352	1.11	[0.89, 1.39]
ELSI-SF	0.00	0.01	.919	1.00	[0.98, 1.02]	0.01	0.01	.668	1.01	[0.98, 1.03]
AQ (1-2)	-0.07	0.38	.860	0.94	[0.44, 1.98]	-0.08	0.38	.843	0.93	[0.44, 1.96]
AQ (3-4)	0.17	0.40	.666	1.19	[0.55, 2.59]	0.16	0.4	.684	1.18	[0.54, 2.56]
AQ (5-6)	-0.24	0.42	.572	0.79	[0.34, 1.80]	-0.28	0.42	.510	0.76	[0.33, 1.74]
AQ (7-9)	0.31	0.49	.530	1.36	[0.52, 3.58]	0.30	0.50	.543	1.35	[0.51, 3.57]
AQ (≥10)	0.05	0.53	.930	1.05	[0.37, 2.93]	0.02	0.52	.970	1.02	[0.37, 2.85]
AF (≤1 time p/month)	0.53	0.25	.035	1.70	[1.04, 2.78]	0.51	0.25	.044	1.66	[1.01, 2.73]
AF (2-4 times p/month)	0.59	0.25	.020	1.81	[1.10, 2.97]	0.58	0.25	.022	1.79	[1.09, 2.95]
AF (2-3 times p/week)	0.56	0.25	.025	1.75	[1.07, 2.87]	0.55	0.25	.028	1.74	[1.06, 2.85]
AF (≥4 times p/week)	0.52	0.26	.044	1.68	[1.02, 2.79]	0.51	0.26	.050	1.66	[1.00, 2.76]
SF-12 PCS	-0.01	0.01	.058	0.99	[0.97, 1.00]	-0.01	0.01	.052	0.99	[0.97, 1.00]
Physical Activity (inactive)	0.14	0.14	.314	1.15	[0.88, 1.51]	0.11	0.14	.413	1.12	[0.85, 1.47]
Smoking (current)	-0.18	0.20	.371	0.84	[0.57, 1.24]	-0.14	0.2	.477	0.87	[0.59, 1.28]
Comorbidities (count)	0.16	0.03	<.001	1.18	[1.10, 1.26]	0.17	0.03	<.001	1.18	[1.11, 1.26]
Quality of life (poor)	0.37	0.34	.279	1.44	[0.74, 2.80]	0.33	0.34	.336	1.39	[0.71, 2.71]
SF-12 MCS	-0.05	0.01	<.001	0.95	[0.94, 0.96]	-0.05	0.01	<.001	0.95	[0.94, 0.96]
Job Satisfaction (dissatisfied)						0.51	0.19	.009	1.66	[1.14, 2.43]
Work Hours (p/w)						0.01	0	.024	1.010	[1.00, 1.02]
Constant	4.48	0.97	<.001	87.82		3.43	1.03	<.001	30.90	

Note. Degrees of freedom for all variables =1. Values for Model 0: *B*=-0.95, (*SE*=0.05), *p*=<.001, Exp(*B*)=0.39. ELSI-SF: Economic Living Standard Index – Short Form; AQ: alcohol quantity; AF: alcohol frequency; p/month: per month; p/week: per week; Short Form Survey – 12 item physical component summary; SF-12 MCS: Short Form Survey – 12 item mental component summary; Job Satis. (dissatis.): job satisfaction (dissatisfied).