The relationship between income adequacy and cognitive function: An Aotearoa New Zealand lens

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Abstract

Background

Globally, ageing populations have increased health concerns for cognitive decline. International and local studies have extensively documented the influence of modifiable factors such as socioeconomic status on cognitive functioning. However, there has been limited research specifically on the association of income adequacy and cognitive functioning in Aotearoa New Zealand. Income adequacy is the self-perception that an individual is able to meet their everyday needs through their current income. This thesis aims to address this gap.

Methods

A cross-sectional study was completed with 970 participants from around Aotearoa New Zealand as part of the New Zealand Health, Work and Retirement (NZHWR) cohort study of ageing. Recruitment for NZHWR involved random sampling from the electoral roll and over-sampling of those identifying themselves as a person of Māori descent for adequate representation of Aotearoa New Zealand's Indigenous population. This study consists of a survey, administered in 2010, which includes self-report questionnaires that comprise the assessment of income adequacy, and face-to-face assessments which have informed the cognitive functioning of the study population. Furthermore, the self-reported questionnaires were utilised to collect sociodemographic characteristics and information on living

conditions of participants. Linear regression was used to assess the association between income adequacy and cognitive functioning. Further testing was completed to understand the relationship between age, gender, ethnicity, education, marital status, employment, area-based socioeconomic deprivation, and area of residence with income adequacy.

Results

The results indicated there was an association between higher levels of income adequacy and higher cognitive functioning. The findings also highlighted gender, ethnicity, education level, and area-based socioeconomic deprivation levels to be associated with cognitive functioning. Low area-based deprived living conditions were also found to be associated with higher cognitive functioning. Further ingroup testing revealed the distribution of levels of income adequacy amongst sociodemographic characteristics and living conditions.

Conclusions

This thesis provides insight into the importance of an adequate income for cognitive functioning in older adults. It reveals higher adequate income is associated with higher cognitive functioning among older adults in Aotearoa New Zealand. Furthermore, findings showed important differences in the distribution of adequate income levels with age, gender, ethnicity, education, marital status, employment, area-based socioeconomic deprivation levels, and area of residence. The findings and derived recommendations of this thesis seek to contribute to informing Aotearoa New Zealand policies and systemic reform, suggesting that adequate income may be an important factor for good cognitive functioning. Further research is required to understand the longitudinal effects of income adequacy on cognitive functioning.

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“He rourou mā koutou, He rourou mā mātou, Ka ora te manuhiri, Ko te rau aroha ki mau, Ngā mahi o te whānau, Hei orangatanga mo te ao.”

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1. Introduction

It is estimated that New Zealanders over the age of 65 will make up a fifth of Aotearoa New Zealand's population by 2026 (Stephens et al., 2011). Extended life expectancy has led to growing concerns regarding the prevalence of age-related health conditions globally (Yu et al., 2021). More studies have begun unmasking the relationship between socioeconomic status and cognitive impairment. Thus, extended life expectancy raises concerns regarding older adults' income adequacy and brain health.

Income adequacy is a socioeconomic characteristic which refers to the self-perception of an individual's ability to meet their everyday needs based on their current income. Extended life expectancy is a threat to the income adequacy of individuals and the government as it poses challenges to pension systems, the workforce, and healthcare services. Understanding the consequences of extended life expectancy is crucial as socioeconomic status has been linked with cognitive impairment and the prodromal phase of dementia (Demir Akça et al., 2014). This is a concern as increasing costs for individuals and governments associated with cognitive impairment are driving further social inequities for vulnerable communities (Morris et al., 2021).

As people live longer, they are more likely to experience a decline in their health. Miu et al. (2016) and Rawat et al. (2024) are among many who confirm that age is a primary risk factor for cognitive impairment. This could be attributed to structural changes in the brain, cognitive domain changes, neurobiological changes, and individual variability. This is concerning as cognitive decline and impairment has been commonly found to reduce an individual's quality of life and independence. This may manifest in daily life as inability to perform activities or tasks, impaired decision making, emotional dysregulation, or communication challenges. These challenges prompted further exploration into modifiable factors of cognitive decline and impairment which has linked sociodemographic and living conditions with adverse effects on individuals' cognitive function.

The relevancy of this to New Zealand is identified through the disproportional effects of cognitive decline Indigenous and vulnerable communities experience (Clark et al., 2022). Indigenous communities have reported experiencing further inequities in the form of increased costs, treatment disparities, and systematic challenges in addition to more pronounced effects of cognitive impairment (Morris et al., 2021). This is relevant to Aotearoa New Zealand as they hold a large and growing ageing population with a diverse ethnic composition (Stephens et al., 2022).

While insights into socioeconomic factors are valuable to guide health promotion and government policy, it does not provide knowledge about an individual's perceived ability to meet their everyday needs. Utilisation of a self-rating item for income adequacy is a way to address this gap. This would provide insight into individuals income adequacy for personal or household needs such as accommodation, food, healthcare, and other necessities. Thus, the purpose of this thesis is to investigate the relationship between income adequacy and cognitive functioning in Aotearoa New Zealand older adults, using data of the New Zealand Health, Work and Retirement (NZHWR) study. With that, the study aims to provide novel knowledge about income adequacy in relation to brain health, which can support transformational change in health-care promotion and government policy.

2. Literature Review

2.1 Search strategy

To complete a comprehensive literature review, a systematic approach was used to identify relevant literature for this research. Using the Prisma 2020 checklist as a guideline, a literature search was performed using the Massey Universities Discover Database from inception until October 2024. Discover scoured the databases of: MEDLINE, Complementary Index, Academic Search Premier, APA PsycINFO, CINAHL Complete, Health Source: Nursing/Academic Edition, Directory of Open Access Journals, Psychology and Behavioural Sciences Collection, Education Source, Springer Nature Journals, Supplemental Index, EconLit, Education Research Complete, Business Source Complete, Scopus®, MasterFILE Premier, SPORTDiscus with Full Text, Social Sciences Citation Index, JSTOR Journals, Science Citation Index Expanded, ERIC, Health Business Elite, APA PsycArticles, Library Information Science & Technology Abstracts, Computers & Applied Sciences Complete, Humanities International Complete, Teacher Reference Center, GreenFILE, Australia/New Zealand Reference Centre Plus, Health Source - Consumer Edition, ScienceDirect, IEEE Xplore Digital Library, MAS Ultra - School Edition, Historical Abstracts, SciTech Connect, Emerald Insight, Informit Collections, and PsychiatryOnline for both my global and local searches. I searched for articles that reported on topics related to my hypotheses such as income adequacy, socioeconomic factors, cognitive function, and cognitive-related disease specific to deterioration in people aged 65 and older both globally and relative to Aotearoa New Zealand. Search terms were kept relevant to cognition and cohorts to the population present in my data set. Asterisks were utilised for root word expansions and wildcard searches to broaden the search within the databases that Discover explores. Root word and wild card expansions allow the databases to find all variations of the words to retrieve all potential derivatives without having to manually add the variations into the search. To ensure all relevant literature was captured in this thesis I utilised Prisma 2020 flow chart (Page et al., 2021). This quantified the inclusion and exclusion of literature for this thesis. The full search strategy and Prisma flow charts are available in the Appendix.

2.2 Criteria for inclusion

Articles were included in my literature review if the articles originated from peer-reviewed journal articles, books, systematic reviews, and meta-analyses. These articles we filtered based on topics associated with income adequacy as a primary topic or a secondary topic concerning socioeconomic status. Also included within the literature were articles based on cognitive functioning within those aged sixty-five and older or older populations. From here, I completed both a local search which encompassed Aotearoa New Zealand and a global which encompassed all of the world. Articles written in English that were found to be of relevance were kept. Lastly, both qualitative and quantitative studies that discussed information relevant to my hypotheses were included to provide a robust understanding of income adequacy and cognitive functioning.

2.3 Criteria for exclusion

Articles were excluded from the literature review if they were deemed to be irrelevant to establishing a broad understanding of this research. Any articles written in a language other than English were discarded to ensure the accessibility and relevance of the articles to the present research. Articles were also excluded if full reports were necessary for further assessment of eligibility but were unable to be retrieved to ensure the article's full context was considered.

2.4 Selection of included articles and data extraction

The selection of the articles within this literature review was performed independently by me. Initially, I screened the articles for duplicates which Massey University's Discover database automatically removed within both local and global searches. I confirmed this by going through the local and global searches and ensuring duplicates had indeed been removed. To gather relevant articles, I evaluated the title of each article against the inclusion to establish whether it was appropriate for selection. If the title was insufficient to evaluate the article against the inclusion criteria, I evaluated the abstract of the article. When the abstract was insufficient to confirm inclusion or exclusion, the full article was retrieved. If available, information and data directly related to income adequacy and cognitive functioning within older populations were extracted. When there was information or data regarding the effect of ageing and environmental factors on both income adequacy and cognitive functioning over one's lifespan, it was also extracted to inform the broader context of the research.

2.5 Overview of final selection process

The initial search for local and global searches was completed on the 11th of June 2024. Final selection for both searches was completed on the 29th of July 2024. A record of both searches was kept in line with the Prisma 2020 flow diagram for new systematic reviews specific to databases and registers (Page et al., 2021). The PRISMA 2020 flow chart was used in accordance with the Creative Commons Attribution (CC BY 4.0) license which permits others to distribute, adapt, and build on the template for commercial use if the original work is accurately cited (Page et al., 2021).

The local search returned 294 hits within Massey Universities Discover Database with "available in library collection" remained unticked. Of the 294 results, 177 duplicates were removed using Massey Universities Discover Database automatic removal system. The remaining 177 articles were then assessed for eligibility. Articles were assessed in order of their title, abstract, and then their full article dependent on whether initial assessments aligned with inclusion or exclusion criteria. Of the 177 articles, 107 did not meet the topic inclusion criteria. This left 10 local articles to inform the literature review.

The global search returned 2,944 hits within Massey Universities Discover Database with “available in library collection” remained unticked. Of the 2944 results, 1,477 duplicates were removed through Massey Universities Discover Database automatic removal system. The remaining 1,467 articles, 1,339 articles were excluded as they did not meet the topic inclusion criteria. The same process utilised within the local search for topic exclusion was employed within the global search for exclusion. A further 88 articles were manually identified as duplicates that Massey Universities Discover Database automatic removal system had initially missed and excluded. This left 43 global articles to inform the literature review. 41 of these articles provided full reports. Please refer to the appendices for further details regarding the Prisma 2020 flow charts.

2.6 Cognitive functioning and its importance

Cognitive functioning encompasses the functionality an individual possesses across domains of the brain which are responsible for memory, attention, learning, language, and executive functioning (Brody et al., 2019). Cognitive performance is expected to exhibit variability during the ageing process for each individual. Mild changes in cognitive functioning may present as changes to memory or new challenges in completing daily tasks (Han et al., 2015).

Moderate to severe impairment in cognitive functioning is characterised as cognitive disability or health concerns involving neuropsychiatric symptoms which require increased caregiving support (Miu et al., 2016). Changes in cognitive functioning have been associated with a reduction in quality of life, relationships, finances, and independence. This is important as a reduction in one's quality of life and independence often only becomes noticeable when the cognitive impairment progresses, affecting one's ability to recall, process new information, or perception becomes disrupted (Muhammed, 2023; Stephens et al., 2015). Cognitive decline or cognitive impairment may be more complex to identify later in life with cognitive functioning peaking around the age of 40 before changes begin to affect memory or daily tasks (Zhang et al., 2015). Liu et al. (2023) findings support this, with processing and memory challenges presenting for individuals between the ages of 53-69. Literature suggests severe changes to cognitive functioning after the age of 40 may manifest as Dementia, Alzheimer's disease, or Lewy-body disease. However, there is a wide range of changes to cognitive functioning which do not necessarily result in a severe deterioration in one's abilities. It is important to note changes to cognitive functioning often co-exist with other health conditions later in life (Brody et al., 2019).

Some variability in cognitive functioning is expected in older age (Ellwood et al., 2022). However, there are many sociodemographic characteristics and living conditions which have been associated with changes in cognitive functioning outside of normal ageing related changes (Muhammed, 2023). These sociodemographic characteristics and living conditions include age, gender, ethnicity, education level, employment status, marital status, area of residence, and level of area-based socioeconomic deprivation. Of these sociodemographic characteristics and living conditions, literature identifies age to be the biggest predisposing factor for changes in cognitive functioning (Zhang et al., 2015). Ageing has been found to catalyse many degenerative health conditions and reduce an individual's independence (Nutakor et al., 2021). Historically, discussions for maintenance of health and independence centred around physical health. However, recent discoveries within the fields of psychology and neuroscience have prompted further discussions regarding the role of cognitive functioning in maintaining independence and healthy ageing. While some New Zealanders embrace a narrative around ageing gracefully without intervention others are beginning to adopt preventative strategies to maintain their overall health and their independence.

Longer life expectancy, globally, creates greater pressure on the governments infrastructure to provide effective social policies, financial aid, and healthcare (Nutakor et al., 2021). Social and financial costs associated with cognitive decline are a growing burden for individuals and the New Zealand government. As the prevalence for cognitive decline grows, so too has the dependency of older adults diagnosed with cognitive impairment. Lack of support at home requires further healthcare and financial assistance to maintain a basic standard of living. Without the support of government assistance for daily tasks and healthcare needs individuals are faced with challenges of neglect and reduced quality of life. While the New Zealand government would face concerning plummets to New Zealanders mortality rates. These findings reinforce the importance of national campaigns and policies to promote preventative strategies for brain health.

2.7 Income Adequacy and Socioeconomic Status

The relationship between socioeconomic status and income adequacy is nuanced. Socioeconomic status is multifaceted, encompassing numerical income, education, occupational status, living conditions, and social mobility (Hempel et al., 2021; McCann et al., 2018). However, income adequacy differs from socioeconomic status as it is a subjective evaluation vs. an objective one. Income adequacy considers the self-perception of whether an individual’s everyday needs are met by their current income (Thornton & Bowers, 2024). It is important to make this distinction between income adequacy and socioeconomic status as it provides a nuanced understanding of the dimensionality of an individual’s and community’s circumstances. The gap identified between socioeconomic status and income adequacy is how an individual may hold a higher standing of socioeconomic status and hold the perception, they have lower income adequacy. This could also be true for those who hold low socioeconomic status but report higher levels of income adequacy. Thus far literature has focused on the relationship between socioeconomic status and health outcomes. From this, lower socioeconomic status in childhood and adulthood has been linked to health inequities such as cognitive impairment later in life (Peterson et al., 2021; Stephens et al., 2019). However, it is still unclear if socioeconomic status is associated with the severity of cognitive impairment (Muhammed, 2023). While other literature delves into the drivers behind socioeconomic status, material living standards, and income adequacy for cognitive functioning. Much of the literature is convergent that demographic and lifestyle factors can promote healthy ageing. Education level, marital status, and employment status were consistently found to be associated with better overall health in older age (Allen & Alpass, 2020; Thornton & Bowers, 2024). This is an important aspect of income to consider as Stephens et al. (2011) discovered there to be a relationship between socioeconomic status and self-rated health. This discovery underscores this thesis as income adequacy is the primary variable of interest in relation to cognitive function as previous research has primarily centred around socioeconomic status. In order to begin unpacking the influence financial stability has upon cognitive function it is necessary to quantify individual's self-perception of their level of income adequacy.

Furthermore, prolonged exposure to low socioeconomic conditions has been linked to physiological changes to the structure of the brain (Clark et al., 2022). Inflammation of the brain was associated with higher white matter hyperintensity burden and neurodegeneration in individuals from low socioeconomic backgrounds. This suggests individuals from low socioeconomic status are more likely to experience abnormal changes to their brain structure which may affect their cognitive function. This is relevant to income adequacy as little is known regarding biological, social, environmental, and cultural factors which initiate and maintain cognitive decline. Furthermore, there is little research regarding the impact of income adequacy on daily living and quality of life.

Understanding the association of income adequacy and cognitive functioning is an important step towards the creation of effective health promotion schemes and policies for the prevention and intervention of brain health-related diseases, which can have a significant impact on a populations' quality of life and health challenges in older age.

2.8 Income adequacy and cognitive functioning

The relationship between income adequacy and cognitive functioning appears cyclic. Experience of income adequacy is driven by income attainment to meet daily needs (Thornton & Bowers, 2024). However, there are many lifestyle factors which intersect with income adequacy (Allen & Alpass, 2020). Income adequacy is the notion that individuals can meet their everyday needs based on their current income level. More broadly it requests individuals to consider the quality of their relationships, overall health, and living standards in relation to their own expectations and values (Demir Akça et al., 2014). However, when income adequacy is low, individuals may be unable to do or have the things in life that meet basic needs or bring them joy. Long-term, this can have a significant impact on an individual’s job opportunities, financial literacy, and income growth opportunities (Foong et al., 2021; Hempel et al., 2021). Consequently, income adequacy struggles can filter into other areas of life. One aspect of life, income adequacy may affect are peoples’ relationships and their capacity to engage in fulfilling relationships (Yang et al., 2024). The absence of income adequacy may create barriers to quality time with loved ones, experiencing enjoyable activities, giving gifts, and showing up to appointments. As relationships can be personal or professional, income adequacy can also affect the relationships held in professional spaces with colleagues or medical professionals. Martinez-Ruiz et al. (2020) have found those who have not participated in social activities recently, unidentified limitations in independence, or limited access to resources to be less likely to receive a of diagnosis for cognitive impairment. This was attributed to symptomology remaining unnoticed by an individual’s social networks and experiences of low-income. These challenges may manifest as geographical or engagement struggles (McCann et al., 2018). This is because those with cognitive impairment may additionally experience low levels of income adequacy which could create barriers transportation. Consequentially this may prevent individuals from attending social activities or making medical appointments due to logistical challenges (Lindsay et al., 2022). Furthermore, income adequacy constraints may influence individuals’ capability to engage in workplace activities such as getting coffee or lunch together. Consequently, prolonged exposure to income inadequacy which is affecting relationship building can filter down into individuals’ overall well-being (Hempel et al., 2021; Liu et al., 2023). This may manifest in the form of physical, mental, or cognitive challenges (Staff et al., 2016). This can delay diagnosis and intervention for individuals and exacerbate perpetuation disparities for vulnerable communities.

Income adequacy can support access to resources which allow individuals to meet basic needs. While worldview and cultural contexts may differ globally, to function to share underlying basic needs such as a sense of belonging, access to food and water, shelter, sleep, and income adequacy (Demir Akça et al., 2014). Without a sense of belonging, access to food and water, shelter, sleep, or income adequacy cognitive capabilities may become affected (Elbejjani et al., 2017). Consequently, individuals' may become unable to engage in self-care or prosocial activities when their basic needs remain unmet (Allen & Alpass, 2020; Demir Akça et al., 2014). Rawat et al. (2024) and Tawfik et al. (2024) found individuals may experience poorer health outcomes or poorer overall quality of life when basic needs are consistently and repetitively unmet. However, Lindsay et al. (2022) suggests technological advances can bridge the gap of some aspects of income adequacy and poorer health outcomes. Hsu et al. (2019) and Lindsay et al. (2022) have suggested advances in technology and transportation can improve individuals' access to education, employment, and loved ones. Giving individuals the opportunity to meet their basic needs. However, when income adequacy is low this can be a further barrier to meeting everyday needs and accessing education, employment, and leisurely activities, individuals are less inclined to participate regardless of age (Hsu et al., 2019). Exacerbating pre-existing disparities due to lower income adequacy.

Furthermore, Lindsay et al. (2022) found a positive association between higher mean household material resources and better cognitive function among older adults in rural South Africa. Specifically, improvements in income adequacy and material resources were linked to better cognitive scores. Brody et al. (2019) findings have associated nutritional food, social connection, and cognitive stimulation with enhancing one's health and quality of life. An international study in Peru found lower household food insecurity and good nutritional status to be a positive indicator of higher levels of cognitive functioning and successful ageing (Olivera & Tournier, 2016). Driven by access to amenities like refrigerators, stoves, telephones, televisions, and vehicles which reduced barriers to nutritional food, social connection, and cognitive stimulation (Lindsay et al., 2022). Suggesting cognitive enrichment activities can support the development one's cognitive reserve. Subsequently, promoting the growth and maintenance of individuals' cognitive functioning abilities. Activities involving education, work, or socialisation which challenge and stimulate the brain are important in supporting new neuronal pathways to form (Elbejjani et al., 2017). The development of neuronal pathways supports the growth of the cognitive reserve which is important for preventing abnormal age-related neuropathological decline or insults. This context adds further weight to previous literature, which associate persistent financial adversity with brain atrophy (Clark et al., 2022). Suggesting those carrying the APOE-4 gene are more vulnerable to cognitive impairment when exposed to persistent financial adversity.

2.9 How expected age-related changes in cognitive functioning differ from cognitive impairment

Cognitive functioning plays an important role in maintaining independence later in life (Stephens et al., 2015). The brain is responsible for the coordination of sending signals around the body to maintain basic function as well as managing complexities to regulate emotions, perception, memory, and thoughts (Tawfik et al., 2024). The prevalence of dementia and cognition-related diseases are expected to significantly increase by 2050 (McCann, 2018). Literature identifies mild cognitive impairment (MCI), dementia, Alzheimer's Disease (AD), and Lewy-body disease (LBD) as the conditions most frequently associated with dementia onset (Zhang et al., 2015). However, diagnosis is often prolonged. Martinez-Ruiz et al. (2020) suggests those who live alone, are of Asian descent, have limited social engagement, have recently experienced a major life event, experience limited physical function, and increase in age are at higher risk of delayed diagnostic investigation and diagnosis. These findings suggest there are some overlapping complexities which exist between cognitive decline, neurodegenerative diseases, and the development of dementia. As cognitive function diminishes, often exacerbated by conditions such as AD or LBD, the risk of dementia increases. This emphasises the importance of early detection and intervention in cognitive impairment to attempt mitigation of the progression to dementia.

