Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

Health outcomes associated with nutrition risk in community living older adults in the New Zealand Health, Work and Retirement Study.

A thesis presented in partial fulfillment of the requirement for the degree of

Master of Science in Nutrition and Dietetics

at Massey University, Auckland, New Zealand.

Jade Nicole Curnow

2021

Abstract

Background: The New Zealand population is ageing as life expectancy increases and birth rates decline. Adequate nutrition is vital to increase years lived in good health and decrease health care spending. Previous research indicates 49% of Māori and 38% of Non-Māori living in the NZ community are at a degree of nutrition risk. Understanding the long- term outcomes of nutrition-risk is vital to reduce healthcare spending. This study aims to determine four-year outcomes of community-living older adults who were identified as being at 'malnutrition risk' in the 2014 Health, Work and Retirement Study.

Methods: This study reflects a pre-post, secondary analysis of existing longitudinal data. A total of 1471 community-living older adults aged 49-87 responded to the 2014 and 2018 postal survey in the Health, Work Retirement study (HWR). Nutrition risk was assessed using the validated Seniors in the Community: Risk Evaluation for Eating and Nutrition, abbreviated version (SCREENII-AB) sent by postal survey in 2014. Other measures including demographic, social and health characteristics were included. Physical and mental functioning and overall health-related quality of life was assessed using the 12-item Short Form Health Survey (SF-12v2). Depression was assessed using the verified shortened 10 item Center for Epidemiologic Studies Depression Scale (CES-D-10). Social provisions were determined with the 24-item Social Provisions Scale. Alcohol intake was determined by using the Alcohol Use Disorders Identification Test (AUDIT-C).

Results: A third **(**33.9%) of participants were at nutritional risk (SCREEN II-AB score ≤38). The direct effects of nutrition risk showed that significant differences between at-risk and not-at-risk groups at baseline remained at follow up. Over time, physical health scores and hazardous alcohol use reduced. Mental health improved over time for at-risk, whilst it remained static for the not-at-risk group. Time had non-significant interactions and small effects on all other indicators.

Conclusions: The distinctions between the at-risk and not-at-risk groups remained the same and were not resolved with the passage of time, the only caveat being mental health which improved. The results of this study suggest that dietitians and other health professionals need to target their interventions immediately because these will not change.

For Janette Valerie Smyth

Nana, thank you for always being by my side, through sickness and health.

1937 - 2020

Acknowledgements

Throughout this thesis writing, I have received a large amount of assistance and support, without whom motivation would have been lost.

I would first like to thank my supervisors, Associate Professor Carol Wham and Dr Andy Towers, for their patient support, breadth of knowledge and invaluable expertise.

The HWR team for allowing me to be a part of this research, and the participants of the study for putting in the time to fill out and return both the 2014 and 2018 questionnaires.

To my close family and friends. Thank you for encouraging me, supporting me, and still loving me I whilst battled through arguably my hardest years yet.

Lastly, to my mum, for always being a pillar of support, come hell or high water. Your wise counsel and sympathetic ear is invaluable.