Cognitive impairment is often associated with MCI, AD, and LBD (Miu et al., 2016; Zhang et al., 2015). MCI is characterised as changes in cognitive domains which exceed the expected normal changes for cognitive functioning associated with ageing (Muhammed, 2023). MCI is associated with an increased risk of dementia and is often referred to as a transitionary diagnosis between age-related changes in cognitive functioning and dementia (Han et al., 2015; Rentería et al., 2020). This is because diagnostic criteria of MCI characterize those who display symptomology of cognitive impairment but do not meet the full criteria for Dementia or AD with MCI.

The current diagnosis of MCI is made based on simple cognitive screening measures, limited neuropsychological assessment, and self-report measures (Rentería et al., 2020). Neuropsychological assessment has been found to be a more reliable assessment tool for MCI compared to other screening tools as it utilises broader screening for cognitive domains. Diagnosis of MCI is often discussed as a precursor to the development of dementia or AD due to brain pathology reflected in MCI. A community-based study completed by (Han et al., 2015) associates MCI with lower performance for overall literacy, financial literacy, and health literacy. Education was found to mitigate the effect MCI has upon total literacy and financial literacy with semantic memory being most associated with literacy. Suggesting those with diagnosis or symptomology of MCI may not hold cognitive capacity to identify, understand, or use information to function across contexts (Han et al., 2015). Changes in cognitive function can affect individuals' perception of their environment, relationships, and ADLs which may create greater dependencies (Miu et al., 2016; Muhammed, 2023). Activities in daily living include bathing, toileting, personal hygiene, dressing, and mobility (Demir Akça et al., 2014). Individuals with mild changes and expected age-related changes in cognitive functioning may experience some challenges in daily life but be able to maintain independence. Those with moderate to severe cognitive impairment were found to struggle more than those with mild cognitive impairment in findings from (Demir Akça et al., 2014; Miu et al., 2016). While subtle changes in cognitive function associated with MCI may not impede daily functioning or independence, severe changes in cognitive functioning associated with MCI may affect activities of daily living (ADLs) (Muhammed, 2023). These challenges may present as mobility constraints, loss of motor control, emotional dysregulation, sleep disturbances, organisational challenges or incomplete tasks. Severity of cognitive impairment may also increase an individual’s dependency upon family and require further healthcare assistance to meet basic needs (Gu et al., 2021; Neelam et al., 2024). This support may allow individuals to complete their ADLs and sustain a basic quality of life (Demir Akça et al., 2014). Furthermore, the quality of care can be pivotal in the prevention of further physical or mental health complications that can arise from neglect. While many Indigenous cultures have a familial structure which supports older adults through the ageing process, not all older adults have a support network to help them navigate health challenges (Paredes-Arturo et al., 2019). Subsequently, this places more pressure upon the healthcare system to provide this support (Trani et al., 2023). This requires healthcare professionals to hold culturally responsive and reflexive practice.

AD is a neurodegenerative disorder classified as an impairment in memory retention and cognitive functioning (Rawat et al., 2024). AD involves physiological and pathological shifts within the brain affecting the hippocampus and areas responsible for learning and memory. Literature is divergent on the role the APOE-4 gene has in cognitive decline. Some findings suggest the APOE-4 gene and AD are associated while others found a mixed association and some no association. Interestingly, Liu et al. (2023) found the APOE-4 gene to create further vulnerability for carriers of the APOE-4 gene with brain atrophy when exposed to prolonged financial adversity. Elbejjani et al. (2017) findings also found socioeconomic status to be associated with hippocampal atrophy and changes in cognitive functioning. Furthermore, Clark et al. (2022) have found inflammation to negatively impact cognitive function in Hispanics and Latinos. Suggesting identification of inflammation of the brain, the APOE-4 gene, and prolonged financial adversity could be crucial in developing prevention and intervention strategies against changes in cognitive functioning. Zarringhadam et al. (2024) suggest AD can be attributed to modifiable risk factors and recommend lifestyle modification as an avenue for prevention and intervention. Mudrazija et al. (2024) highlights financial hardship as a modifiable factor which can often be experienced by individuals' years before receiving a diagnosis. Recommendations synthesized within existing literature on financial hardship suggests early intervention may ameliorate the severity of financial and cognitive challenges experienced by individuals. This is especially important for individuals as literature expresses growing concern regarding the financial insecurity that often accompanies dementia. Financial insecurity is a concern for households which include a loved one living with dementia. Individuals have reported needing an additional 48% of their regular income to be able to maintain the same standard of living prior to diagnosis (Morris et al., 2021). Reported levels of caregiver burden and financial strain within the wider family system when a loved one experiences moderate to severe changes to their cognitive functioning are cause for further concern. This highlights the importance of early diagnosis and intervention for cognitive decline and impairment (Martinez-Ruiz et al., 2020). However, primary care clinicians have been found to miss symptomology of cognitive impairment in patients leading to further income and health disparities.

LBD encompasses Parkinson's Disease with dementia (PDD) and dementia with Lewy bodies (DLB) (Rawat et al., 2024). LBD is characterized as changes in cognitive functioning which exceed changes associated with expected age-related cognition changes (Miu et al., 2016). While similar, PDD and DLB may present differently. PDD may present as cognitive, neuropsychiatric, motor, or autonomic changes in functioning. While DLB may present as changes in cognition, neuropsychiatric symptomology, or mood disturbances. Significant cognitive changes related to LBD can be neurodegenerative and affect ADLs which may reduce independence (Miu et al., 2016). Those living with AD, LBD, or dementia often require intensive support from healthcare services to ensure their ADLs are met (Miu et al., 2016; Zhang et al., 2015). This requires using appropriate tools and approaches within assessment.

One of the many neuropsychological tools commonly used to screen for cognitive functioning, cognitive impairment, or possible dementia is the Addenbrooke's Cognitive Examination (ACE) due to its sensitivity to the onset and progression of dementia (Mioshi et al., 2006). The ACE has been used across five continents, often based on adapted version to increase its cultural sensitivity. This led to the development of the Addenbrooke's Cognitive Examination-Revised version (ACE-R), which has been found to be sensitive and specific to detect cognitive impairment including MCI with The Verbal-Language/Orientation-Memory (VLOM) ratio designed to differentiate between AD, LBD, and frontal temporal dementia (FTD). Gaps between clinical and research settings in time, adequate staffing, and financial capacity can make findings and clinical applicability challenging. However, the ACE-R was found to be valid and reliable across settings with the ACE-R being adopted internationally (Mioshi et al., 2006). Callow et al. (2015) explored testing norms of the 'Kiwi' ACE-R in Aotearoa New Zealand, and the findings revealed the

ACE-R held good concurrent validity and reliability within a 1,005-participant sample ranging from 45-85 years old, covering various sex, ethnicity and education levels. The ACE-R has recently been withdrawn due to copyright issues involving the integrated Mini Mental State Examination (MMSE), and has been replaced by the Addenbrooke's Cognitive Examination third edition (ACE-III; without the MMSE items), which has shown good validity and reliability, and equivalence to the ACE-R across research and clinical settings (Callow et al., 2015).

Public health concerns reveal the challenges cognitive decline places upon the health and social care systems (Tawfik et al., 2024). Specialised care required to support individuals with cognitive decline often comes with considerable costs for families and government services (Morris et al., 2021). As cognitive decline becomes more pervasive, the need for intensive and specialized services often increases. Healthcare professionals play an essential role in the quality of older adults' lives through the prevention, detection, and intervention of cognitive decline (Ellwood et al., 2022). Previous research highlights the challenges healthcare professionals have in identifying cognitive decline early and providing an accurate diagnosis due to overlapping symptomology (Martinez-Ruiz et al., 2020). As there is no clarity within the literature regarding causes of the pathological processes driving cognitive decline in MCI, AD, LBD, or dementia, it has created inconclusive treatment options (Miu et al., 2016). While interventions targeted towards lifestyle modifications are important, there are unique life experiences, physical changes, and genetic diversity that have been found to affect cognitive function which needs further exploration (Elbejjani et al., 2017). Lack of understanding for unique life experience creates challenges to the standardisation of prevention, detection, and intervention options during each stage of change in cognitive functioning. Presently, differentiation of diagnosis between normal age-related decline, MCI, AD, and dementia can only be identified over a substantial period of time. This is because accurate diagnosis requires prolonged observation of pathological changes to the brain and changes to cognitive functioning (Miu et al., 2016). Reinforcing the importance of system wide reform to alleviate the financial burden that severe changes in cognitive functioning can create (Ellwood et al., 2022).

2.10 How ageing influences cognitive functioning

Studies suggest that cognitive reserve can play an important role in cognitive functioning (Elbejjani et al., 2017; Zarringhadam et al., 2024). A cognitive reserve refers to an individual's ability to overcome age-related neurological changes and mitigate cognitive decline. Determinants which can influence an individual's cognitive reserve comprise biological, demographic, socioeconomic, and lifestyle factors. Biologically, there are several components such as genetics, health factors, and general biological ageing processes which can impact cognitive functioning as we age (Foong et al., 2021; Han et al., 2015). Natural cognitive ageing can look like neurodegeneration, reduced plasticity, and changes within executive functions such as processing speed, recall, or memory retention (Brody et al., 2019; Miu et al., 2016). Neurodegeneration and reduced plasticity both affect brain pathways through the inability to form new neuron connections through the loss of synapses or natural damage caused by ageing (Elbejjani et al., 2017; Rawat et al., 2024). Damage to neuron connection causes problems with brain function which may impact domains which affect executive functioning, processing speed, recall, or memory retention affecting one's cognitive reserve (Rawat et al., 2024). Consequently, this may limit one's abilities to cognitively perform to the level they may have once been able to. Neurodegeneration and reduced plasticity can accelerate the deterioration of an individual's cognitive functioning baseline through the process of ageing. These processes highlight the core changes that can happen to cognitive domains with ageing. Albeit these changes typically occur at a slower rate during normal ageing processes. Cognitive limitations may begin to manifest in one's daily life through their ability to retain new information, make decisions, reaction times, planning abilities and organisation skills (Demir Akça et al., 2014; Nutakor et al., 2021). These skills are noticed more frequently as they are important skills which are required to maintain and excel with independence.

It has been accepted among literature that age is the biggest risk factor for cognitive functioning and independence by extension (Demir Akça et al., 2014; Miu et al., 2016). With every year older the risk of cognitive impairment increases for individuals and the threat to independence grows. Independence is the notion an individual is able to think, learn, and remember information in order to perform daily tasks to meet their needs. These tasks may be associated with ADLs such as cooking, cleaning, and dressing. Without the ability to perform these tasks individuals are likely to become reliant on others for support and sustenance of basic life. This is a challenge for families and the health system who both may lack capacity to provide adequate care for the individual experiencing cognitive impairment. While there are many modifiable characteristics which have been explored in relation to cognitive decline, reversal of cognitive decline through modifiable characteristics once cognitive decline has begun is not possible at this time. Additionally, the variability of these factors makes it challenging to standardise care for cognitive decline. (Brody et al., 2019). This poses an issue for New Zealand with predictions of cognitive decline suggesting prevalence of cognitive impairment is set to rise over the coming decades.

2.11 Gender

Gender is a significant key sociodemographic characteristic for both income adequacy and cognitive functioning. Existing literature on the role gender has in income adequacy and cognitive functioning is complex. At times the literature diverges, suggesting that both men and women may may be susceptible to income inadequacies in relation to cognitive impairment. However, these are often dependent on the context of sociodemographic characteristics and living conditions for individuals. Despite this, women are more often found to yield higher scores for cognitive functioning. While this may alleviate some concerns for women, their longer life expectancy is cause for health concern in older age (Stephens et al., 2022; Zarringhadam et al., 2024). Particularly as women are likely to report lower living standards and access to resources than men (Demir Akça et al., 2014). Lower living standards and reduced access to resources may be attributed to policies which have prevented women from attaining higher education or employment (Stephens et al., 2022). Differential findings suggest women's higher cognitive functioning scores may be attributed to various hormonal changes associated with menses (Zarringhadam et al., 2024). While there are some instances of literature which report men are associated with higher cognitive functioning, these findings are often attributed to cultural and societal norms (Tu et al., 2024). Furthermore, gender has been identified to not be statistically significant for the severity of cognitive impairment developed (Muhammed, 2023). Findings of gender are crucial in informing policies and reform to improve the wellbeing of countries and ensure economic stability. To be able to prioritize wellbeing and economic stability of Aotearoa New Zealand policymakers need further insights into the relationship between gender and income adequacy for cognitive functioning. This would allow disparities amongst genders to be addressed through appropriate resource allocation, adequate income, healthcare, and social progress.

2.12 Ethnicity

Disparities among New Zealanders act as a silent killer for indigenous populations. Extended life expectancy is a great achievement for Māori and non-Māori, though it has created new challenges. Older Māori adults were found in recent times to be more likely to experience higher levels of economic hardship, have less education, be divorced or widowed, and have more health concerns compared to non-Māori (Dulin et al., 2011). Poor health and hardship could be attributed to adverse distal effects of colonisation experienced by Māori. This is a growing concern in Aotearoa New Zealand as longer life expectancy exacerbates existing health and financial inequities between Māori and non-Māori (Dulin et al., 2011). However, there is limited insights provided within literature of Māori experiences of cognitive decline (Stephens et al., 2022). With Indigenous communities found to be at greater risk of socioeconomic and health disparities, further understanding of the role ethnicity has with cognitive decline is required (Clark et al., 2022).

With this in mind, ethnicity is a key sociodemographic characteristic for both income adequacy and cognitive functioning. Māori are disproportionately represented in lower levels of education attainment and income adequacy (Dulin et al., 2011). While non-Māori are overrepresented in higher levels of education and higher levels of income adequacy. This generates concern for older Māori who are likely already disadvantaged and may be vulnerable to further exclusion with cognitive impairment (Stephens et al., 2011). This suggests Māori may have less access to appropriate resources that support them to flourish due to ongoing effects of colonisation (Dulin et al., 2011). Gradual cultural erosion of the Māori culture has been profound. The systematic dismantling of Māori cultural identity, economic stability, and social wellbeing has left a legacy of intergenerational trauma remains deeply entrenched for Māori. Loss of land and erosion of social structures have shaped contemporary Māori worldviews. Reinforcing health disparities, intergenerational trauma, socioeconomic disadvantage. These experiences can create potential for further dependency for the government support among Māori to meet their daily needs and address complex health challenges. Additionally, the dissolvement of social structures for Māori disrupts tikanga and collective values which have previously enhanced the mana within the whānau.

Cumulative effects of colonisation underscore the threat to income adequacy and cognitive functioning for Māori. Understanding cultural norms for Indigenous communities such as Māori, shapes Māori perceptions of cognitive impairment, income adequacy, and social support available (Tang et al., 2024). Overall, the literature reinforces the importance of cultural responsivity for research, diagnostics, and treatment planning for indigenous communities (Rawat et al., 2024; Stephens et al., 2011). This is especially important within an Aotearoa New Zealand context with Te Tiriti o Waitangi implemented to ensure equality between Māori and non-Māori across settings (Dulin et al., 2011).

2.13 Education

Education attainment has been linked to income adequacy and cognitive functioning. Education has been established as a key protective factor against cognitive decline (Rodriguez et al., 2021). There is a convergence in the literature regarding higher education being associated with higher cognitive functioning levels compared to those who hold less qualifications (Nutakor et al., 2021; Zhang et al., 2024). This was found to be true for those aged fifty and over (Rodriguez et al., 2021). Additionally, Brody et al. (2019) and Stephens et al. (2015) found low educational attainment to be independently associated with lower cognitive functioning. These findings are important as education holds a larger role within humans' physiological processes. Literature acknowledges these physiological changes may influence cognitive functioning.

Biologically, education has been found to influence an individual's cognitive functioning abilities through building their cognitive reserve and developing neuroplasticity (Zarringhadam et al., 2024). These skills are centred around domains for verbal learning, delayed recall, and visual scanning. The more these skills are practiced it is suggested the cognitive reserve develops further. This is done through various problem solving and recall tasks (Zarringhadam et al., 2024). Skoblow et al. (2024) suggests adult educational attainment may contribute positively to individuals cognitive reserve, acting as a protective factor against cognitive impairment in older age. Uniquely, Pai et al. (2024) highlights the role education can play across cultural contexts. Pai et al. (2024) analysed the role of education in India, where older adults are more dependent upon their children and familial structure. Offspring who attained higher levels of education were associated with their parents' having higher cognitive functioning scores in older age. This may be attributed to offspring holding a higher capacity to provide financial and social support needed in older age. These processes can indirectly influence the level of income adequacy individuals experience. Perhaps attempting to elevate a populations' educational attainment, individual's income adequacy will improve, and their lifestyle stressors will reduce (Rodriguez et al., 2021).

Furthermore, it is important to be mindful of the misidentification of low educational attainment as cognitive impairment when this may not be an accurate representation of the situation (Brody et al., 2019). Discrepancies between educational institutions and quality of educational resources have not yet been analysed in relation to income adequacy or cognitive functioning. This reinforces the need for further analysis of education which may provide valuable insights into education for income adequacy for cognitive functioning (Rodriguez et al., 2021).

2.14 Marital Status

With differing societal expectations globally, there are divergent findings within research pertaining to the role marital status plays in cognitive functioning. These findings are detailed below. Chen and Cao (2020) found being married to be associated with a higher risk of cognitive decline in a sample population in China. Chen considered this could be related to increased stress and other variables such as loss of material resources. These findings are inconsistent with other literature; however, this finding could be attributed to other factors within Chen's study such as cultural expectations or socioeconomic status. Paredes-Arturo et al. (2019) findings suggest being married is a protective factor in older age in a sample population in Colombia. Paredes-Arturo theorizes the reliability and consistency of emotional support which suggests the shared financial responsibility couples experience is protective for cognitive function in older age. This suggests having income adequacy and materialistic needs met may influence cognitive function in older age. These findings are consistent with Rodriguez et al. (2021) cross-country comparison between Austria, Belgium, China, Czech Republic, Denmark, France, Germany, Ghana, Greece, India, Ireland, Israel, Italy, Mexico, Netherlands, Poland, Russia, South Africa, Spain, Sweden, Switzerland, United States. Rodriguez et al. (2021) found the average level of cognitive functioning to be lower for those who were unmarried. These individuals were classified primarily as those who were single with a few who were widowed or divorced. Rodriguez and Saenz (2022) also found cognitive functioning concerning verbal learning and delayed recall specific to memory to be better for those who were married at baseline in a Mexican sample population. However, the follow-up analysis did not provide further analysis of marital status on participants' cognitive function. Furthermore, Muhammed (2023) found those who identified as a widower and were living with others, rather than a spouse, to be associated with cognitive impairment in an Iraq sample population. While other studies suggested marital status to not be statistically significant for the severity of cognitive impairment symptomology.

2.15 Employment

Understanding the role employment has on cognitive functioning in older age is still in its infancy. Research conducted by Muhammed (2023) in Iraq found unemployment to be a risk factor for cognitive impairment. This is interesting as Rodriguez and Saenz (2022) found occupational type to be associated with domain-specific changes. This suggested that intellectual occupations are associated with a slower decline of visual scanning which was specified to be related to memory. These findings were consistent with Andel et al. (2019) study in Puerto Rico found complexity of occupation was associated with higher cognitive function in older age. Suggesting complexity of work during participant's careers may be a protective factor against cognitive decline in ageing.

2.16 Area-based Socioeconomic Deprivation and Geographic Location

Geographical hardship can manifest itself in various of ways. Two of the most researched contributors of geographical hardship are area-based socioeconomic deprivation and area of residence. Gu et al. (2021) is among many who have looked into the relationship between area-based socioeconomic deprivation and health broadly. Discovering a negative interaction between area-based socioeconomic deprivation and poor health in older age. Allen and Alpass (2020) findings reveal hardship to be associate with poor health outcomes in Aotearoa New Zealand. This is consistent with Hsu and Bai (2021) who also found high area-based socioeconomic deprivation to be negatively associated with cognitive function in a Taiwain based population. Area-based socioeconomic deprivation is classified as socioeconomic deprivation isolated based on geographical location (McCann et al., 2018). Area-based socioeconomic deprivation considers a geographical areas level of capability through assessing various indicators of disadvantage. These factors are often associated with the community's level of income, employment levels, education, health outcomes, housing opportunities, crime rates, and access to social services. Research into the relationship between area-based socioeconomic deprivation and negative health outcomes appears to be consistent throughout the literature. With area-based socioeconomic deprivation found to be linked to the progressive acceleration of cognitive decline (Tang et al., 2024).

Area of residence considers whether individuals reside rurally or within urban areas. Area of residence also provides insight into living conditions for individuals. Area of residence is also indicative of the various resources available to individuals. Hsu et al. (2019) observed urbanisation to be associated with higher levels of cognitive functioning. Those residing in urbanised areas reported better access to resources such as medical care and technology. While those residing in rural areas were reported less access to health and social wellbeing resources. This suggests an individual's perception that individual needs with environmental perception may be sufficient to create disparities for older adults (Hsu et al., 2019).

Both area-based socioeconomic deprivation and area of residence are key living conditions which have been associated with cognitive functioning. Gu et al. (2021) suggest cumulative disadvantage can create vulnerabilities and dependencies for older adults upon their families and services. Therefore, better access to resources could act as a buffer against the effects of geographical hardship for income adequacy and cognitive functioning.

2.17 Relevance in the context of Aotearoa New Zealand

In an Aotearoa New Zealand-based population found childhood socioeconomic status to be a predictor of health later in life across contexts (Stephens et al., 2022). Allen and Alpass (2020) also found there to be poorer health outcomes for those in mid-late life when facing financial hardship compared to those who had stability within their Aotearoa New Zealand-based sample. The study found hardship to be formed before the pensionable age of 65. As individual's living standards improved so did their health prognosis. Hempel et al. (2021) further found childhood conditions and health outcomes later in life to be significantly related within an Aotearoa New Zealand context. Stephens et al. (2022) found mediating factors such as education, occupation, and wealth to buffer the effects of childhood socioeconomic status. Stephens et al. (2019) findings support the aforementioned research; stipulating health outcomes were associated with the perceived quality of environmental resources. Stephens et al. (2019) found assessment of living standards and access to support security or autonomy were derived from the perceived quality of environmental resources. Hempel et al. (2021) suggested the relationship between childhood conditions and health outcomes could be mitigated by economic standard of living. However, the improvement in health outcomes may not be instantaneous Hempel et al. (2021). These findings are important as another Aotearoa New Zealand-based study found older adults who live alone to be most vulnerable and less likely to receive adequate medical intervention (Martinez-Ruiz et al., 2020). Martinez-Ruiz et al. (2020) also found identifying as Asian descent, limited social engagement, experienced significant life events recently, ageing, and limited access around their home to be risk factors of not receiving adequate healthcare.

Stephens et al. (2019) reinforcing that stigma and discrimination can lead to under-diagnosis of cognitive impairment. Furthermore, financial and mobility barriers may also play an important role in diagnosis and medical intervention Martinez-Ruiz et al. (2020). Acknowledging that these risk factors also contributed to delayed diagnosis and intervention Martinez-Ruiz et al. (2020). Stephens et al. (2022) found different groups experienced different socioeconomic trajectories. Raising awareness of the importance of embracing diversity. Stephens et al. (2022) found Māori to be associated with different socioeconomic status trajectories which are not reflected in the general experience of New Zealanders.

Aotearoa New Zealand literature is convergent on the role socioeconomic status has on cognitive function within New Zealand's population. However, there is still a lot about the relationship between socioeconomic status and cognitive function in Aotearoa New Zealand that is unknown. Stephens et al. (2022) emphasizes the importance of understanding the duration of New Zealanders' life span to better grasp the structural production and reinforcement of health inequities later in life. Currently, there are many policies targeted towards improving health outcomes later in life in Aotearoa New Zealand (Martinez-Ruiz et al., 2020; Stephens et al., 2022). However, due to the lack of understanding of predisposing and perpetuating factors of cognitive impairment, the recommended interventions can exacerbate health conditions (Stephens et al., 2022). Existing literature outlines many opportunities to promote better cognitive health throughout New Zealander's lifespans. These recommendations include a universal pension system, work participation in later life, and improved social policies to address inequities New Zealanders are facing (Allen

& Alpass, 2020; Martinez-Ruiz et al., 2020). Stephens et al. (2022) stresses the importance of Aotearoa New Zealand social policy shifting discourse from an older age lens to addressing inequities across the lifespan. Stephens et al. (2019) suggests a shift from individualised responsibility to a community approach which promotes quality living standards to promote wellbeing. Stephens et al. (2022) further, reinforce the notion that socioeconomic status and health outcomes need to be rooted in diversity to ameliorate the disparities experienced by New Zealand's marginalised and indigenous communities. Without inclusion in public health policy and health promotion New Zealand's marginalised and Indigenous communities may experience further barriers to the accessibility of services. Stephens et al. (2022) recognizes the importance of fostering culturally informed and responsive broad-based interventions to better support New Zealanders to combat the effects of life-long inequity. This involves developing culturally sensitive norms for assessment as well as culturally responsive intervention (Callow et al., 2015).

2.18 A gap in the literature on income adequacy and cognitive functioning in Aotearoa New Zealand

In Aotearoa New Zealand, significant health disparities exist between Māori and non- Māori populations, including cognitive health (Martinez-Ruiz et al., 2020; Stephens et al., 2022). To better understand how these disparities manifest within daily life, there needs to be more research completed to understand the nuances of challenges faced by New Zealanders. While much of the literature about cognition and cognitive impairment looks into socioeconomic status, the findings are often broad and non-specific to daily living. A big gap in Aotearoa New Zealand literature is understanding the role income adequacy for cognitive functioning. While there is some international literature that touches on income adequacy, there is minimal research in Aotearoa New Zealand. Due to the different socioeconomic trajectories among New Zealand's diverse population, it is expected that New Zealanders will also face different cognitive functioning trajectories (Allen & Alpass, 2020). Therefore, it is meaningful to explore the relationship between income adequacy and cognitive function as well as the role demographic or living conditions may play. This would provide quantify what enough income adequacy is for New Zealanders and how to best promote brain health. Exploring the role of income adequacy with cognitive function can provide valuable insights into the cultural nuances within Aotearoa New Zealand's population. This would aid in the creation of culturally appropriate interventions and policies, to better support New Zealand's most vulnerable.

2.19 Proposed study

New Zealand's socioeconomic environment has evolved over the last fifty years. Whilst the new millennium brought technological and medical advancement leading to longer life expectancy (Demir Akça et al., 2014; Elbejjani et al., 2017). Similarly, Stephens et al. (2015) found extended life expectancy to increase the risk of cognitive impairment as New Zealand's population grows. With an ageing population, Aotearoa New Zealand has seen a rise in new health challenges which include cognitive impairment and dementia. This is important as cognitive functioning is a key aspect in older adults maintaining their quality of life and independence (Rawat et al., 2024; Tawfik et al., 2024). Greater population growth requiring more resources places further strain on New Zealand's infrastructure to provide adequate health and social care.

This thesis will look into whether income adequacy is associated with cognitive functioning in Aotearoa New Zealand's older population. This thesis seeks to establish whether having higher income adequacy is associated with higher cognitive functioning and evaluate if this relationship differs among sociodemographic groups. It will look at the relationship New Zealand's wider socioeconomic environment may have with cognitive functioning. This thesis intends to facilitate a better understanding, influence policy changes, and guide brain health interventions in Aotearoa New Zealand.

3. Methods

3.1 Ethics

The study has been approved by the Human Ethics Committee (HEC Southern B; 09/70, 10/43) of Massey University. It adheres to ethical standards of the 1964 Declaration of Helsinki and its later amendments. All participants provided written informed consent.

3.2 Data collection procedures

The New Zealand Health, Work and Retirement (NZHWR) study is one of the longest running nationwide ageing studies in Aotearoa New Zealand. The NZHWR survey is designed to explore ageing in three key domains: health and well-being, social participation, and economic participation. NZHWR explores physical, emotional, and cognitive aspects of well-being, the presence of familial support, social capital, and general social participation, and the meaning of work, employment, and the role of retirement in ageing. Within the surveys administered, the Healthy and Ageing Research Team (HART) through Massey University have provided added sections to the survey which elicit further examination of relevant ageing concerns in Aotearoa New Zealand.

NZHWR have conducted off-wave surveys to assess relevant issues that ageing populations may face in Aotearoa New Zealand. One of the off-wave surveys that is relevant to this thesis is the face-to-face assessment which evaluated cognitive performance in 2010 which has informed the cognitive functioning of the population in this thesis. The NZHWR is a biennial survey which is administered by letter in the post. In some instances where additional information may be required a telephone interview or face-to-face interviews may be conducted, for example, for cognitive testing. The study began in 2006 to explore the experiences of those aged 55 and older in Aotearoa New Zealand. The original cohort was aged 55-70 years old with the average age being 61 years old. Of this cohort, 54% identified as female and 46% as male with 50.7% of the cohort acknowledging their ethnicity to be New Zealand European, 46.5% as Māori, and 2.8% of the cohort as other ethnicities. In 2006, the NZHWR study began with 6,661 participants with approximately 3,064 participants agreeing to continue to be reapproached for an ongoing longitudinal study. To date, NZHWR has collected over 12,000 responses to one or more of the biennial surveys conducted between 2006 and 2022. Of the overall 12,000 responses collected over the longitudinal NZHWR study, 970 participants were included in the current cross-sectional study. Inclusion criteria for this thesis required participants to complete two off-wave surveys that informed income adequacy and cognitive performance in 2010 additional to the routine biennial survey. All other participants were excluded from this thesis.

3.3 Study Design

The 2010 wave data collected by NZHWR informs the current thesis which employs a cross-sectional study design. Recruitment for NZHWR involved random sampling from the electoral roll which ensured over-sampling of those on the roll identifying themselves as a person of Māori descent to ensure adequate representation of Aotearoa New Zealand's indigenous population.

3.4 Description of participants

The sample population for this thesis were volunteers from the broader NZHWR participant pool who agreed to complete face-to-face interviews with NZHWR researchers in addition to the postal survey. These interviews were initially conducted in 2010 and then a follow-up interview was conducted in 2012. This subset analysis in 2010 included 1,001 participants from the NZHWR study which specifically explored cognitive functioning. This allowed the NZHWR research team to establish a baseline understanding of cognitive functioning within the sample population. This is useful as the researchers can evaluate cognition against other data collected to assess any trends. In 2010, the subset age range was between 49 and 84 years old, 53.2% of participants were women and 25.8% identified as Māori. The 2010 survey and interviews utilised standardised measures to assess the cognitive functioning and socioeconomic experiences of participants. Interviews for cognitive functioning were administered through one-hour home visits conducted face-to-face with participants. The present study will focus on the 2010 data set as it is the most complete data set.

3.5 Materials and Instruments

3.5.1 Cognitive functioning

The ACE was originally developed and normed in 2000 by Mathuranath et al. (2000) in the United Kingdom. The ACE was then revised (ACE-R) in 2006 by (Mioshi et al., 2006). The revised ACE included the Mini-Mental State Examination (MMSE). This was designed to improve sensitivity and better assess various cognitive domains. These cognitive domains were attention, language, memory, visual-spatial skills, and fluency, which provided a total score of 100 points. The ACE-R demonstrated high internal consistency and concurrent validity. This has demonstrated the ACE-R is an effective screening tool for cognitive functioning.

Since the time of data collection, the ACE-R has been withdrawn due to copyright issues regarding the inclusion of the Mini-Mental State Examination (MMSE). The ACE-R has since been replaced with the ACE-III which is non-inclusive of the MMSE. Prior to the withdrawal of the ACE-R the adapted “Kiwi” Addenbrooke’s Cognitive Examination-Revised (ACE-R) was used for screening and detection of possible dementia and assessing cognitive functioning in Aotearoa New Zealand (Callow et al., 2015). In Aotearoa New Zealand, the ACE-R has been adapted to ensure reliability and validity within an Aotearoa New Zealand context. Changes to ACE-R which are specific to the Kiwi ACE-R are modifications to questions such as recalling the Aotearoa New Zealand Prime Minister rather than the American president (Callow et al., 2015). It has been found that these modifications have not altered the measure’s psychometric properties (Callow et al., 2015). The Kiwi ACE-R was utilised by the NZHWR team as part of the 2010 study to assess participants' cognitive functioning.

3.5.2 Income Adequacy and the Economic Living Standard Index Short Form (ELSI$_{SF}$)

The Economic Living Standard Index (ELSI$_{SF}$) was originally developed in 2000 by New Zealand’s Ministry of Social Development (Jensen et al., 2005). While many measures of income explore the relationship between income and social outcomes, the ELSI$_{SF}$ disentangles numerical income from living standards relevant to demographics (Jensen et al., 2005). The ELSI$_{SF}$ can be utilised to evaluate a population or subgroup's living standards in relation to social and health outcomes (Jensen et al., 2005). To accurately and meaningfully interpret findings of the ELSI$_{SF}$ the user manual provides normative information for Aotearoa New Zealand population and demographic characteristics. This allows for deeper exploration into the role income may have in social outcomes.

The ELSI$_{SF}$ is comprised of four components which evaluate living standards (Jensen et al., 2005). The four components are ownership restrictions, social participation restrictions, economising, and self-rating scales. Self-rating scales explore individuals' perceptions and assessment of their living standards. These self-rating scales look into their overall standard of living, income adequacy, and satisfaction of their standard of living (Jensen et al., 2005).

This thesis utilizes one self-rating item of the ELSI$_{SF}$ to measure a person's own perception of their material standard of living. The income adequacy self-rating item asks participants how well their own and, if applicable, their partner's combined income, meet their everyday needs. I chose the item for income adequacy to focus on as previous literature is convergent upon the role of socioeconomic status on cognitive functioning. However, socioeconomic status fails to capture an individual's perceptions of their own financial well-being and circumstances. The self-rating item for income adequacy provides unique insight into an individual's everyday needs and financial security that socioeconomic status does not capture. While many individuals may hold the same or similar levels of income the numerical data on income does not capture the variability of needs met among individuals. This information provides unique insights of New Zealanders income adequacy stressors in relation to their basic needs being met. Income adequacy is important as literature has found persistent financial adversity to be linked with adverse cognitive functioning outcomes. As previously identified, financial stability has been linked to improved access to resources to which support cognitive health in later life. As income opportunities may become limited in older age it is essential to consider the level of adequate income adults hold later in life. This is especially important as older adults hold greater vulnerability to cognitive impairment and decline.

The self-rating income adequacy item prompts participants to reflect on their ability to meet fundamental needs of accommodation, food, clothing and other necessities. The income adequacy item requires people to identify and categorise their level of income adequacy into more than enough, enough, just enough, or not enough to meet their daily needs (Jensen et al., 2005). Administration of the income adequacy item may be completed over the telephone or during a face-to-face interview with pen and paper test. The user manual for a direct measure of living standards provides the interviewer with instructions to administer the self-rating item. All sections of the ELSI$_{SF}$ are coded to ensure accurate calculation of each item. Self-rating scales are coded slightly differently to the other components. The income adequacy item is coded as three for more than enough, two for enough, one for just enough, and zero for not enough. The coding of the income adequacy item informs the statistical analysis of this thesis' study population's income adequacy levels.

3.5.3 Covariates

The present study considers relevant covariates, which were included based on findings from previous literature indicating a robust relationship with cognitive functioning, to account for potential confounding that these factors may assert on the association between income adequacy and cognitive functioning. The following covariates from the NZHWR 2010 wave survey were included in the analysis, age, gender, ethnicity, education level, employment, marital status, area of residence, and area-based socioeconomic deprivation level. Data for the covariates other than area-based socioeconomic deprivation score were self-reported. Area-based socioeconomic deprivation score was analyzed using the NZDep2006. The following paragraph outlines how these covariates were analysed for the purpose of this thesis.

Age was treated as a continuous variable; measured in years. Gender was included as a categorical covariate for males and females. Education level was included as a categorical measure as no qualification, secondary school qualification, post-secondary certificate or diploma, and university degree. Ethnicity was included as a categorical covariate for Māori and non-Māori. The non-Māori category is primarily comprised of NZ European participants with few Pasifika and Asian participants included. Similarly, relationship status was included as a categorical covariate for partner or no partner. Employment status was also included, as a categorical variable for employed and non-employed. Area of residence was included and split into rural vs. urban living areas which was included as a categorical variable. Area-based socioeconomic deprivation was included and measured by the NZDep2006. The NZDep2006 combines nine variables from the census to reflect different dimensions of area-based socioeconomic deprivation (Salmond et al., 2007). The NZDep2006 provides a area-based socioeconomic deprivation score for each mesh block within Aotearoa New Zealand. Within the raw data set, area-based socioeconomic deprivation scores were originally measured as a continuous variable but were subsequently categorized into three groups. This transformation was made for several reasons. First, categorizing the variable allows for clearer comparisons between distinct groups (e.g., low, medium, and high levels), which aids in interpreting the results. Additionally, the relationship between area-based socioeconomic deprivation score and cognitive functioning appeared non-linear, making categorization more appropriate for detecting the impact of area-based socioeconomic deprivation scores upon cognitive functioning. Finally, this approach aligns with previous research and ensures robust and interpretable results. This scale acknowledges high area-based socioeconomic deprivation as a score of <11, medium area-based socioeconomic deprivation between 11 and 16, and low area-based socioeconomic deprivation as 16>.

3.5.4 Data Management and Security

All information provided to NZHWR undergoes several steps to ensure anonymisation of the data. Participants names are replaced with unique ID numbers which can no longer be linked to a specific individual. Additional steps include data encryption, secure merging and storage of additional data from national health records or ACC records, and restricted access to data held by NZHWR. These processes ensure participants confidentiality is maintained.

4. Statistical Analysis

To ensure the data set was a high-quality complete cases data set, I completed data cleaning. The raw data set was checked for missing values, outliers, and data inconsistencies. Initially, I inspected the data set to identify missing values through manual inspection of null counts per column and cross-checked the manual inspection with automated detection using the statistical software package R. There were a combined 48 missing values for age, gender, ACE-R scores, employment, area of residence (rural vs urban), and income adequacy. These 48 missing values were removed to ensure there was a complete cases data set available for analysis.

I then assessed the data set for any outliers that could skew the results. To detect any outliers, I used summary statistics and bar plots to assess the distribution of cognitive functioning scores, income adequacy levels, education levels, and area-based socioeconomic deprivation levels. Based on my analysis I identified and removed the outliers. Overall, 31 participants were removed due to missing values (30 participants) and outliers (1 participant) from the data.

4.1 R software

R version 4.3.2 was used for data analysis. Descriptive and inferential statistics were completed to allow for meaningful interpretation of the data set.

Specific descriptive tests run calculated the mean and standard deviation. While inferential tests run involved a linear regression, an adjusted linear regression, Chi-Square Test of Independence (Chi-Square test), *t*-tests, and analysis of variance on the adjusted regression (ANOVA). Furthermore, I employed data visualisation methods in the form of bar graphs to identify outliers, counts, proportions, and distribution of the data.

4.2 Descriptive Analysis

4.2.1 Mean

The mean was used to identify the average values and central tendency of all variables used in this statistical analysis. It also supported the identification of extreme values that existed within the data.

4.2.2 Standard Deviation

Standard deviation was used to measure the spread of data around the mean for each variable used in this statistical analysis.

4.2.3 Overall

Using a combination of mean and standard deviation provides valuable insights into the population's central tendency and variability to draw accurate analysis and interpretation from. For the purpose of descriptive statistics age was adapted to be categorical. This allows informed conclusions and recommendations to be drawn based on accurate statistical analysis.

4.3 Inferential Analysis

4.3.1 Linear regression

Linear regression was run through R software to assess the relationship between income adequacy and cognitive functioning. This linear regression included sociodemographic characteristics of age, gender, ethnicity and education. For the purpose of inferential analysis age was used as a continuous variable. The linear regression was run to test hypotheses. While these demographic characteristics were utilised to control for confounding factors, improve model accuracy, and explore population differences. These findings were then interpreted to accept or reject the null hypotheses. This was then used to inform the interpretation of the role adequate income has for cognitive functioning in Aotearoa New Zealand and subsequent recommendations.

4.3.2 Adjusted linear regression

An additional linear regression was run adjusted for sociodemographic characteristics and living conditions to further assess the role adequate income has for cognitive functioning in Aotearoa New Zealand. The adjusted linear regression was run to further test hypotheses in relation to sociodemographic characteristics and living conditions. This model was specifically adjusted for marital status, employment, area of residence, and area-based socioeconomic deprivation level. The adjusted model was again used to control for confounding factors, improve model accuracy, and explore population differences. These findings were then interpreted to accept or reject the null hypotheses. This also informed the interpretation and recommendations for income adequacy in relation to New Zealanders brain health.

4.3.3 Chi-Square Test of independence

Chi-Square tests were used to assess the relationship between income adequacy with categorical sociodemographic characteristics and living conditions. Results of chi-square tests informed group differences and hypothesis testing.

4.3.4 Student's *t*-test

Student's *t*-test (*t*-test) was used to compare the means of categorical sociodemographic characteristics and living conditions against the ACE-R where sociodemographic characteristics and living conditions only had two categories. *T*-tests were employed for gender, ethnicity, employment, marital status, and area of residence. *T*-tests informed group differences and further hypothesis testing.

4.3.5 Analysis of Variance

An analysis of variance (ANOVA) test was run on the adjusted linear regression model using the Anova function ‘anova()’ in R to analyse whether cognitive functioning abilities varied across income adequacy levels, sociodemographic characteristics, and living conditions. The ANOVA provided further insight into whether significant difference between groups were present. Allowing for meaningful analysis and interpretation of relationships between variables.

4.4 Data Visualisation Analysis

4.4.1 Bar graphs

Bar graphs were used to provide visualisation of data across categories, data distribution, counts, and proportions of variables. To further analyse the relationship between income adequacy and demographic characteristics count and proportion graphs were created. Count graphs provided further data insights into how many participants identified with certain sociodemographic characteristics as well as living conditions against self-rated income adequacy levels. Furthermore, proportion graphs we created to better understand the proportion of sociodemographic characteristics as well as living conditions against self-rated income adequacy levels.

This was done to gain further insight into the statistical characteristics of the population. That information gathered from proportions helps to identify trends in the population to derive meaningful data to support public health campaigns and social policy.