Table of Contents

Abstract *1*

Acknowledgements *3*

List of Tables *6*

List of Figures *7*

List of Appendices *8*

List of Abbreviations *9*

Chapter 1: Introduction, Aims and Objectives *10*

1.1 Introduction **10**

1.2.1 Aims 13

1.2.2 Objectives 13

1.2.3 Hypothesis 13

1.2 Aims and Objectives **13**

1.3 Thesis Structure **13**

1.4 Researcher's contributions **14**

Chapter 2: Literature Review *15*

Older adults are a population at risk of malnutrition **15**

The importance of nutrition **15**

Screening for nutrition in older adults **16**

The SCREENII **17**

Why malnutrition is a problem for older adults **21**

The key health and social covariates of malnutrition affect **22**

What we still need to explore concerning malnutrition and older adults **26**

Chapter 3: Research Manuscript *28*

Abstract: **28**

Key words: **28**

Introduction **29**

Methods **31**

Study design 31
Participants and recruitment 31
Ethical statement 31
Measures 32
Statistical analysis 34
Exploring the baseline differences. 36
Exploring differences between baseline and four- year follow-up. 37
..... 39
Assessing statistically significant change 39
Differences between nutrition risk groups 41
Changes across time 43
Interaction of nutrition risk and time on health outcomes 45
Results **35**
Discussion **41**
Chapter 4: Conclusion and Recommendations ***47***
4.1 Brief overview **47**
4.2 Contribution to health **47**
4.3 Strengths **48**
4.3 Limitations **48**
4.5 Recommendations for further research **49**
Bibliography ***50***
Appendices ***60***
Appendix 1: Previous nutrition risk research amongst community-living older adults **60**
Appendix 2: Health outcome scores for nutrition-risk and not-at risk-groups in 2014 and 2018. ..... **62**

List of Tables

Chapter 2

Table 1: malnutrition

Chapter 3

Table 1: Participants' sociodemographic characteristics categorised by nutrition risk in 2014.

Table 2: Key outcome measure scores of at-risk and not at-risk groups in 2014.

List of Figures

Chapter 3

Figure 1: Physical Health Estimated Marginal Means

Figure 2: Mental Health Estimated Marginal Means

Figure 3: Depression Estimated Marginal Means

Figure 4: Hazardous Drinking Estimated Marginal Means

Figure 5: Attachment Estimated Marginal Means

Figure 6: Social Integration Estimated Marginal Means

List of Appendices

Appendix 1: Previous nutrition risk research amongst community-living older adults.

Appendix 2: Health outcome scores for nutrition-risk and not-at risk-groups in 2014 and 2018.

List of Abbreviations

Abbreviation	Definition
BMI	Body Mass Index
BMR	Basal Metabolic Rate
DALY	Daily Adjusted Life Year
LiLACS NZ	Life and Living in Advanced Age: a Cohort Study in New Zealand
HWR	Health, Work and Retirement
NZ	New Zealand
NZANS	New Zealand Adult Nutrition Survey
MNA-SF	Mini Nutritional Assessment Short Form
MUST	Malnutrition Universal Screening Tool
OR	Odds Ratio
SCREENI	Seniors in the Community; Risk Evaluation for Eating and Nutrition, version I
SCREENII	Seniors in the Community; Risk Evaluation for Eating and Nutrition, version II
SCREENII-AB	Seniors in the Community; Risk Evaluation for Eating and Nutrition, version II, Abbreviated Version
WHO	World Health Organisation
GDS	Geriatric Depression Scale

Chapter 1: Introduction, Aims and Objectives

1.1 Introduction

Like the rest of the developed world, the New Zealand (NZ) population is ageing (Statistics New Zealand 2017). Although life expectancy is increasing, the quality of life is not. NZ health surveys have reported a reduction of 2% in older adults reporting their health to be 'good, very good or excellent' (Ministry of Health 2019), and found one quarter of each older adults life is likely to be in poor health (Ministry of Health 2016). The segment of life most likely to be lived in poor health is 75+ years (Ministry of Health 2016). This age group only makes up 6.2% of NZ's older population (Statistics New Zealand 2018) but are responsible for 42% of funding for health services (Statistics New Zealand 2013) and 58% of the overall one-third of the disability-adjusted life years (DALYs), which older adults account for (Ministry of Health 2016).

The leading causes of health loss in NZ older adults are cancers, cardiovascular disorders, and musculoskeletal disorders, followed by complex chronic lung, liver, and kidney diseases (Ministry of Health 2016). However, diet acts as the leading cause of health loss, accounting for 9.4% of DALYs (Ministry of Health 2016). By 80 years of age, average food intake has decreased by 30% (Chapman 2004). This decrease in food intake leaves older adults at a high risk of reduced lean muscle, bone mass, cognitive decline, low immunity, slow wound and illness recovery and overall increased mortality risk (Chapman 2004, Nowson 2007). A prolonged decrease in food intake leading to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease is defined as Malnutrition (Cederholm 2017).