5. Results

5.1 Sample Characteristics

The 2010 study had total of 1,001 participants. Of those, 96.9% (970) participants were included in the analysis for this report. 31 participants were removed due to missing values (30 participants) and outliers (1 participant) from the data. The final sample identified 27% (*n* = 262) of study population to be under 60 years of age, with a minimum age of 49 years. Participants aged 60 or below made up the largest age group. 26% (*n* = 249) were between ages of 60 and 65, 21% (*n* = 199) were between 65 and 70, 15% (*n* = 168) were between 70 and 75; and 9% (92) were over 75 years of age, with maximum age of 84 years. The study population had slight overrepresentation of females. Females making up 54% (*n* = 524) of the population, compared to 51% national average population; and male made up 46% (*n* = 446), compared to 49% of the national average population. The study had large overrepresentation of people identifying as Maori, with 26% of the study population identified as Māori. This was 1.75 times higher than the national average Māori population in 2010 which was at 15.7% of population. Most participants in the study had at least some qualification. The largest was of 378 (39%) participants with post-secondary certificate or diploma. 216 (22%) had Secondary or school qualifications, 212 (22%) had university degree or higher. Those with no qualification made up the smallest group with just 164 (17%) participants. More than half (*n* = 539, 56%) of participants stated they were in employment, while the rest were non-employed. The non-employed group includes those who receive a retirement benefit, unemployment benefit, or other benefit. Majority of participants (*n* = 799, 82%) reported living in urban areas and were living in low area-based socioeconomic deprivation areas (*n* = 827, 85%). Further details are presented in Table 1.

Table 1

Sociodemographic characteristics of the study sample (n = 970).

Characteristics	Full sample	
	n	%
Age		
Less than 60	262	27%
60 to 65	249	26%
65 to 70	199	21%
70 to 75	168	17%
75 or more	92	9%
Gender		
Male	446	46%
Female	524	54%
Residence		
Urban	799	82%
Rural	171	18%
Education		
No qualifications	164	17%
Secondary school qualification	216	22%
Post secondary certificate or diploma	378	39%
University degree	212	22%
Ethnicity		
Māori	254	26%
Non-Māori	716	74%
Marital Status		
Partner	689	71%
Single	281	29%
Employment		
Employed	539	56%
Non-employed	431	44%
Area-based Deprivation		
Low	827	85%
Medium	106	11%
High	37	4%

5.2 Cognitive functioning scores with group characteristics

Ace-R mean scores, along with standard deviations (*SD*) were analysed across income adequacy, sociodemographic characteristics, and living conditions. This was completed to identify patterns with cognitive functioning for the population. ACE-R scores varied slightly across different levels of income adequacy. Participants who reported having "not enough" income had a mean score of 91.82 (*SD* = 6.91), while those who considered their income "just enough" scored marginally higher at 92.26 (*SD* = 5.68). The highest mean score was observed among those with "more than enough" income, with a mean ACE-R score of 94.86 (*SD* = 3.91), indicating a positive association between higher income adequacy and higher cognitive functioning scores. Notably, participants with "enough" income scored 92.63 (*SD* = 5.60), showing relatively stable scores across different income levels, though higher income adequacy may be associated with higher cognitive functioning scores. Contrastingly, a gradual decrease in mean ACE-R scores was observed in age groups as age increased. Those under 60 years old, held the highest had the highest mean ACE-R score of 94.76 (*SD* = 4.41). While participants aged 60-65 had a mean ACE-R score of 94.01 (*SD* = 4.51) followed by those aged 65-70 who had a mean score of 92.61 (*SD* = 5.68), and those aged 70-75 who had a mean score of 91.40 (SD = 6.01). As expected, those aged 75 and older yielded the lowest mean ACE-R score of 89.89 (SD = 6.63). Mean ACE-R score differences were observed for gender. Females had slightly higher mean ACE-R score of (93.72, *SD* = 5.10) compared to males (92.33, *SD* = 5.78). ACE-R mean score varied slightly across ethnicities. A slightly lower mean score was observed for Māori participants who had a score of 92.06 (*SD* = 6.23). Non-Māori participants mean score was 93.45 (*SD* =

5.12). The lower mean score for Māori participants possibly reflecting challenges for cognitive functioning experienced by Māori participants. Educational attainment was observed to have a positive association with cognitive functioning scores for the ACE-R. Those with no qualifications were observed to have the lowest mean score of 88.48 (*SD* = 7.22), while those with a high school qualification scored 93.33 (*SD* = 4.59). Not a lot of difference was observed between those with a high school qualification and those with a post-secondary qualification. Those with a post-secondary qualification had a mean score of 93.73 (*SD* = 4.48). However, the biggest difference was observed for university graduates who held the highest mean cognitive functioning score of 95.23 (*SD* = 4.20). This indicates cognitive functioning scores are relatively stable scores across different education levels, though higher educational attainment may be associated with higher cognitive functioning scores. Employment status revealed those who were employed to have a higher cognitive functioning mean score of 94.19 (*SD* = 4.71), compared to those who were classified as non-employed. Their non-employed counterparts scored lower, with a mean of 91.69 (*SD* = 6.01). Mean cognitive functioning scores for marital status did not show significant variability for those with a partner and those without a partner. Participants with a partner scored a mean of 93.43 (*SD* = 5.22), while those without a partner scored a mean of 92.23 (*SD* = 5.95). There was little difference observed in cognitive functioning mean scores for area of residence. Rural residents had a mean score of 93.15 (SD = 6.00), while urban residents scored 93.07 (*SD* = 5.35). There was an observed difference between area-based socioeconomic deprivation levels and cognitive functioning mean scores for participants. Participants experiencing low area-based socioeconomic deprivation had the highest mean score of 93.46 (*SD* = 4.88), while interestingly those experiencing medium area-based socioeconomic deprivation scored 90.74 (*SD* = 8.30). While participants experiencing high area-based socioeconomic deprivation had the lowest mean score of 91.27 (*SD* = 5.90).

Table 2

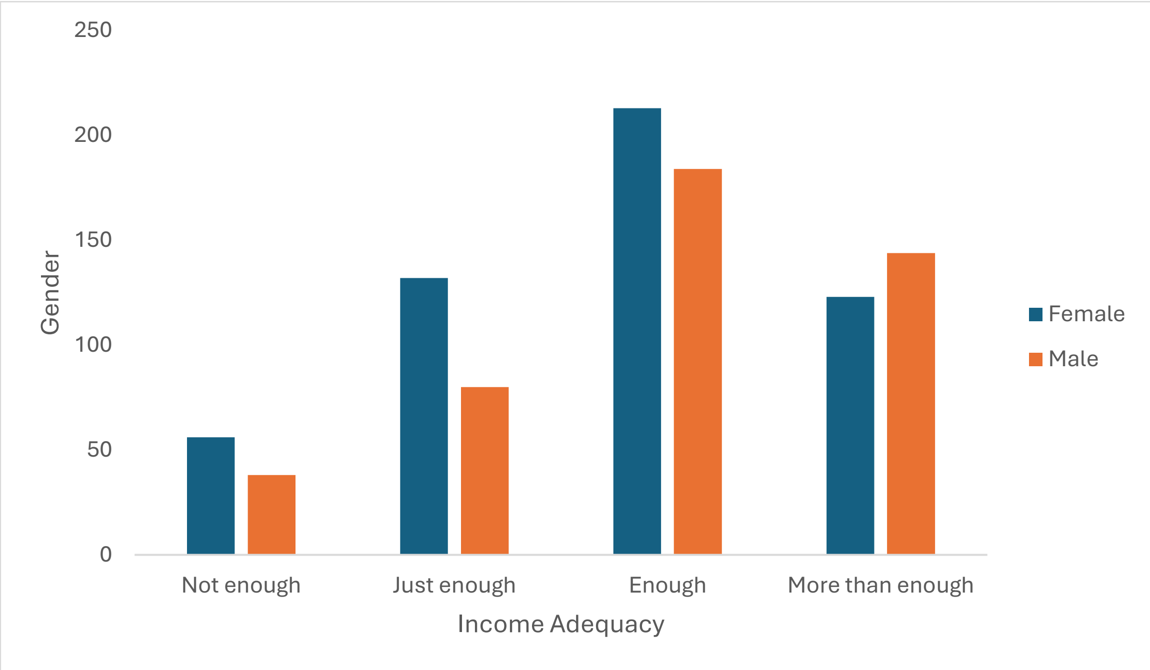
Mean ACE-R score and standard deviation of study sample

Characteristics	ACE-R score	
	Mean	SD
Income Adequacy		
Not enough	91.82	6.91
Just enough	92.26	5.68
Enough	92.63	5.60
More than enough	94.86	3.91
Age		
<60	94.76	4.41
60-65	94.01	4.51
65-70	92.61	5.68
70-75	91.40	6.01
75+	89.89	6.63
Sex		
Female	93.72	5.10
Male	92.33	5.78
Ethnicity		
Māori	92.06	6.23
Non-Māori	93.45	5.12
Education		
No Qualification	88.48	7.22
High School	93.33	4.59
Post Secondary	93.73	4.48
University	95.23	4.20
Employment		
Employed	94.19	4.71
Non-Employed	91.69	6.01
Marital Status		
Partner	93.43	5.22
Single	92.23	5.95
Urban Rural		
Rural	93.15	6.00
Urban	93.07	5.35
Area-based deprivation		
Low	93.46	4.88
Medium	90.74	8.30
High	91.27	5.90

5.3 Group differences according to level of income adequacy

Figure 1

Gender and Income Adequacy

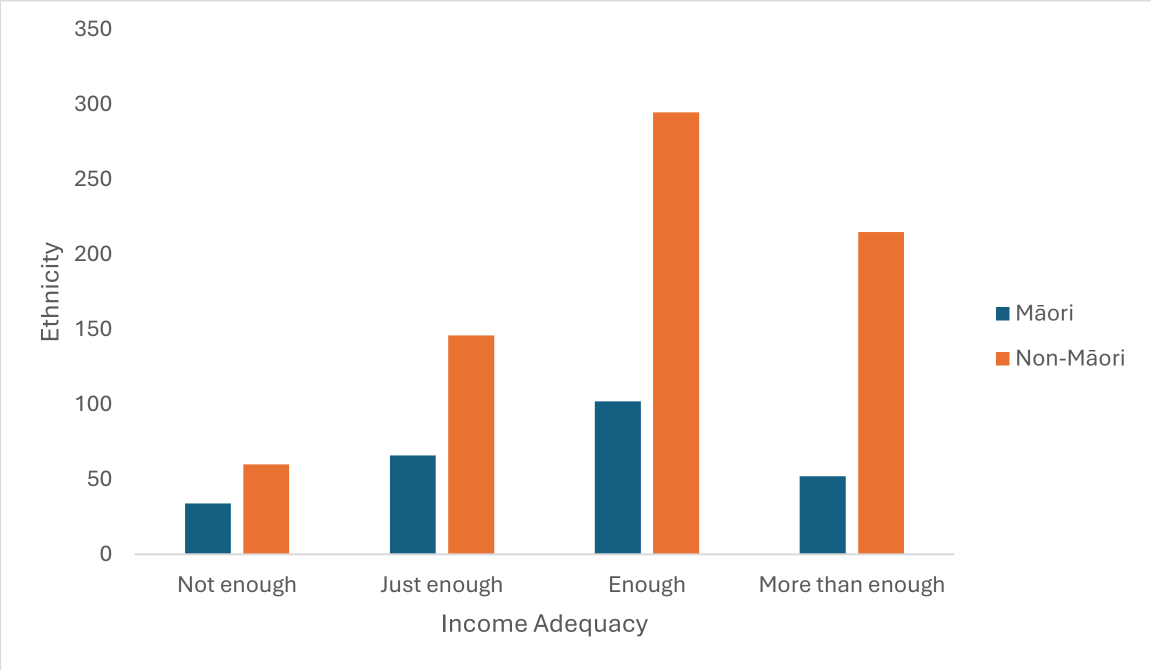


Note: The counts in Figure 7 reflect the relative distribution of gender across income adequacy levels.

Figure 1 indicates there is a higher number of females who report they do not have enough, or they have just enough income adequacy. Comparatively, more males indicate they have enough or more than enough income adequacy. This could indicate a disparity in income adequacy between genders.

Figure 2

Ethnicity and Income Adequacy

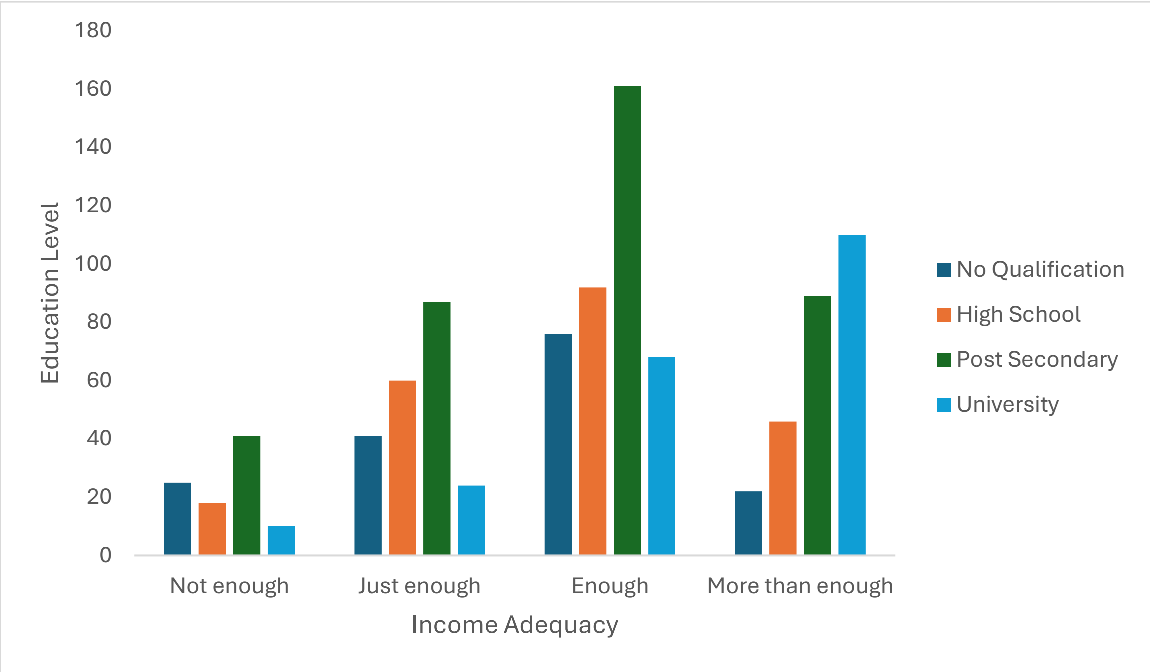


Note: The counts in Figure 7 reflect the relative distribution of ethnicity across income adequacy levels.

Figure 2 indicates there is a higher number of Māori who report having below-enough income adequacy. Comparatively, non- Māori report having higher levels of income adequacy reporting they more commonly have just enough or more income adequacy. This indicates there may be a discrepancy between Māori and non- Māori income adequacy levels.

Figure 3

Education and Income Adequacy

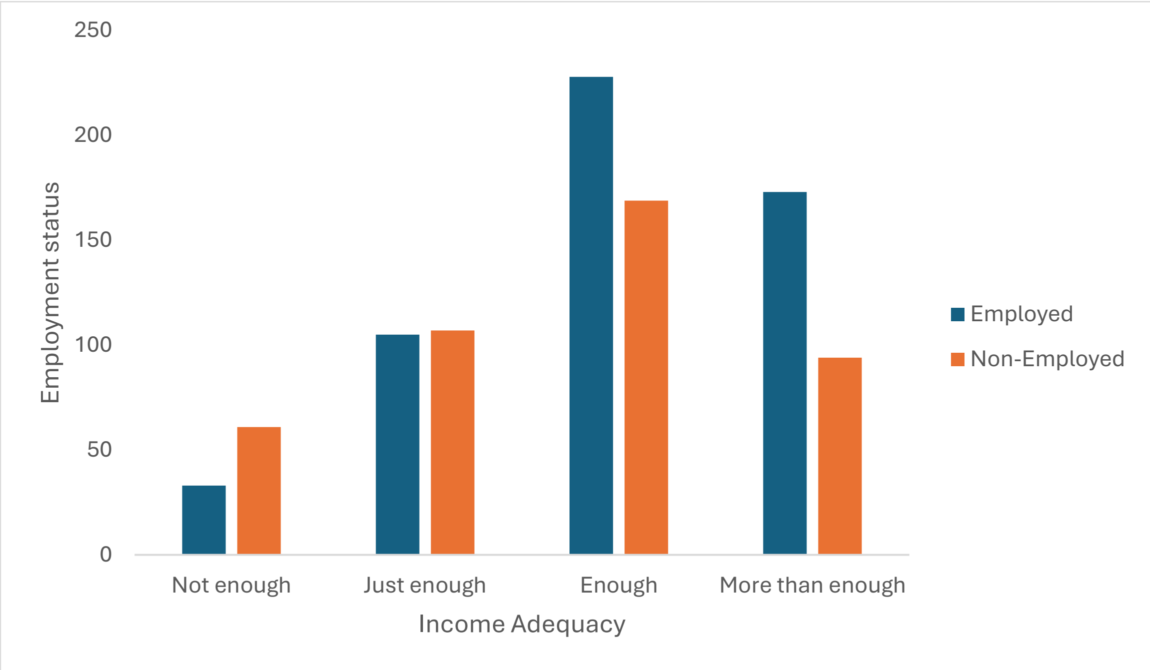


Note: The counts in Figure 7 reflect the relative distribution of educational levels across income adequacy levels.

Figure 3 indicates varied levels of income adequacy across educational levels. Those who hold a university degree report the highest level of income adequacy. Most commonly university graduates report enough or more than enough income adequacy. Interestingly, those who held a post-secondary qualification or a high school qualification appear to have normal distributions with most respondents in both categories reporting just enough or enough income adequacy. Contrastingly those with no qualifications reported lower levels of income adequacy. Suggesting there may be an association between education levels and income adequacy.

Figure 4

Employment Status and Income Adequacy

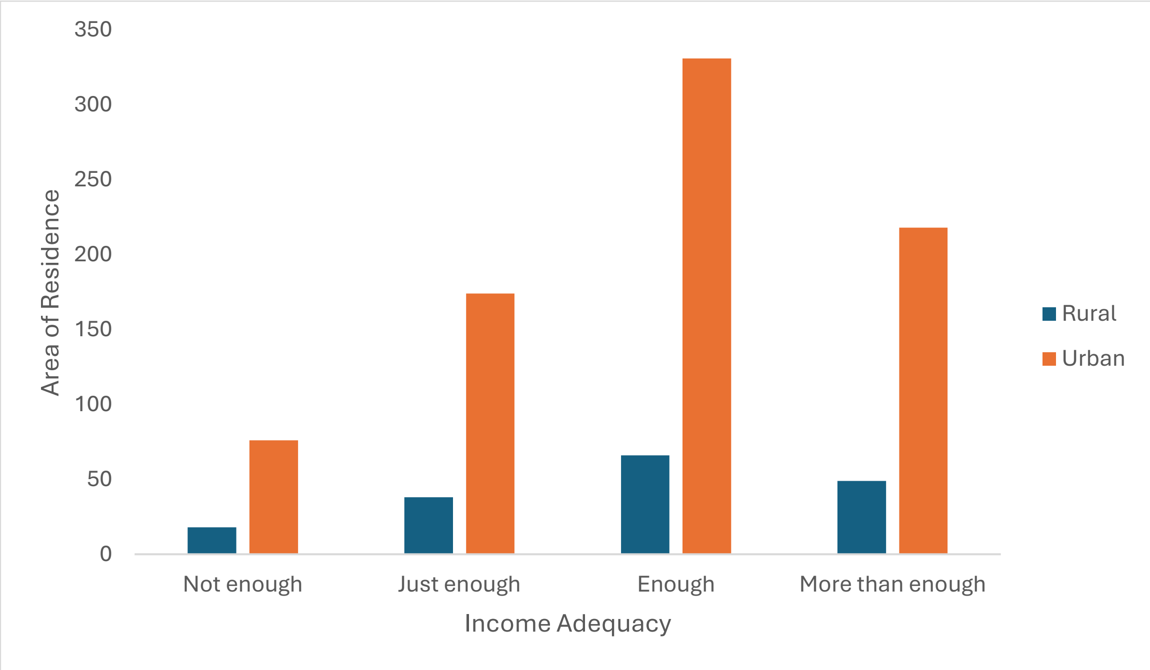


Note: The counts in Figure 4 reflect the relative distribution of employment status across income adequacy levels.

Figure 4 indicates those who are employed report having higher income adequacy levels than those who are non-employed. Those who are employed indicate they have enough or more than enough income adequacy. Compared to those who are non-employed and who have more commonly reported having below enough income adequacy.

Figure 5

Area of residence and Income Adequacy

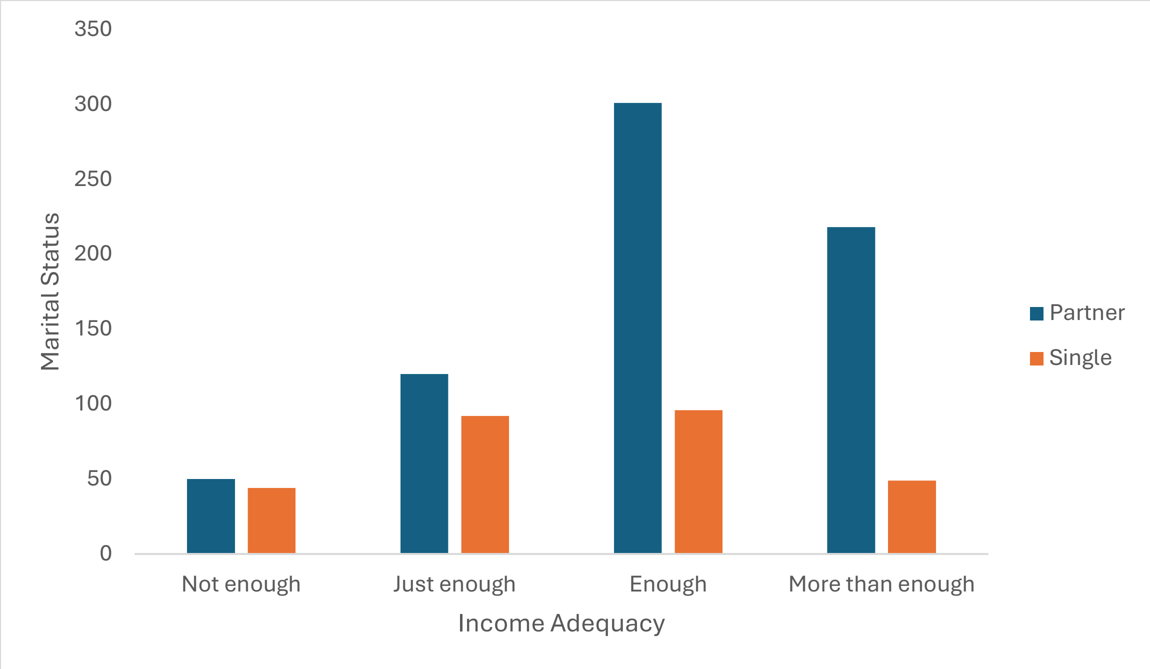


Note: The counts in Figure 5 reflect the relative distribution of residence across income adequacy levels.

Figure 5 indicates those living in urban and rural areas report similar income adequacy. Interestingly, those living in urban areas reported slightly lower levels of income adequacy than those living in rural areas. While those living in rural areas reported slightly higher levels of income adequacy. These results could indicate other mitigating factors that may be associated with area of residence and income adequacy.

Figure 6

Marital Status and Income Adequacy

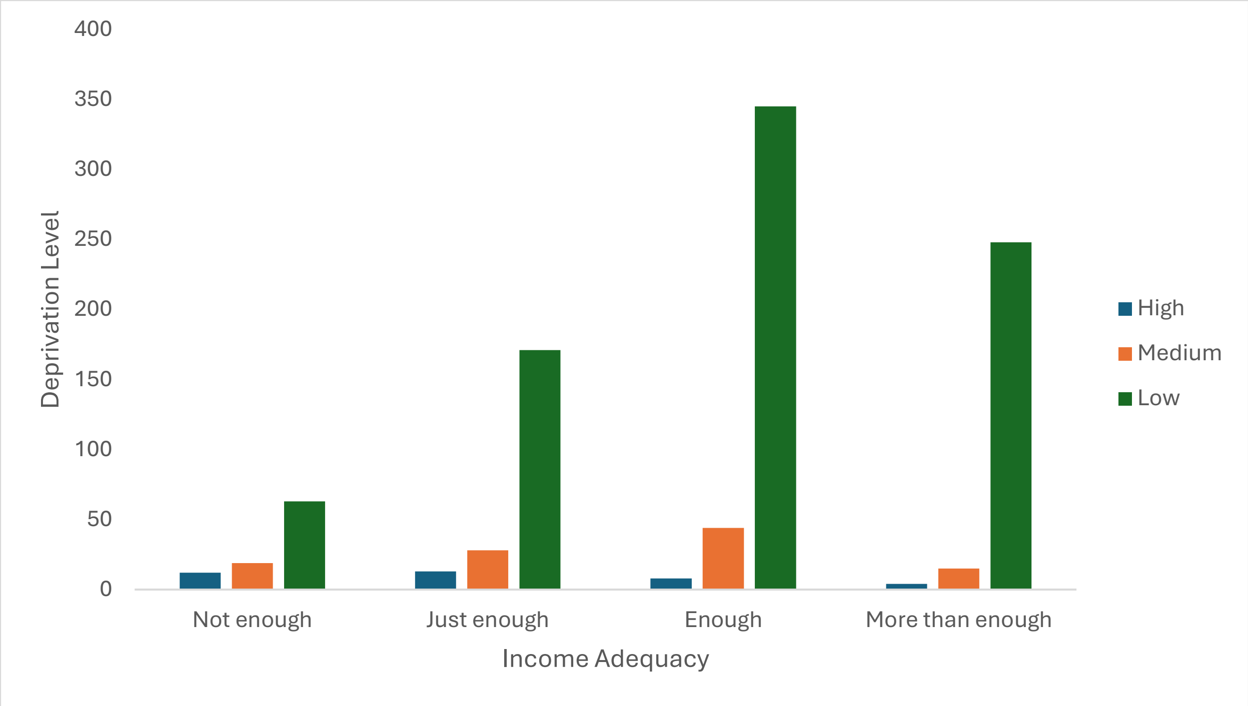


Note: The counts in Figure 6 reflect the relative distribution of marital status across income adequacy levels.

Figure 6 indicates those who have a partner report higher levels of income adequacy than those who are single. Comparatively, those who are single report significantly lower levels of income adequacy than those with partners. This suggests marital status may be associated with income adequacy level.

Figure 7

Area-based socioeconomic deprivation Level and Income Adequacy

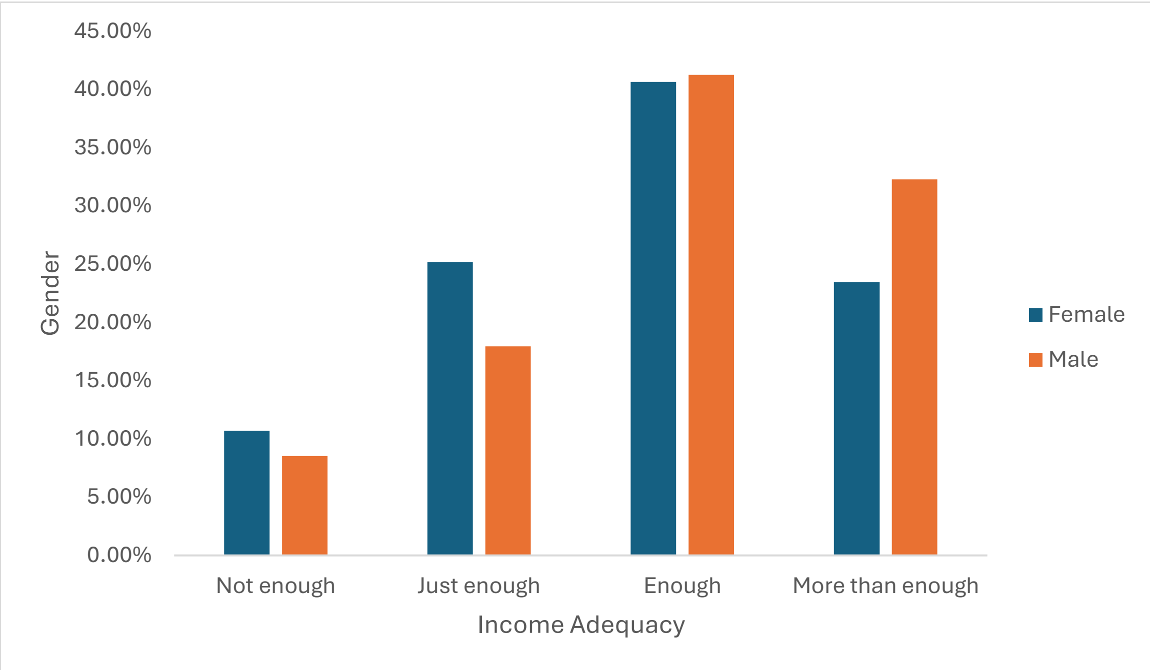


Note: The counts in Figure 7 reflect the relative distribution of area-based socioeconomic deprivation levels across income adequacy levels.

Figure 7 indicates those with lower area-based socioeconomic deprivation levels have higher income adequacy. Those with low area-based socioeconomic deprivation report having just enough to more than enough income adequacy. Comparatively, medium and higher levels of area-based socioeconomic deprivation report lower levels of income adequacy. Medium area-based socioeconomic deprivation appears to be more evenly distributed across income adequacy levels, with most respondents reporting just enough or enough income adequacy. Whereas high area-based socioeconomic deprivation respondents report having lower levels of income adequacy. With most respondents reporting having not enough or just enough income adequacy. This suggests there are income adequacy disparities experienced across area-based socioeconomic deprivation levels.

Figure 8

Gender and Income Adequacy

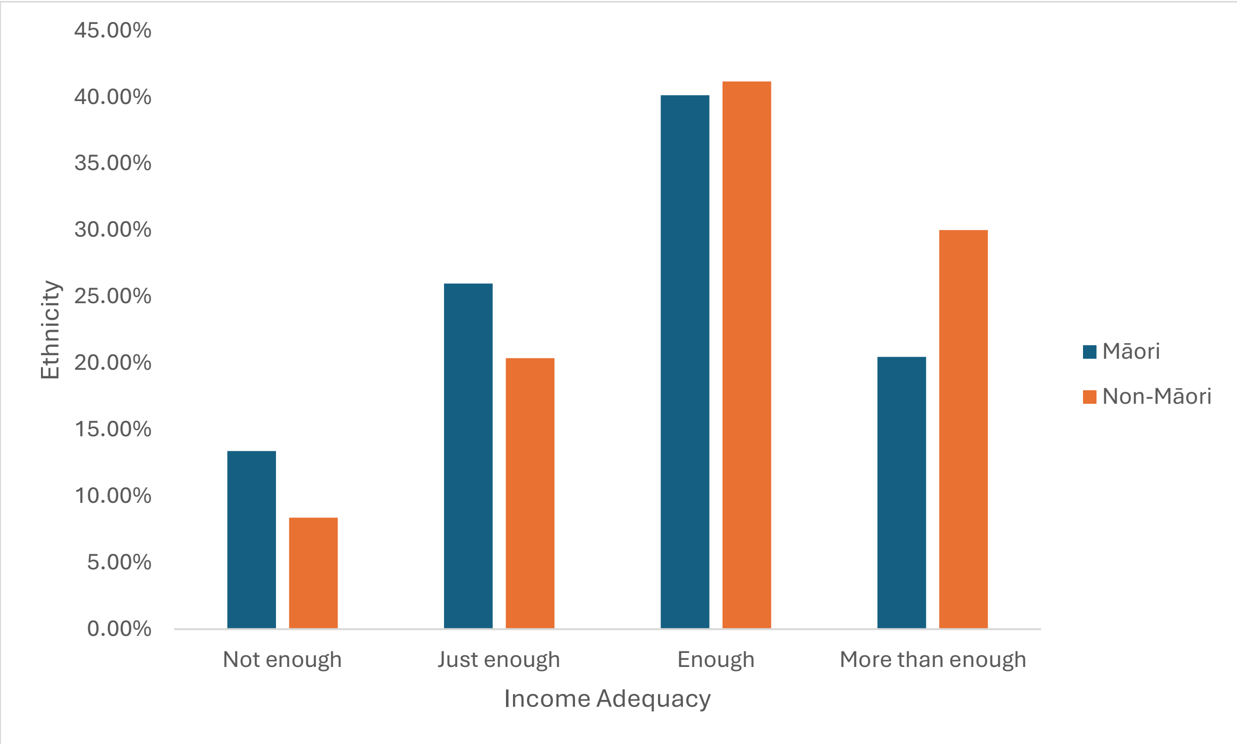


Note: The proportions in Figure 8 reflect the relative distribution of gender across income adequacy levels.

Figure 8 reveals females have higher percentages in not enough and just enough categories compared to males. This suggests that females have a higher proportion of dissatisfaction or do not feel they have enough income adequacy compared to their male counterparts. Males, however, proportionally have a higher percentage in more than enough. This indicates males have a higher proportion of satisfaction about their daily needs being met. Although, both females and males proportionally are similar in having enough income adequacy, with females reporting slightly higher.

Figure 9

Ethnicity and Income Adequacy

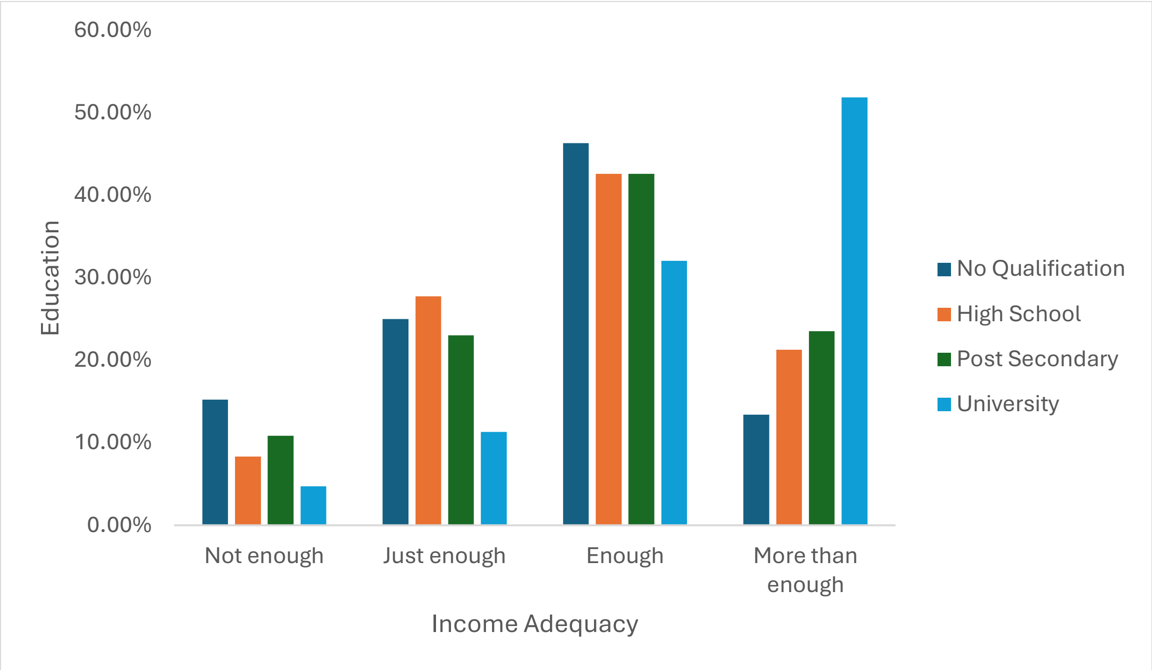


Note: The proportions in Figure 14 reflect the relative distribution of ethnicity across income adequacy levels.

Figure 9 reveals Māori report lower levels of income adequacy in proportion to their non-Māori counterparts. Figure 9 indicates Māori hold a higher level of dissatisfaction with their income adequacy compared to non-Māori who report higher levels of income adequacy. This indicates a disparity in income adequacy amongst Māori and non-Māori.

Figure 10

Education and Income Adequacy

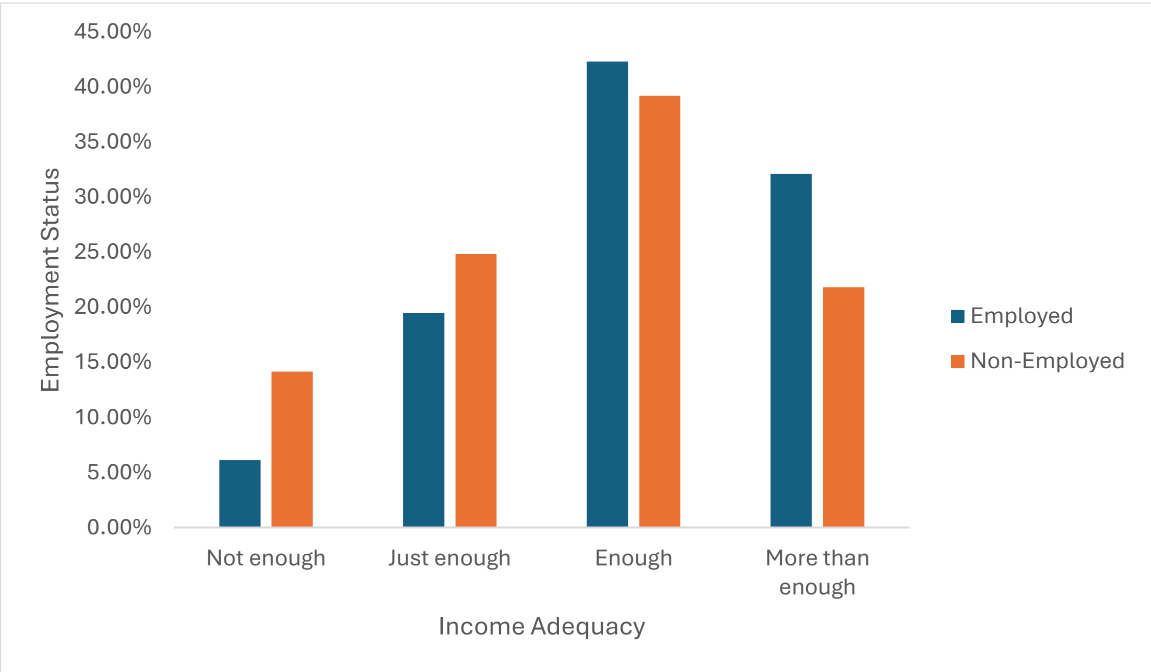


Note: The proportions in Figure 10 reflect the relative distribution of educational attainment across income adequacy levels.

Figure 10 shows varying levels of income adequacy across education levels. With those holding a university qualification reporting the highest levels of income adequacy. 32% of those holding a university qualification report enough income adequacy and 52% indicate more than enough income adequacy. Indicating those holding a university qualification may hold a higher level of income adequacy compared to other education levels. Those holding a post-secondary school qualification reported similar income adequacy levels with over 50% of respondents reporting they have enough or more than enough income adequacy. While those holding a high school qualification or no qualification reported similar proportions of income adequacy with both categories having higher proportions of respondents indicating not enough or just enough income adequacy.

Figure 11

Employment Status and Income Adequacy

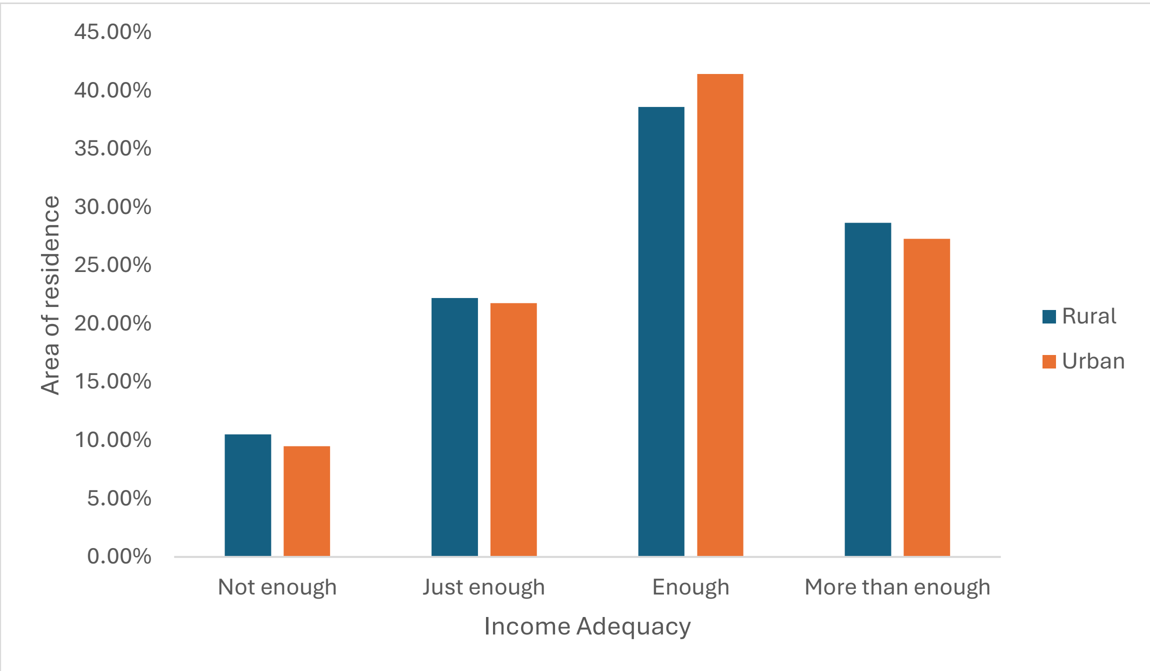


Note: The proportions in Figure 11 reflect the relative distribution of employment status across income adequacy levels.

Figure 11 shows similar distributions of income adequacy for those who are employed and non-employed. Employed respondents indicate higher income adequacy than their non-employed counterparts. Most employed respondents report they have enough or more than enough income adequacy. However, those who are non-employed report a higher proportion of not enough income adequacy.