Early identification of malnutrition improves individual health outcomes and reduces healthcare spending. Malnourished patients have higher healthcare usage and expenditure and cost 47% more than well-nourished patients (Martínez-Reig 2017). There are three main tools which have been validated and are accurate when used in a community setting; Mini Nutritional Assessment Short-form (MNA-SF), Malnutrition Universal Screening Tool (MUST) and Seniors in the Community Risk Evaluation for Eating and Nutrition (SCREEN II) (Phillips 2010). The Seniors in the Community Risk Evaluation for Eating and Nutrition (SCREENII) screening tool is a validated questionnaire designed to assess malnutrition risk in a community setting (Keller 2005). When this tool was validated, 90% of the individuals

which SCREENII indicated as being at high nutrition risk were actually at high nutrition risk (Keller 2005).

There have been multiple studies using SCREENII in NZ to identify older adult's malnutrition risk. A study with 937 participants found 49% of Māori were at malnutrition risk whilst 38% of non-Māori were at risk (Wham 2015). A Christchurch-based study of 152 older adults found 54% of participants were at nutrition risk (Watson 2010), and a North Island study found 52% of their 108 participants were at high nutrition risk (Wham 2011). These concerning statistics continue throughout the literature and is having an impact on individuals likelihood of successful ageing (Wham 2011, McElnay 2012, Wham 2015). In western cultures, successful ageing is commonly attributed to being healthy (Amin 2017). Healthy ageing includes both physical and social determinants, for example, adequate physical function, life satisfaction and wellbeing, personal development and growth, inclusion in social support networks, participation within communities and self-reported successful ageing, as well as low physical and cognitive decline (Strawbridge 2002, Bowling 2006, Ouwehand 2007, Cosco 2013, Cosco 2014, Rowe 2015).

Mental illness and depression are health areas that affect all ages and all population groups, and prevalence in the NZ population increases. In the 2018 NZ health survey, 8.6% of adults reported experiencing psychological stress recently, a 1% increase from the 2016/17 survey and a 2% increase from 2006/2007 (Ministry of Health 2019). The relationship between malnutrition risk and emotional problems is strong, and there are associations both ways; malnutrition risk contributes to mental illness development, and mental illnesses contribute to malnutrition risk (Naseer 2015)(Appendix 1).

Often, mental illness is exacerbated by loneliness or improved through social connections. However, increased nutrition risk is consistently associated with loneliness (Ramic 2011, Tomstad 2012, Tomstad 2017). Social connections are a vital element in life, specifically for older adults. So much so that having successful social connections is strongly associated with the individual feeling successfully aged (Amin 2017). However, successful ageing's intricate relationships with health outcomes continue as social connections are harder to maintain when community-dwelling older adults have poor physical health.

Physical health can be both a cause and an outcome of nutrition risk in older adults. Physical factors include; low energy, decreased muscle mass, sarcopenia and frailty (Leonel 2017). Malnutrition risk in older adults directly correlates to the inability to stand from a chair five times unaided(Sutton 2016). Furthermore, fractured bones through increased fall risk are much more likely in older adults who identify as malnourished than those who are not (Chien 2014, Trajkov 2018). Fractured bones and reduced muscle mass create lower levels of function (Firebaugh 2018). This reduced physical function is likely to have a negative impact on mental health like depression and anxiety (Guitierrez 2016).

One in five community-dwelling NZ older adults have a hazardous alcohol intake (Wham, Teh et al. 2011). However, there is a paucity of research on older adults alcohol use concerning malnutrition. A single study analysing alcohol use and malnutrition in older adults found that hazardous alcohol use increases parallel with malnutrition risk (Wham, Teh et al. 2011). However, some conflicting studies within the literature suggest that drinking frequency does not change when malnutrition is prevalent (Mathew, Das et al. 2016, Streicher, van Zwienen-Pot et al. 2018, O'Keeffe, Kelly et al. 2019). Whilst others conclude alcohol consumption increases (Damayanthi, Moy et al. 2018). We must understand the relationship between alcohol use and nutrition risk in older adults, as both are prevalent in our community and have adverse health outcomes.