Figure 12

Area of residence and Income Adequacy

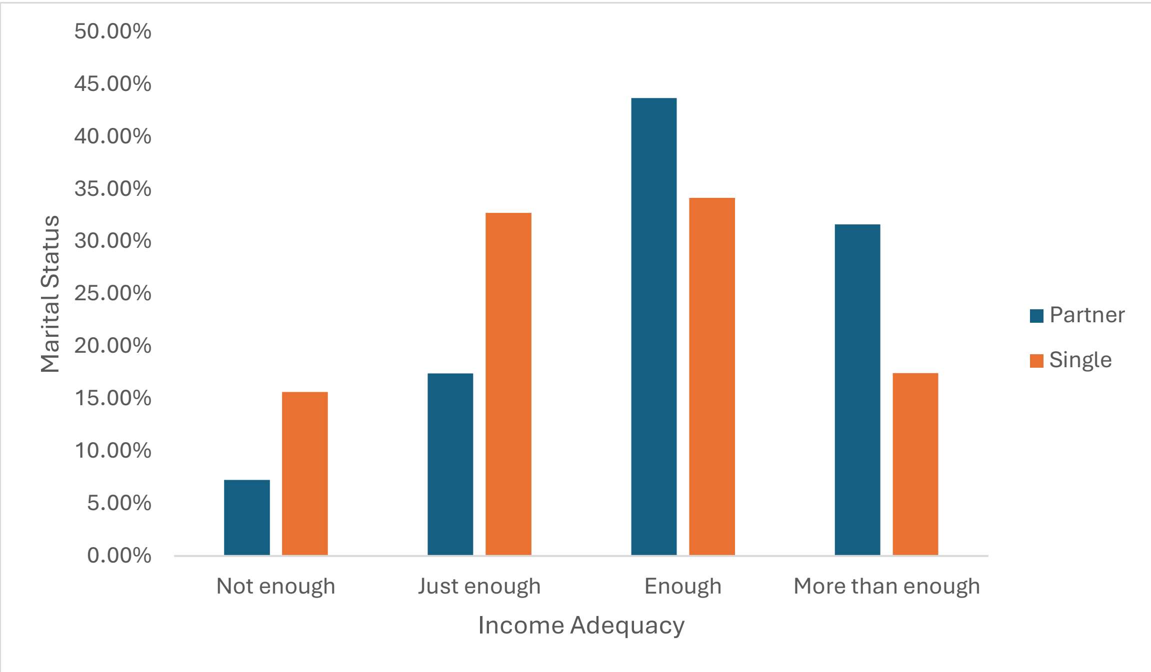


Note: The proportions in Figure 12 reflect the relative distribution of area of residence across income adequacy levels.

Figure 12 indicates respondents living in urban and rural areas report having similar levels of income adequacy. However, figure 12 indicates those in rural areas report having slightly less income adequacy. Compared with respondents living in urban areas primarily reporting they have enough or more than enough income adequacy. Suggesting those living in urban areas may hold slightly better income adequacy.

Figure 13

Marital Status and Income Adequacy

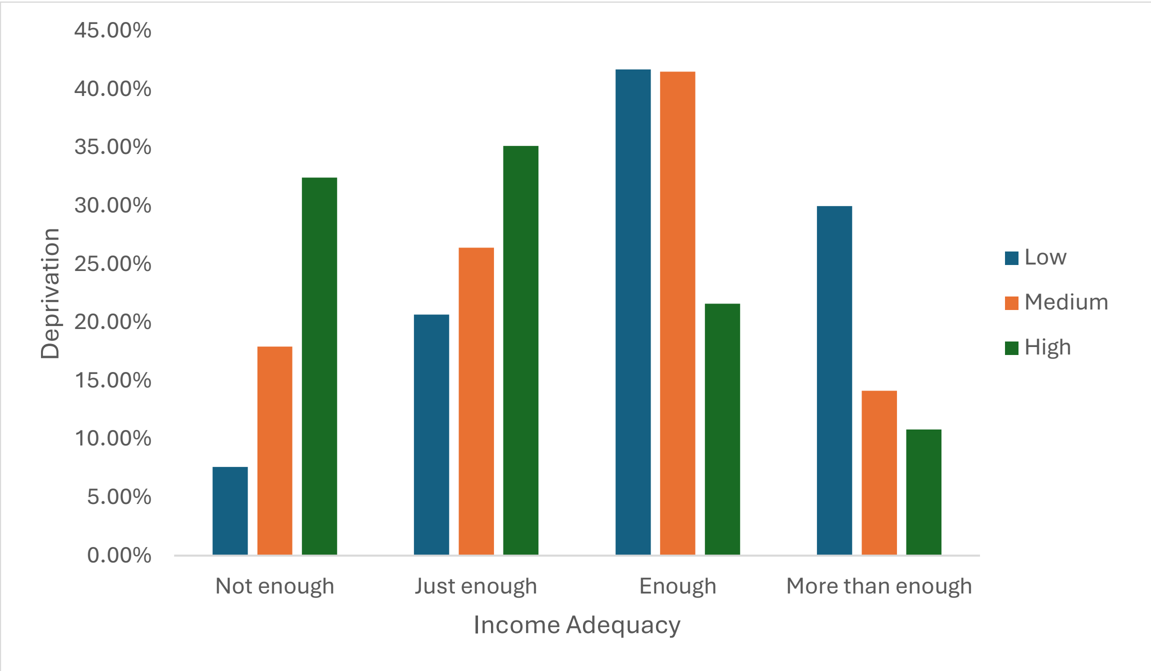


Note: The proportions in Figure 13 reflect the relative distribution of marital status across income adequacy levels.

Figure 13 reveals respondents with a partner report higher levels of income adequacy. A larger proportion of those with a partner report that they have enough or more than enough income adequacy. Those who are single report lower levels of income adequacy proportionately. With more respondents who are single reporting having just enough income adequacy.

Figure 14

Area-based socioeconomic deprivation level and Income Adequacy



Note: The proportions in Figure 14 reflect the relative distribution of area-based socioeconomic deprivation levels across income adequacy levels.

Figure 14 reveals those with low area-based socioeconomic deprivation reported higher levels of income adequacy. Larger proportions of respondents living in low area-based socioeconomic deprivation reported having enough or more than enough income adequacy. However, respondents in medium and high area-based socioeconomic deprivation reported lower levels of income adequacy. With a higher level of respondents in medium and high area-based socioeconomic deprivation reporting they have enough, just enough or not enough income adequacy.

5.4 Chi-square tests

Chi-square tests were run to determine if there is a significant association between the distribution of income adequacy levels with categorical variables. These categorical variables were the sociodemographic characteristics and living conditions of participants.

A chi-square test of independence was performed to examine the relationship between gender and income adequacy distributions. The relationship between gender and income adequacy distributions was significant and indicated there was a positive association, $X^2(3, 970) = 13.79$, $p = .003$. Higher levels of income adequacy were more frequently reported by men compared to women. A chi-square test of independence between education and income adequacy distributions revealed the relationship between education and income adequacy distributions to be significant with a positive association, $X^2(9, 970) = 95.20$, $p = <0.001$. This revealed those who held a university degree more frequently reported higher income adequacy compared to those without a qualification. A chi-square test of independence was also performed to examine the relationship between ethnicity and income adequacy distributions. This revealed there was a positive association between ethnicity and income adequacy distributions, $X^2(3, 970) = 13.80$, $p = 0.003$. These findings indicate higher levels of income adequacy were more frequently reported by non-Māori compared to Māori. A chi-square test of independence between marital status and income adequacy distributions revealed a positive association between the variables distributions, $X^2(3, 970) = 0.55$, $p = <0.001$. This revealed higher levels of income adequacy were more frequently reported by those with a partner compared to those without a partner. The chi-square test of independence further examined the relationship between employment and income adequacy distributions. This found a positive association between employment and income adequacy distributions, $X^2(3, 970) = 51$, $p = <0.001$. These findings indicate those who were employed more frequently reported higher levels of income adequacy compared to non-employed individuals. Furthermore, the chi-square test was used to examine area-based socioeconomic deprivation level with income adequacy distributions. This revealed a positive association between area-based socioeconomic deprivation level with income adequacy distributions, $X^2(6, 970) = 51$, $p = <0.001$. This indicated those who had low area-based socioeconomic deprivation level more frequently reported higher income adequacy than those who had moderate or severe area-based socioeconomic deprivation. All other variables were not found to be statistically significant in relation to income adequacy. For further details refer to Table 3.

Further chi-square tests were run to determine if there is a significant association between other categorical variables. These categorical variables were the sociodemographic characteristics and living conditions of participants. The chi-square test examined the relationship between education and employment distributions. Findings indicated there was a positive association between education and employment distributions, $X^2(3, 970) = 43.92$, $p = <0.001$. These findings revealed those who held qualifications more frequently reported they were employed compared to those with no qualifications. Additionally, the chi-square test examined the relationship between area-based socioeconomic deprivation levels and marital status distributions. The chi-square test revealed there to be a positive association between area-based socioeconomic deprivation levels and marital status distributions, $X^2(2, 970) = 7.35$, $p = 0.02$. These findings revealed those who were of low area-based socioeconomic deprivation more frequently reported having a partner compared to those of from high area-based socioeconomic deprivation.

5.5 *T*-Tests

An independent *t*-test was performed to assess whether there was a significant difference of cognitive functioning between female and male participants. Table 3 shows the 524 female participants cognitive functioning scores ($M = 93.72$, $SD = 5.10$) compared to the 446 male participants cognitive functioning scores ($M = 92.33$, $SD = 5.78$) demonstrated higher cognitive functioning, $t(895.22) = -3.948$, $p = <0.001$.

An independent *t*-test was performed to assess whether there was a significant difference of cognitive functioning between non-Māori and Māori participants. Table 4 shows the 716 non-Māori participants cognitive functioning scores (M = 93.45, SD = 5.12) compared to the 256 Māori participants cognitive functioning scores (M = 92.06, SD = 6.23) demonstrated higher cognitive functioning, $t(381.02) = -3.197$, $p = 0.002$.

An independent *t*-test was performed to assess whether there was a significant difference of cognitive functioning between participants who have a partner and those who do not have a partner. Table 5 shows the 689 partnered participants cognitive functioning scores (M = 93.43, SD = 5.22) compared to the 281 single participants cognitive functioning scores (M = 92.23, SD = 5.95) demonstrated higher cognitive functioning, $t(464.55) = -2.932$, $p = 0.004$.

An independent *t*-test was performed to assess whether there was a significant difference of cognitive functioning between employed and non-employed participants. Table 6 shows the 539 employed participants cognitive functioning scores (M = 94.19, SD = 4.71) compared to the 431 non-employed single participants cognitive functioning scores (M = 91.69, SD = 6.01) demonstrated higher cognitive functioning, $t(801.77) = -7.072$, $p = <0.001$. All other variables were found to not be statistically significant. Please refer to tables 3 to 7 for further details.

Table 3

Gender and Cognitive function

Gender	Male		Female		*t*-value	*p*-value	Cohen's *d*
	M	*SD*	*M*	*SD*			
ACE-R	92.33	5.78	93.72	5.10	-3.948	<0.001	-0.26

Table 4

Ethnicity and Cognitive function

Ethnicity	Maori		Non-Maori		*t-value*	*p*	Cohen's d
	M	*SD*	*M*	*SD*			
ACE-R	92.06	6.23	93.45	5.12	-3.197	0.002	-0.11

Table 5

Marital Status and Cognitive function

Marital Status	Partnered		Single		*t-value*	*p*	Cohen's d
	M	*SD*	*M*	*SD*			
ACE-R	93.43	5.22	92.23	5.95	-2.932	0.004	-0.08

Table 6

Employment and Cognitive function

Employment	Employed		Non-Employed		*t-value*	*p*	Cohen's d
	M	*SD*	*M*	*SD*			
ACE-R	94.19	4.71	91.69	6.01	-7.072	<0.001	-0.34

Table 7

Area of Residence and Cognitive function

Area of Residence	Rural		Urban		*t-value*	*p*	Cohen's d
	M	*SD*	*M*	*SD*			
ACE-R	93.15	6.00	93.07	5.35	-0.156	0.876	-0.01

5.6 Association between income adequacy and cognitive functioning adjusted for key demographics

The observed scores from the linear regression indicate that enough income adequacy had a positive association with cognitive functioning scores (B = 1.1, *95%CI* = 0.3-2.2, p = 0.04). This was similar for more than enough income adequacy and cognitive functioning scores (B = 2.4, *95%CI* = 1.3-3.6, p = <0.001). Higher education also had a positive association with cognitive functioning scores, high school qualification (B = 4, *95%CI* = 3-5, p = <0.001), post-secondary school qualification (B = 4.4, *95%CI* = 3.5-5.3, p = <0.001), and university degree (B = 5.2, *95%CI* = 4.1-6.2, p = <0.001). The model indicates participants holding a secondary qualification or higher were likely to see a higher cognitive functioning score of 4 points and above compared to those who had not completed secondary schooling. Being female was identified as positively associated with cognitive functioning scores (B = 1.4, *95%CI* = 0.8-2, p = <0.001). Non-Māori was also associated with cognitive functioning scores (B = 0.6, *95%CI* = -0.01-1.4, p = 0.05).

The intercept estimated at 96.6 represents the predicted value of cognitive functioning when independent variables are one. As the *p*-value is below 0.05 this indicates the estimate is statistically significant. Comparatively, the model highlights higher age has a negative association with cognitive functioning within this sample. The *p*-value of age at <0.001 indicates age holding a negative association with cognitive functioning is statistically significant. For detailed insights refer to Table 8.

Table 8

Results of the Linear Regression Analysis: Associations of Income Adequacy and Cognitive Functioning, Accounting for sociodemographic Characteristics

	Estimate	*SE*	95% CI		*p*
			LL	*UL*	
Intercept	96.6	1.5	94	99.5	<0.001
Income Adequacy					
Not enough	Ref.				
Just enough	0.7	0.6	-0.4	1.9	0.2
Enough	1.1	0.5	0.03	2.2	0.04
More than enough	2.4	0.6	1.3	3.6	<0.001
Age, per one-year increase	-0.1	0.02	-0.2	-0.1	<0.001
Gender					
Male	Ref.				
Female	1.4	0.3	0.8	2	<0.001
Ethnicity					
Māori	Ref.				
Non-Māori	0.6	0.3	-0.01	1.4	0.05
Education					
No qualifications	Ref.				
High school qualification	4	0.5	3	5	<0.001
Post-secondary qualification	4.4	0.5	3.5	5.3	<0.001

University degree	5.2	0.5	4.1	6.2	<0.001

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

Table 2 shows for every year older participants get; it is expected they will perform -0.1 points worse (95%CI = -0.1; p < .001) on their cognitive functioning test.

5.7 Association between income adequacy and cognitive functioning adjusted for key demographics and living conditions

The adjusted model between income adequacy and cognitive functioning, while adjusted for sociodemographic characteristics and living conditions could explain 24.8% ($R^2 = 0.248$) of variation in cognitive functioning. The residual standard error is 4.739 indicating cognitive functioning scores can deviate from the regression line by 4.739. The overall adjusted regression model was statistically significant, $F(14, 955) = 23.87$, $p < 0.001$. This indicates that the model explains a significant amount of variance in participants cognitive functioning.

The observed scores from the adjusted model for sociodemographic characters and living conditions indicate having more than enough income adequacy holds a positive association with cognitive functioning (*B* = 1.8, *95%CI* = 0.6-3, *p* = 0.03). Sociodemographic characteristics also showed positive associations with cognitive functioning. These sociodemographic characteristics were females (*B* = 1.5, *95%CI* = 0.89-2.1, *p* = <0.001) and non-Māori (*B* = 0.67, *95%CI* = -0.01-1.3, *p* = 0.05). The adjusted linear regression model indicated educational attainment at all levels were associated with higher cognitive functioning scores. However, the adjusted model indicates with each qualification progression, the association between education and cognitive functioning appears more positive. This association between education and cognitive functioning is reflected in those who hold a high school qualification (*B* = 3.8, *95%CI* = 2.8-4.8, *p* = <0.001), a post-secondary school qualification (*B* = 4.2, *95%CI* = 3.4-5.1, *p* = < 0.001), or a university degree (*B* = 4.8, 3.8-5.9, *p* = <0.001). Furthermore, living conditions for low area-based socioeconomic deprivation indicated a positive association with cognitive functioning (*B* = 2.1, *95%CI* = 0.48-3.7, *p* = 0.01). As expected, the adjusted model indicates a negative association between age and cognitive functioning (*B* = -0.14, *95%CI* = -0.02-0.1, *p* = <0.001). For further information please refer to Table 9.

Table 9

Results of the Linear Regression Analysis: Associations of Income Adequacy and Cognitive Functioning, Accounting for sociodemographic Characteristics and Living Conditions

	Estimate	*SE*	95% CI		*t*	*p*
			2.5 %	*97.5 %*		
Income Adequacy						
Not enough	Ref.					
Just enough	0.409	0.609	-0.785	1.604	0.672	0.501
Enough	0.630	0.583	-0.515	1.775	1.079	0.281
More than enough	1.846	0.620	0.630	3.063	2.979	0.003
Age, per one-year	-0.149	0.025	-0.198	-0.100	-6.003	<0.001
Gender						
Male	Ref.					
Female	1.509	0.314	0.892	2.125	4.803	<0.001
Ethnicity						
Māori	Ref.					
Non-Māori	0.679	0.351	-0.011	1.369	1.932	0.054
Residence						

Urban	Ref.					
Rural	-0.031	0.403	-0.821	0.760	-0.076	0.939
Marital Status						
No Partner	Ref.					
Partner	0.230	0.357	-0.472	0.931	0.643	0.521
Education						
No qualification	Ref.					
High School	3.863	0.502	2.877	4.850	7.689	<0.001
Post Secondary	4.277	0.457	3.380	5.174	9.360	<0.001
University degree	4.880	0.530	3.840	5.920	9.205	<0.001
Employment Status						
Non-employed	Ref.					
Employed	0.286	0.380	-0.459	1.031	0.754	0.451
Area-based deprivation						
High	Ref.					
Low	2.105	0.824	0.487	3.723	2.553	0.011
Medium	-0.013	0.918	-1.814	1.788	-0.014	0.989

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

5.8 Analysis of Variation/Deviance for Fitted Adjusted Linear Model

The ANOVA results provide valuable insights into the relationship for income adequacy, sociodemographic characteristics, living conditions, with cognitive functioning. Income adequacy shows a positive association with cognitive functioning, with an F-Value of 5.41 and a statistically significant p-value (<0.001). This suggests higher levels of income adequacy are associated with higher levels of cognitive functioning. Age also appears to be significant for cognitive functioning (F = 107.22, p = <0.001) indicating that cognitive functioning varies across different age groups, possibly reflecting changes in cognition due to ageing. Education was found to be associated with cognitive functioning, with an F-value of 52.05 and a p-value of

<0.001. This suggests that change in education level can lead to changes in cognitive functioning. Gender, although with a smaller *f* value, was found to be associated with cognitive functioning (F = 16.29, p = <0.001), suggesting gender disparities for cognitive functioning may exist for older adults. Furthermore, area-based deprivation shows an association with cognitive functioning (F = 14.93, p = <0.001) suggesting that living in lower (higher) levels of deprivation may have positive (negative) impacts on cognitive functioning in older adults. The residuals, representing unexplained variance, have a sum of squares of 21443.48, indicating that while our model explains a significant portion of the variance in cognitive functioning, there are other factors not accounted for in this analysis. Other variables were not found to be statistically significant. Please refer to Table 10 for further information. These findings highlight the complex interplay of participants income adequacy, sociodemographic characteristics, and living conditions upon cognitive functioning. They underscore the importance of addressing income inequalities and promoting education as potential strategies for promoting brain health in later life.

Table 10

ANOVA for Cognitive Functioning on Adjusted Model

	df	*SS*	*MS*	*f*	*p*
Income Adequacy	3	364.12	121.37	5.41	<0.001
Age	1	2407.49	2407.49	107.22	<0.001
Gender	1	365.72	365.72	16.29	<0.001
Ethnicity	1	83.84	83.84	3.73	0.054
Area of residence	1	0.02	0.02	0.001	0.974
Marital Status	1	76.46	76.46	3.40	0.065
Education	3	3505.94	1168.65	52.05	<0.001

Employment status	1	29.75	29.75	1.32	0.250
Area-based deprivation	2	670.58	335.29	14.93	<0.001
Residuals	955	21443.48	22.45		

6. Discussion

This study seeks to contribute to the current literature in Aotearoa which addresses the relationship between income adequacy and cognitive functioning among older people. Currently, there are few quantitative studies which explore the relationship between income adequacy and cognitive functioning specific to Aotearoa New Zealand's older population. The primary aim of this thesis was to explore the relationship between income adequacy and cognitive functioning. The secondary aim of this thesis was to explore the relationship of sociodemographic characteristics and living conditions within the relationship between income adequacy and cognitive functioning. A summary of the findings of this study is provided, followed by discussion of these findings with relevant literature, and implications within an Aotearoa New Zealand context.

6.1 Income Adequacy and Cognitive Functioning

The findings of this study support previous research conducted internationally and within Aotearoa New Zealand which acknowledges the association income adequacy has with cognitive functioning. The objective of the hypothesis was to assess whether the income adequacy of older adults in Aotearoa New Zealand affected their cognitive function. The statistical analysis provided evidence to reject the null hypothesis. Results accounting for sociodemographic characteristics indicated enough and more than enough income adequacy was statistically linked to higher cognitive functioning. Therefore, it can be concluded, that higher income adequacy of older adults in Aotearoa New Zealand is associated with higher levels of cognitive functioning. These findings are similar to Clark et al. (2022) and Liu et al. (2023) who have found persistent financial adversity to be associated with reduced cognitive function in mid to later life. However, further research may be required to gather a deeper understanding of the relationship between income adequacy and cognitive functioning with recent population data. This could create greater awareness regarding income adequacy levels post-COVID and greater awareness of the daily nuances within income adequacy.

When additionally adjusted for living conditions, there was an association between more than enough income and higher cognitive functioning. While the adjusted model for living conditions revealed, enough income adequacy becomes less significant in the adjusted model for cognitive functioning. Findings also indicated that living conditions may influence the relationship between income adequacy and cognitive functioning. This aligns with findings from Tang et al. (2024) who acknowledge demographic, socioeconomic, and living conditions can influence cognitive functioning. The findings of this thesis are consistent with Lindsay et al. (2022) longitudinal findings. This study explored the relationship between household material resources and cognitive function in adults older than 40 years old in rural South Africa. It was found on average that higher household resources were associated with better cognitive functioning. Longitudinally, this was also found to be true, with variables observed over time. Lindsay et al. (2022) attributed this to technological advancements over 13 years and indicated these advancements may have provided cognitive enrichment opportunities through social engagement and mobility outside of the home. Similarly, Nutakor et al. (2021) found higher household income was associated with better cognitive functioning among older adults living in Ghana. Findings from both studies are relevant to the current study as their research highlights the relationship between income adequacy and cognitive functioning spans across different cultural and geographical contexts. Thus far, there has not been research conducted in Aotearoa New Zealand to specifically address the relationship between income adequacy and cognitive functioning within an older demographic. Most of the available Aotearoa New Zealand-based research addresses broader socio-economic interactions upon cognitive functioning within an older-aged demographic. Aotearoa New Zealand studies such as Stephens et al. (2019) have investigated environmental resources one holds and the impact of this on physical, mental and social well-being. Stephens et al. (2019) acknowledge the variance of experiences of ageing and emphasize health in this context to be a symbiotic relationship of physical, mental, and social well-being reflecting a state of complete wellness. Stephens et al. (2019) found those with perceived poor quality of environmental resources, housing satisfaction, and social cohesion to experience higher inequities of physical, mental, and social well-being. These findings support the argument that income adequacy may explain some variations in cognitive functioning within an Aotearoa New Zealand context.

Further testing with ANOVA was used to examine the relationship between income adequacy and cognitive functioning. These findings aligned with the linear regression model and adjusted model which finds income adequacy and cognitive functioning scores to be associated. This relationship was again found to be statistically significant with income adequacy accounting for a higher level of variance amongst cognitive functioning scores. Providing further evidence of the broader relationship between income adequacy and cognitive functioning.

6.2 Sociodemographic Characteristics and Cognitive Functioning

In addition to income adequacy, the study sought to consider sociodemographic characteristics in relation to cognitive functioning. The sociodemographic characteristics considered were age, gender, ethnicity, educational level, marital status, and employment.

As anticipated, age increasing by year was associated with lower cognitive functioning. ANOVA testing between age and cognitive functioning revealed age explained substantial levels of variation in relation to cognitive functioning. These findings were noted as statistically significant. Indicating that ageing is an important risk factor for reduced cognitive functioning capabilities. This has been well established within literature and the current findings provide further evidence of the relationship between ageing and cognitive decline. Cognitive impairment and cognitive decline exacerbated by ageing may be attributed to structural changes in the brain and cognitive reserve which inhibit executive functioning abilities. This is a concern as it may place older adults at risk of becoming increasingly dependent upon the health care system and social services. The following sociodemographic factors explore identified modifiable factors that may deter cognitive impairment and decline exacerbated by ageing.

Women displayed higher cognitive functioning levels compared to men in both linear regression models. This was supported by the t-test and ANOVA results which indicated females had slightly higher cognitive functioning scores than males. Existing literature indicates females often outperform males within western society. Divergence within literature for gender and cognitive functioning could be attributed to different cultural contexts, accessibility to resources such as education or employment, and sample population characteristics. Findings of gender in this thesis provide further evidence of the broader relationship between gender and cognitive function as well as for women specifically. This supports previous international, and Aotearoa New Zealand-based findings in relation to gender and cognitive functioning. The current findings highlight the need for further research into the relationship between gender and cognitive functioning within an Aotearoa New Zealand context.

Non-Māori participants demonstrated higher cognitive functioning than Māori participants when adjusted for other demographic characteristics and context factors. The non-Māori group were primarily comprised of participants who identified as New Zealand Europeans. These findings were supported by both *t*-test and the ANOVA on the adjusted model which both found non-Māori to produce higher cognitive functioning scores than Māori. This is important as Māori are over-represented in worse health outcomes. This disparity may be attributed to a combination of historical and structural factors which reinforce systematic discrimination. Stephens et al. (2022) has shown that Māori have many barriers to adequate and equitable healthcare. Barriers may manifest as lack of access to quality healthcare, lack of trust in healthcare providers, and lack of culturally competent clinicians within medical providers (Martinez-Ruiz et al., 2020; Stephens et al., 2022). Without inclusive public health initiatives and cultural competency training targeted at reducing health inequalities, these barriers will continue to persist.

Furthermore, statistical analysis revealed higher levels of education were associated with higher cognitive functioning scores within this thesis. An ANOVA revealed education to explain a higher amount of variance than other sociodemographic characteristics and was found to be statistically significant. This revealed a broader relationship between education and cognitive functioning scores. Further, statistical analysis through regression analysis provided further context into the relationship between education and cognitive functioning scores. Education in both models was found to hold a positive association with cognitive function. However, there was some variability in scoring from those who held a secondary qualification, a post-secondary school qualification, or a university degree. Suggesting, those who had higher educational attainment such as a university degree were likely to perform better than those who held no qualifications. These findings align with Rodriguez et al. (2021) who found the effect of education on cognitive functioning to be double the effect size of income with cognitive functioning.

Rodriguez et al. (2021) identified this to be common among those aged 50 and over across cultural contexts. Furthermore, these findings are adjacent to those of Pai et al. (2024). Pai et al. (2024) found education to have an association with cognitive functioning and income adequacy for older adults whose children had higher educational attainment. This is relevant to the current study as it builds cultural awareness of different cultural norms. Pai et al. (2024) outline the cultural context within India of children financially and socially supporting their parents later in life. Pai et al. (2024) findings suggest that a child's educational attainment not only mitigates the child's own experience of cognitive functioning but their parents later in life too. This is significant as it highlights the protective properties education possesses against cognitive decline across generational and cultural contexts. Furthermore, education has been linked to building individuals' cognitive reserve through improving their brain reliance and strengthening their neuronal pathways (Yu et al., 2021). McCann et al. (2018) support this, suggesting prevention strategies targeted at increasing an individual's cognitive reserve and improved management of health-related risk factors of cognitive decline could prove most effective moving forward. Mitigating factors of education upon cognitive functioning may influence mitigating factors income adequacy has concerning cognitive functioning. To better understand this relationship in an Aotearoa New Zealand context, further research needs to be completed to unpack the interaction of these factors.

The findings from this thesis revealed marital status and employment to be less statistically significant than other studies. *T*-tests also revealed marital status and employment to have small effect sizes for cognitive functioning. Combined the inferential analysis suggests that there may be additional context which needs to be considered such as cultural norms and societal trends. This is interesting as previous literature have identified both marital status and employment to support the development of individual’s cognitive reserve and neuroplasticity (Yu et al., 2021). Therefore, further research is required to better understand these relationships.

6.3 Living conditions and Cognitive Functioning

The current study also aimed to investigate the association between living conditions and cognitive functioning. The hypothesis proposed living conditions such as living rurally and high area-based socioeconomic deprivation were associated with lower cognitive functioning levels.

Findings from the statistical analysis conducted within this thesis reveal the relationship between area-based socioeconomic deprivation levels and cognitive functioning. Findings also reveal a more specific relationship between low area-based socioeconomic deprivation and higher cognitive functioning scores. This was also found to be true for high area-based socioeconomic deprivation and lower cognitive functioning scores. This supports previous research conducted by McCann et al. (2018) which suggested that older adults with high area-based socioeconomic deprivation had a greater risk of lower cognitive function than those with low area-based socioeconomic deprivation. McCann et al. (2018) also suggested that high area-based socioeconomic deprivation often increases an individual’s experience of psychosocial stress, lower educational attainment, and limited access to resources such as health services. Tang et al. (2024) has found that reduced income adequacy is associated with higher area-based socioeconomic deprivation levels making it hard to meet basic daily needs contributing to perceived cognitive strain. Tang et al. (2024) identifies the relationship between low area-based socioeconomic deprivation levels and high-income adequacy can mitigate the effects upon cognitive functioning. The current research supports these findings. Allen and Alpass (2020), suggest reduced income adequacy may give individuals fewer opportunities for education or vocational training which could perpetuate the potential impacts of reduced income adequacy. The current research supports these findings as it shows there is an association between medium to high area-based socioeconomic deprivation and low-income adequacy. McCann et al. (2018) further states area-based socioeconomic deprivation levels are a risk factor in the development of dementia and require further global intervention.

6.4 Income Adequacy and Demographic Characteristics

The findings of this thesis have revealed an association between income adequacy and sociodemographic characteristics. Specifically identifying associations with gender, ethnicity, education, marital status and employment.

As expected, income adequacy disparities were found to be higher for older women in Aotearoa New Zealand. Contributing further evidence to existing local and international literature which report women have lower socioeconomic status and income adequacy. Lower income adequacy levels may be attributed to on-going disparities faced by women previously which have failed to provide adequate remuneration for women receiving an income or sought to exclude women from education and employment. Understanding these disparities is crucial to creating transformative change for women's experience of income adequacy. However, the normal distribution of the findings amongst women and men highlights the recent societal shift in western countries from traditional gender roles women and men faced. Suggesting women are becoming financially independent of their family or their spouse. These findings highlight structural inequalities and challenges women face. Unpacking these challenges will support structural reform and social policy to reduce disparities of income adequacy between men and women.

Māori were found to report lower levels of income adequacy than non-Māori. These findings provide further evidence for existing literature which suggests Māori to be more likely to experience hardship before pensionable age. Highlighting possible disparities between Māori and non-Māori that contribute to Māori's low-income adequacy. Raising further awareness that Aotearoa New Zealand needs to ensure assessment and interventions targeted to reducing ethnic disparities are culturally and linguistically responsive.

Higer educational attainment was found to be associated with higher levels of income adequacy. However, the findings of this thesis differentiate cognitive functioning abilities between levels of education. Those who hold a university degree were found to have the highest levels of income adequacy in older age. Those who held a post-secondary school qualification reported slightly lower levels of income adequacy than those with a university degree. However, reports of income adequacy for post-secondary school graduates identified they had much higher income adequacy than those with a high school qualification or no qualification. These discoveries align with Aotearoa New Zealand-based research and international research which suggests education is a key factor for socioeconomic status and provide further insights into income adequacy (Rawat et al., 2024; Stephens et al., 2022). This is of concern for New Zealanders as those who experience hardship are less likely to attain a tertiary-level qualification. Suggesting the relationship between income adequacy and educational attainment may be cyclical. While further research needs to be completed to assess the relationship in more depth, the current study highlights structural inequities in Aotearoa New Zealand. These inequities reveal there needs to be changes in social policy and educational reform to make a meaningful difference in New Zealander's daily lives.

Those who had a partner reported higher levels of income adequacy than those who were single. Contributing further evidence within existing literature that acknowledges having a partner provides greater financial security, access to resources, and social support than those who are single. This suggests, having a partner could be a protective factor for income adequacy within older New Zealanders. However, it is important to consider evolving societal trends and generational contexts alongside income adequacy. Marital expectations may have been more prominent amongst older adults within 2010 which could explain the high number of older adults in Aotearoa New Zealand that reported having a partner. Policymakers need to understand the impact of evolving societal trends to ensure targeted policies and campaigns are relevant and effectively seek to reduce disparities of income adequacy moving forward.

Those who were employed identified higher-income adequacy compared to those who were non-employed. Unsurprisingly employed individuals in New Zealand typically receive higher income levels to support individuals to meet their everyday needs. Employment often provides financial flexibility, routine salary increases, additional lifestyle benefits, and protection against economic fluctuations that non-employed individual’s do not experience. Collectively, the flexibility and stability promote greater income adequacy to meet an individual’s everyday needs. The relationship between employment and income adequacy levels underscores the importance policies and social support that assist individual’s in attaining employment. Furthermore, addressing employment gaps supports national economic growth and alleviate system pressures on government services such as work and income.

6.5 Income Adequacy and Living conditions

Chi-square testing revealed there to be associations between income adequacy and living conditions. Findings revealed associations between income adequacy and area of residence as well as area-based socioeconomic deprivation level. These discoveries are significant as the chi-square tests indicate these associations were unlikely to have occurred by chance.

Chi-square testing revealed there to be a relationship between income adequacy and area of residence. Further count and proportion testing revealed those living in an urban area reported higher income adequacy than those who lived rurally. More respondents reported living in urban areas. Similarly, literature has found individuals who hold a higher socioeconomic status are more likely to reside in urban areas (Hsu et al., 2019). This suggests those with low socioeconomic status may seek out more affordable housing and living costs often associated with rural living. However, those residing in urban areas may choose to remain in affluent areas due to greater access to infrastructure, services, and social capital that is often associated with urbanisation. Proportion graphs revealed a normative distribution of income adequacy between urban and rural areas. However, proportionally individual's residing in rural areas reported having slightly less income adequacy than those living in urban areas. Literature supports these findings and acknowledges prolonged access restrictions to infrastructure, services, and social capital may widen the gap between urban and rural residence. Collectively this highlights greater need for support who reside in rural areas to mitigate the association this may have for adequate income on cognitive functioning in older adults.

Further chi-square tests revealed there to be a relationship between income adequacy and area-based socioeconomic deprivation levels. Further count and proportion testing revealed those living in lower area-based socioeconomic deprivation reported higher income adequacy than those who lived in medium or high area-based socioeconomic deprivation. While those with medium area-based socioeconomic deprivation were found on average to have just enough or enough income adequacy. These findings aligned with the proportion of data collated. Similarly, literature has found income inequities to be a key factor in lower area-based socioeconomic deprivation levels for individuals (McCann et al., 2018). These findings could be attributed to those in low area-based socioeconomic deprivation levels having more access to services as well as the quality of service being delivered. It could also be attributed to broader opportunities for income and educational attainment. This may be driven by access to educational opportunities and more job options. Suggesting the relationship between income adequacy and area-based socioeconomic deprivation level to be cyclical. Understanding this relationship is crucial to the development of treatment-responsive interventions for cognitive functioning. Creating space for the development of intentional support services and social policy to target specific modifiable factors. Honing into Aotearoa New Zealand-specific modifiable factors allows Aotearoa New Zealand to begin to address and unpack structural inequities at macro levels to drive meaningful and quantifiable micro changes in New Zealanders' daily lives.

6.7 Limitations

The study has several limitations that should be considered when interpreting the findings. Limitations to this thesis comprise aspects of the study design, the measures used, and the broader context that is not reflected within demographic characteristics and living conditions data. The following section will outline these limitations in further detail as many life experiences can alter income adequacy and cognitive functioning trajectories for New Zealanders. It is crucial Aotearoa New Zealand-based researchers explore the effective implementation of preventative strategies and interventions against cognitive impairment.

Aotearoa New Zealand society has many moving parts, particularly within an economic and health context. While the present study provides an opportunity to create a historical baseline to provide insights into longer-term trends, there are many limitations to the singularity of these results. As the data was collected in 2010 the applicability and relevancy of the results in a 2025 context is limited. This is important as there have been many societal, economic, and health shifts over the past two decades which the current results are unable to capture. Data from 2010 may struggle to accurately reflect demographic changes, cultural values, technological advances, health policies, economic policies, and healthcare infrastructure. However, comprehensive data on cognitive functioning, embedded in a wealth of sociodemographic and health data, is still scarce in Aotearoa New Zealand, which is why the findings of this research has still merit; importantly as financial hardship in a current cost-of-living crisis may likely have worsened outcomes.

The singularity of the data through a cross-sectional design creates limitations the analysis can derive from the results. While this design allows for the identification of associations between variables it cannot establish temporal or causal relationships between income adequacy and cognitive functioning. In addition to this, acknowledgement of complex relationship between demographic characteristics, living conditions, income adequacy, and cognitive functioning must also be drawn, which were not investigated. The lack of longitudinal data cannot capture how variables shift over time making it difficult to accurately unpack identifiable relationships. To address this limitation in future research, a longitudinal study may be considered

Limitations of demographic characteristics include age range, ethnicity, and education level. While this thesis looks at aged 49-84 years old with the average age being 61 years old, a broader age range of 40-95 years old may provide valuable insights into income adequacy and cognitive functioning across stages of ageing from mid-adult through to older age. A broader age range would allow for better representation of diverse age groups in Aotearoa New Zealand’s population. This would improve reliability, validity, and generalisability of the findings. It would contextualise age-related challenges for individuals and policymakers to better understand the changes in income adequacy for cognitive function across the life span and it's impacts later in life. Knowledge of income adequacy across the lifespan would ensure policy changes and healthcare interventions are responsive to the specific needs of New Zealanders. It would also capture further generational contexts and allow for the tracking of societal change within Aotearoa New Zealand.

Secondly, further ethnic representation within the present study creates limitations to the generalizability of the findings within modern-day contexts. The present study looks at Māori and non-Māori experiences of income adequacy and cognitive function. However, the non-Māori sample is primarily comprised of NZ European participants with few Pasifika or Asian participants reflected within the non-Māori group. The ethnic grouping within this study is comprised of Māori and non-Māori in the 2010 data set had low participation from Pacifica and Asian communities. However, with societal changes in Aotearoa New Zealand, future research must be representative of the current population's diverse ethnic makeup. This is to ensure policy recommendations are not skewed and ensure policy implementation effectively addresses the diverse ethnic needs of New Zealand's population. The importance of inclusivity is to ensure accurate cultural relevance to social and health policies and interventions to disempower disparities New Zealand's vulnerable communities face. Furthermore, the present study lacks depth and understanding of education levels. education within the present study is broken into four categories which distinguish whether a participant holds no qualification, a secondary school qualification, a post-secondary school certificate or diploma, and a university degree. While these are great indicators for the level of education a participant has received, it does not inform us of the quality of education the participant received. While participants may have obtained a qualification there is no indicator within the data set to establish the consistency of the quality of education each participant received across the qualifications. For example, a Bachelor of Science may have different academic requirements from their peers who may have obtained a Bachelor of Business. Lack of context for education quality can increase the risk of confounding variables appearing within the study. Future research should consider that insufficient context for education may hinder detailed analysis of the relationship between income adequacy and cognitive functioning. This creates challenges for understanding and interpreting associations between the quality of education provided and income adequacy or cognitive function in older age. Capturing the finer details of demographic characteristics would allow the creation of a nuanced approach towards income adequacy and cognitive function. Further research for Aotearoa New Zealand may uncover further evidence of demographic characteristics which predispose New Zealanders to poorer outcomes.

Limitations of sociodemographic characteristics and living conditions may include marital status, employment, and area-based socioeconomic deprivation score. Marital status may have limitations within future research and due to shifting societal norms. While marital status is an accurate measure within the present study this variable may require further exploration due to declining marital rights over the last few decades within NZ. It is important to consider the role of cohabitation outside of marriage and alternative family structures which marital status data may not capture. Expanding the marital status variable will also allow us to better understand how same-sex partnerships may impact income adequacy later in life.

Additionally, employment needs to be further unpacked. A larger data set or a cross-sectional study may allow researchers to unpack the nuances of employment upon income adequacy and cognitive function. The traditional sense of employment has adapted since COVID-19 to include working from home, hybrid work, in-office work, and working in the community. A larger data set or cross-sectional study may allow researchers to unpack this to better understand whether certain modalities of employment may provide higher income adequacy or promote healthier cognitive function over prolonged exposure. It may then also allow researchers to unpack whether the type of employment such as physical labouring work or office jobs may promote higher income adequacy to promote healthier cognitive function over an individual's lifespan. Additionally, as people often change places of employment or occupational roles before pensionable age future research may need to track how employment may relate to income adequacy and cognitive function. However, future research may have the ability to control for changes in employment during the life course upon income adequacy levels and cognitive function trajectories later in life. An in-depth analysis would allow for targeted approaches towards policy implementation and health intervention to promote higher income adequacy and cognitive function in Aotearoa New Zealand older adults. Furthermore, it is important that the present study does not capture resource allocation to areas that were found to have higher area-based socioeconomic deprivation levels around Aotearoa New Zealand between 2010 to the present day. This is important because area-based socioeconomic deprivation around Aotearoa New Zealand may have changed slightly over the past couple of decades. This is crucial to keep in mind when considering the results as they may not be reflective of NZ's current societal area-based socioeconomic deprivation level context.

6.8 Implications

The findings reported in this thesis contribute novel insights on the link between income adequacy and cognitive functioning in older adults in Aotearoa New Zealand. Previous studies have looked at broader, objective socioeconomic factors in relation to cognitive functioning within mid to later life for New Zealanders. This thesis looked at a self-perceived evaluation of income meeting personal needs for living, which adds to our understanding of socioeconomic factors in brain health.

The thesis found that income adequacy was associated with cognitive functioning, in that individuals who stated to have more than enough income to meet their needs was linked to higher levels of cognitive functioning. Findings identified the relationship between sociodemographic characteristics and living conditions that were identified to be associated with income adequacy levels. These were as expected, gender, ethnicity, education level, employment, relationship status, and area-based socioeconomic deprivation level. These findings are important on an individual and national scale as these key variables inform New Zealanders about key drivers of income adequacy to best inform policy changes alongside social and economic reform. Understanding the crucial role income adequacy has upon cognitive functioning later in life allows young adults to sustainably plan for their futures. This supports health reduction strategies targeted towards promoting brain health in relation to income adequacy.

Furthermore, findings revealed sociodemographic characteristics and living conditions to be associated with cognitive functioning. Females demonstrated higher cognitive functioning scores compared to their male counterparts. Ethnic disparities were also observed, with those who identified as non-Māori showing an association with higher cognitive functioning scores compared to Māori. This indicates there are gaps in care and opportunities provided to Māori. Reinforcing the need to implement culturally responsive support in place for Māori so Māori can thrive. The study also found those who held a higher educational qualification were associated with higher cognitive performance, suggesting education plays a significant role in cognitive functioning later in life. Furthermore, lower levels of area-based socioeconomic deprivation were associated with higher cognitive functioning, suggesting that broader socioeconomic factors may influence cognitive performance.

These findings indicate an opportunity for future prevention and intervention. Practical prevention and intervention implications could be implemented through economic relief and reduction in barriers to education to ensure those in higher area-based socioeconomic deprivation areas are not further disadvantaged. Importantly, this study suggests that providing opportunities to ensure there is adequate income to cover basic needs may be an avenue to promote brain health.

As Aotearoa New Zealand has an ageing population and currently increasing economic pressures in a cost-of-living crisis, it is expected that older people's cognitive performance will continue to be affected. The findings of the current study into the relationship between income adequacy and cognitive functioning address a gap in Aotearoa New Zealand research and highlights the importance of income adequacy within the broader context of socioeconomic factors for older adults within Aotearoa New Zealand.

6.9 Recommendations

Understanding that income adequacy is relevant for cognitive functioning provides new clues for local governmental strategies to design effective prevention and intervention programmes. To address current concerns regarding income adequacy and cognitive functioning within New Zealand’s population there are many approaches that could be actioned. These approaches include economic relief, national health campaigns, educational reforms, and primary health which could support the delayed impacts that low-income adequacy may have on disturbances to cognitive function. This is crucial to the prevention of cognitive impairment and decline amongst younger generations to promote healthy ageing amongst New Zealand’s ageing population. Consequentially, this may extend independence for older New Zealanders.

Recommendation one considers the government implementing a universal basic income (UBI) supporting higher income adequacy. The UBI would be in line with the current living wage to reduce disparities experienced due to inadequate income. The UBI could be implemented before the pensionable age or at the pensionable age as a pilot trial. This could be an important first step in addressing inadequate income and high area-based socioeconomic deprivation levels amongst the Aotearoa New Zealand population. Allen and Alpass (2020) acknowledges often there are socioeconomic struggles before pensionable age and suggests a universal based pension could mitigate health disparities accumulated over a lifespan. The implications of this recommendation would need to be carefully considered as potential risks could arise from the implementation of a UBI. The greatest implication that may present from a guaranteed UBI too early in New Zealander's careers may diminish people's incentive to achieve their educational or career aspirations. However, if implemented at a pensionable age this may mitigate the presented limitation. A piloted UBI could provide researchers with reasonable evidence regarding income adequacy and the effects of this on cognitive functioning in a different cohort.

Recommendation two considers further support from WINZ across the lifespan inclusive of pensionable years supporting higher income adequacy and cognitive function. Socioeconomic struggles experienced across the lifespan and the impacts on poorer health outcomes later in life suggest income to be a modifiable risk factor for New Zealanders (Allen & Alpass, 2020). International and Aotearoa New Zealand research supports these findings that socioeconomic status plays a key role in cognitive function later in life (Liu et al., 2023; Skoblow et al., 2024). The challenge of this is that the New Zealand government holds finite resources and is required to allocate these to those in most need. Given the pervasiveness of cognitive decline, it is imperative that the government provides sufficient prevention and intervention strategies. Further support from WINZ could provide enough income adequacy to mitigate the consequences of socioeconomic disparities before pensionable age (Allen & Alpass, 2020).

Recommendation three considers economic relief for New Zealanders in the form of tax relief supporting higher income adequacy. Tax relief can provide several benefits for individuals such as higher disposable income, increased savings, investment opportunities, and homeownership opportunities. These opportunities may increase perceived income adequacy for individuals. Therefore, reducing New Zealanders' experiences of economic stressors. Tax relief could be an effective approach to supporting higher cognitive function. However, it is again important to remember the finite resources the New Zealand government holds. Therefore, the most efficient and effective financial relief must be provided alongside social interventions.

Recommendation four considers the provision of affordable housing initiatives supporting higher income adequacy and cognitive function. Affordable housing initiatives could support vulnerable communities through rent control, first-home buyers, addressing diverse housing needs, and supply vs demand needs in needed areas. Rent control policies can provide stabilisation for renters and support higher income adequacy levels for older adults. Those renting later in life or those who may enter retirement homes may benefit from such policies which limit rising rent prices. This is especially important in higher demand areas which could displace older adults who may not be able to afford rent increases. Rent control policy may also prevent the loss of New Zealanders' support networks integral to maintaining independence later in life. This notion is similar to first home buyer support as a preventative measure against displacement, loss of social network, and cognitive decline later in life. First-home buyer support could also provide sustainable income adequacy levels for older adults assuming their mortgage is paid before pensionable age. Furthermore, management of the supply and demand of affordable housing may better support income adequacy and area-based socioeconomic deprivation levels for New Zealanders. The present study has shown association of low area-based socioeconomic deprivation levels with higher levels of cognitive function. Suggesting affordable housing may indirectly support cognitive function through income adequacy. Overseas home buyers may pose a threat to this if they have higher disposable income than New Zealanders in the same housing market. Therefore, higher protection of Aotearoa New Zealand buyers against international buyers is crucial to reducing disparities New Zealanders may face. This may support the supply and demand levels for affordable housing across Aotearoa New Zealand. These options support the New Zealand government to address the diverse and affordable housing needs that older Aotearoa New Zealand adults may hold. Affordable housing may reduce area-based socioeconomic deprivation levels and support independence for Aotearoa New Zealand older adults. Additionally, it may alleviate costs that government services have to pay in resource allocation to mitigate further detriment to poor health outcomes such as cognitive impairment.

Recommendation five considers educational reform supporting higher income adequacy and cognitive function. As found within the present study and previous literature education plays an essential role in income adequacy and cognitive function. However, the current system exacerbates disparities further for New Zealand's vulnerable communities. Although resource-intensive, changes to teaching modalities, curriculum design, and assessment delivery may better support later-life cognitive function. Changes to the educational system to enhance the delivery of learning material through various modalities may better support the flourishment of New Zealanders. Different individuals may learn best through teaching styles and environments which differ from traditional approaches. These factors can make a big difference in people's motivations to continue their education journey. Implementation of an educational system which is inclusive, accessible, and affordable is crucial to supporting New Zealanders to achieve higher cognitive function in older age. This approach will also seek to improve income adequacy for New Zealanders through enhancement of skills and knowledge which may create a cyclic effect for promoting healthy cognitive function. Furthermore, equitable access to education and support is essential for promoting cognitive functioning later in life. A preventative approach for education upon cognitive function is to promote and begin education as early as possible. This may help to support the cognitive reserve and resilience each individual holds. A way which may make this equitable for younger generations is to implement services which reduce barriers to accessing education. For example, a social service such as Plunket or family starts working alongside all parents to support the enrolment of each child within Aotearoa New Zealand into kindergarten and primary school. Furthermore, a reduction of paperwork and requirements for parents to enrol their child in kindergarten and primary school may reduce barriers to access within younger generations of New Zealanders. Furthermore, workplace accommodations should be made to ensure there are fewer workplace stressors which could negatively impact cognitive functioning, such as bullying, high caseloads, and appropriate responsibilities placed on team members. This would ensure employees are working in healthy work environments which support work-life balance. An intervention-based approach for older Aotearoa New Zealand adults could promote accessible education to support cognitive function. Accessible and affordable education for older adults may have similar benefits that younger generations have been found to reap from education. Education across the lifespan has been linked within international and Aotearoa New Zealand research to higher cognitive function abilities. Additionally, increased access to healthy coping strategies for emotional regulation and stress may benefit older adult's cognitive reserve. These could be advertised and taught through local education providers, social services, healthcare settings, workplaces, and broadcasting channels. These strategies should be culturally reflexive and provide holistic tools which transcend socio-economic factors and are accessible to the entire Aotearoa New Zealand population. Additionally, it is important to consider the quality of education being delivered across the lifespan. While the present study did not capture this data it is an avenue which needs to be explored further to better establish the relationship education has with cognitive function in older age. Pre-existing Aotearoa New Zealand school decile information for previous generations may provide further evidence and quantification of the quality of education delivered and educational resources available. Quantification of the quality of education relevant to income adequacy and cognitive function could provide adequate evidence for the advocation of more resource allocation to specific schools to mitigate disparities. Furthermore, a change in the narrative around education could better support New Zealanders to achieve their goals in their time. The narrative that education is for five to eighteen-year-olds and university qualifications are unattainable requires further consideration. Currently, the pathway for New Zealanders seeking to re-engage in education or apply for tertiary-level education creates further barriers to accessing education for New Zealanders. The cyclical relationship found between income adequacy and cognitive function highlights the importance of promoting educational engagement as a modifiable risk factor for later life in New Zealanders. Educational reform could provide Aotearoa New Zealand with the opportunity to explore these challenges further in a way that is meaningful for New Zealanders.

Recommendation six considers healthcare prevention and interventions supporting higher income adequacy and cognitive function. This initiative would seek to bolster the primary care system to make healthcare more accessible and cost effective. This initiative would ensure the healthcare system holds safe staffing levels and primary health clinicians are well-trained to understand the first signs of cognitive impairment or decline. A highly skilled universal healthcare system in Aotearoa New Zealand will ensure clinicians are aware of how to make appropriate referrals to community services. This would allow individuals to be treated faster for signs of cognitive impairment and receive support to alleviate financial stressors endangering patients’ income adequacy. Additionally, to improve healthcare access and reduce income adequacy challenges for marginalised communities within

Aotearoa New Zealand clinicians would be cultural responsivity and reflexive in practice.

Recommendation seven considers national health campaigns supporting higher income adequacy and cognitive function. National health campaigns seek to educate the population about healthy cognitive ageing and provide effective inexpensive strategies to enhance cognitive functioning. These campaigns should be holistic and culturally responsive to the needs of New Zealand's population which targets individuals of all age ranges to both prevent and intervene in age-related cognitive function changes. This should be delivered in conjunction with improving access to primary healthcare interventions. Clinicians should be specifically trained to screen and identify changes in cognitive functioning. This would allow doctors to provide early intervention to patients. Clinicians should have appropriate versatile psychoeducation resources which are culturally sensitive and accessible to all patients.

Broader national social and economic policy changes in Aotearoa New Zealand may be the key to enhancing income adequacy. UBI, WINZ support, tax relief, housing initiatives, educational reform, healthcare prevention and intervention, and health campaigns collectively have the potential to reduce risk factors of cognitive impairment caused by modifiable lifestyle experiences. The aforementioned recommendations seek to look beyond New Zealanders' survival and ensure their basic needs are met so New Zealanders can flourish. Implementing these recommendations seeks to alleviate stress that stems from a lack of adequate income and adverse consequences for brain health. It also seeks to promote early detection of cognitive impairment or decline, reduce health disparities through improved access to healthcare, and create more awareness of cognitive function.

6.10 Future Research

While this thesis provides valuable insights into the association between income adequacy and cognitive function, the aforementioned recommendations highlight the need for further research in this area. Moving forward, future research should consider the effects of societal and technological advancement since 2010 to ensure research is relevant to the current Aotearoa New Zealand societal context. Whilst this study has contributed to reducing a current gap in Aotearoa New Zealand literature, future research is required to address the limitations of the current research. Future research contributions specific to income adequacy and cognitive function within Aotearoa New Zealand will promote healthier ageing for New Zealanders.

A longitudinal study into the relationship between income adequacy upon cognitive function in older Aotearoa New Zealand adults would enhance the quality of the present cross-sectional study. This is because it would look at multiple data points over a long period of time using repeated measures. Multiple data points would allow researchers to examine causal relationships within the data, track trends and patterns over time, identify individual or group differences, modifiable risk factors and improve the reliability of the study. Anomalies or specific changes in an individual's circumstances may not be accurately reflected in the results from one data point. An example of this might be a recent divorce, separation of assets, on-going effects of economic recessions, or pandemics that have recently. This information would prevent short-sighted policies from being implemented and allow for a more targeted approach to income adequacy and cognitive function. Ideally, a longitudinal study may provide further insights into the influence of income adequacy on cognitive functioning throughout childhood, adolescence, midlife, and older age. These benefits could be used to inform public health campaigns and policy changes. Potential drawbacks of a longitudinal study could be the intensity of resources required to maintain the longitudinal study. These drawbacks could manifest as time-consuming, expensive, dropout rate, complexity of the data set, and the generalizability of the data set. These challenges could be mitigated using pilot studies, funding opportunities, careful data collection and analytic techniques, rapport building, frequent contact, regular incentives, flexible data collection, imputation to account for missing data, utilisation of statistical software, diverse sampling, and utilisation of control variables. Implementation of one or more of these techniques in combination with each other can mitigate potential challenges raised and ensure the reliability and validity of future findings. A longitudinal study may also increase the generalisability of the findings to the wider Aotearoa New Zealand population. Through addressing these challenges, the longitudinal design will be more effective in the exploration of causal relationships over time. Understanding lifelong factors may allow policymakers, community workers, and healthcare professionals to provide targeted prevention and intervention strategies for cognitive functioning.

Future research may also look into different measures used to analyse income adequacy for greater context about the relationship between income adequacy and cognitive function. While this thesis looks at a single self-rating item to reflect income adequacy, there are many avenues which may support the quantification of income adequacy in daily living. This information may provide researchers with further information about participants individual circumstances of income adequacy. These trends or patterns might provide a nuanced understanding of New Zealander's experience of income adequacy. The findings of future research may allow researchers to draw conclusions on specific material items which have the most impact on the study population's self-rated income adequacy levels. This information would be crucial to the development of social, economic, and health policies within Aotearoa New Zealand.

As New Zealand’s societal expectations shift it is important to capture the broader context of demographic characteristics and living conditions within the data. The aforementioned limitations in the present study highlight several gaps in the data. These gaps will continue to grow as younger generations age. Therefore, it is important Aotearoa New Zealand tracks these demographic and lifestyle trends over time. Tracking quantitative and qualitative shifts in education levels, marital status, employment status, and area-based socioeconomic deprivation level would allow researchers to understand the broader context of living conditions. The combination of quantitative and qualitative data would allow researchers to create targeted policies and interventions for income adequacy and cognitive function for New Zealanders. Further analysis of education should consider the quality of education, modality of learning, and level of educational attainment. Exploring these layers of New Zealanders' educational attainment would allow researchers to explore how specific educational experiences may relate to income adequacy for cognitive function. Due to recent shifts away from traditional modalities and approaches to delivering education due to technological advances and natural events. Gathering quantitative and qualitative data may provide valuable insights across the life span for future Aotearoa New Zealand generations. Additionally, unpacking generational changes within marital status would allow researchers to better understand cohabitation that occurs for New Zealanders outside of marriage. This would allow researchers to unpack how this looks on income adequacy across New Zealander's lifespans. Additionally, understanding different modalities of employment within a modern context. Such as working from home, hybrid working, working within the community, and working in an office would allow researchers to hone into how employment modalities may affect income adequacy and its relationship with cognitive function over time. It would also allow researchers to unpack the relationship physical labour jobs versus office jobs may have with income adequacy for cognitive function over time. Furthermore, area-based socioeconomic deprivation levels need further investigation within future research for researchers to understand changes over the last few decades. Significant societal shifts due to economic recession and global pandemics may have affected current area-based socioeconomic deprivation levels. These shifts may have caused 2010 area-based socioeconomic deprivation levels to hold less relevancy in a modern-day Aotearoa New Zealand context. However, this data provides an important baseline for researchers to draw comparisons from.

6.11 Conclusions

The thesis makes a novel contribution by showing that income adequacy is associated with cognitive functioning in older adults, in that having at least enough income is linked to higher cognitive functioning. While there has been international research conducted to investigate the relationship between income adequacy and cognitive functioning, there is limited research within Aotearoa New Zealand. Thus, this thesis is addressing a research gap. Income adequacy may explain some variance in cognitive functioning within an older Aotearoa New Zealand population, and thus may constitute one of many potentially modifiable factors for brain health. This is important as lower cognitive functioning is linked to the risk of developing dementia and loss of independence in older age. Loss of independence later in life has a significant impact on one's ability to actively participate in life. Inadequate income, i.e. not having enough income to cover basic needs, may impact the ability to retain meaningful relationships and engage in activities people enjoy. A reduction in participation in life can lead to lower cognitive functioning and a reduction in quality of life for those in older age. This can lead to poorer health outcomes and reduce life expectancy.

Sociodemographic characteristics and living conditions were found to be associated with positive outcomes for both income adequacy and cognitive functioning. Notably, age was significantly associated with decreased cognitive functioning in older adults, aligning with previous research and suggesting New Zealanders often experience progressive decline in cognitive performance with age. Gender differences were observed, with women performing better cognitively than men. Education levels were positively associated with cognitive functioning, indicating that higher educational attainment may serve as a protective factor against cognitive decline in later life. Ethnic disparities were evident, with non-Māori individuals showing higher cognitive functioning, potentially due to greater access to resources and opportunities. Living conditions, particularly low area-based socioeconomic deprivation, were associated with better cognitive functioning, reinforcing the role income adequacy has in cognitive health for older New Zealanders.

These findings provide foundational insights into income adequacy in relation to cognitive functioning in older adults. Further research, particularly longitudinal insights, are needed to underscore the findings and translate them into effective strategies that can contribute to promoting brain health in all New Zealanders.

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Appendices

Search Strategy

Local Search

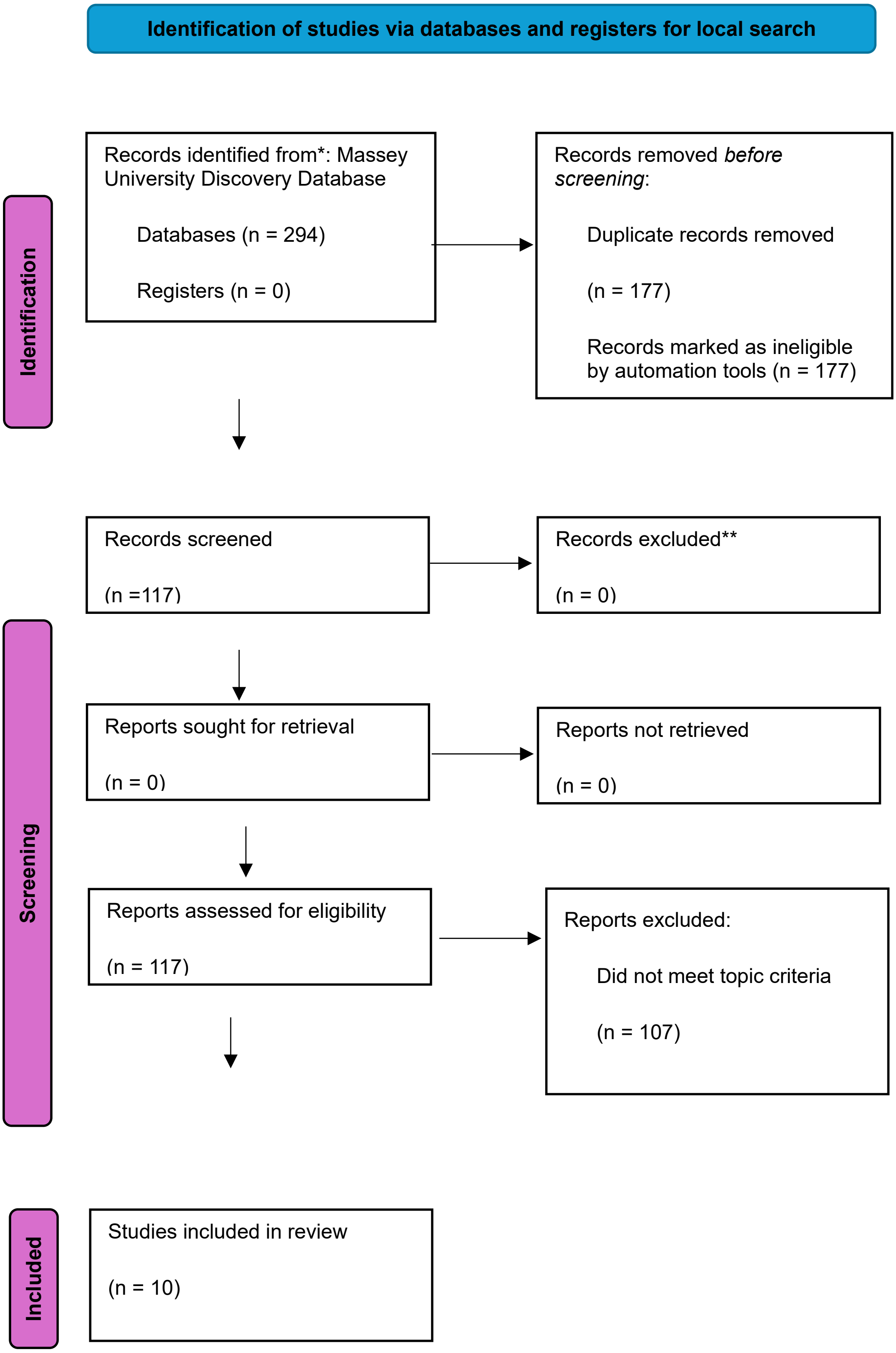
The following characteristics were utilised within the inclusion criteria to ensure relevance to this research: “cognitive*”, “mental*”, “intellectual*”, “abilit*”, “declin*”, “function*”, “impair*”, "low socioeconomic", "low socio-economic", "low income*", “socioeconomic*”, “socio-economic*”, “poverty”, “income*”, "standard* of living", "living standard*", “wealth*”, “elderly”, "older people", "older adult*", “senior citizen*”, “very old”, “old age”, "over 65", ">65", “65 years”, “65+ years”, “zealand*”, and “aotearoa*”.

Global Search

A similar process was employed for the global search. However, the following characteristics were utilised within the global search’s inclusion criteria “cognitive*”, “mental*”, “intellectual*”, “abilit*”, “declin*”, “function*”, “impair*”, "living standard*", “poverty”, "standard* of living", "low socioeconomic", "low socio-economic", "low income*",elderly "older people", "older adult*", “senior citizen*”, “very old”, “old age” "over 65", ">65", “65 years”, and “65+ years”.

PRISMA 2020 Searches

PRIMSA 2020 Local Search



Prisma global search