From the current research, we can see that those at nutrition risk are typically worse off in mental health, physical health, and depression, while the relationship with alcohol use remains debatable. There are multiple complex relationships between nutrition risk and health outcomes. However, there is currently no longitudinal research in NZ showing what occurs with these relationships long term compared to a well-nourished group. Thus, to determine if malnutrition risk predisposes community-dwelling older adults to more negative health co-morbidities over time, a longitudinal cohort study is necessary.

1.2 Aims and Objectives

1.2.1 Aims

To determine four-year health-related outcomes of community-living older adults who were identified as being at 'malnutrition risk' in the 2014 Health, Work and Retirement Study.

1.2.2 Objectives

To identify the four-year outcomes of malnutrition risk on:

self-reported physical health

- self-reported mental health

self-rated depression

- social connectedness (e.g social integration, attachment).
- hazardous alcohol use.

1.2.3 Hypothesis

That low quality of life, low physical and mental health, high rates of depression, increased hazardous alcohol use and decreased social connectedness are associated with malnutrition risk in community living older adults.

1.3 Thesis Structure

This thesis begins with an introduction and overview in Chapter One, with a literature review in Chapter Two. This begins with an assessment of the health of older adults in New Zealand, including a discussion of the potential outcomes of nutrition risk. Chapter Three is the thesis manuscript formatted for the Journal of Nutrition, Health and Ageing including results for nutrition risk prevalence and associated factors. Chapter Four concludes the research and includes recommendations, including postulations as to how the findings of this thesis may benefit policy makers.

1.4 Researcher's contributions

Researcher	Contributions
Jade Curnow	Student researcher. Researched and prepared literature review, analysed data, and prepared thesis manuscript including tabulating results and forming discussion and recommendations.
A/Prof Carol Wham	Dr. Wham provided the study concept, proofread and gave feedback on the literature review and thesis manuscript.
Dr. Andy Towers	A senior research officer on the HWR study. Dr. Towers proofread and gave feedback on the literature review and thesis manuscript and provided statistical guidance regarding SPSS use and syntax creation.

Chapter 2: Literature Review

Older adults are a population at risk of malnutrition

Our population is rapidly changing as New Zealanders live longer and have less children (Statistics New Zealand 2017). The New Zealand (NZ) older adult population has nearly doubled since 1981 (Statistics New Zealand 2013), and the 60 - 80 age group is expected to double again between 2013 and 2050 (Kowal 2014). Within the same time frame, the 80+ population may increase by up to 220% (Kowal 2014).

Not only is the life expectancy of New Zealanders increasing, but the gender gap in life expectancy has also decreased (Ministry of Health 2016). However, we must question if life is being enhanced by the extra years gained. The updated NZ health survey reported a reduction of 2% in older adults reporting their health to be 'good, very good or excellent' (Ministry of Health 2019). Recent statistics showed one-quarter of each older person's life is likely to be in ill health (Ministry of Health 2016). This reduction of good health negatively impacts the individual and their families whilst creating an increasing financial and resource burden on the health care system. The population most likely to live in poor health is those aged 75+ years (Ministry of Health 2016). This age group only makes up 6.2% of NZ's older population (Statistics New Zealand 2018) but are responsible for 42% of funding for health services (Statistics New Zealand 2013) and 58% of the overall one-third of the Disability-Adjusted Life Years (DALYs), which older adults account for (Ministry of Health 2016). DALYs are a measure of years lost due to premature death from disease or condition, including the years lived with a disability. One DALY is representative of the loss of a single year of full health (World Health Organistion 2021).

The importance of nutrition

From a direct nutrition perspective, inadequate fruit and vegetable intake accounts for 2.5% of DALYs, whilst high sodium intake accounts for 1.3% (Ministry of Health 2016). However, when looking within specific risk factors, diet acts as the leading cause of health loss, accounting for 9.4% of DALYs. This suggests that many chronic conditions causing increased DALYs in NZ older adults can be prevented or minimized through adequate nutrition. However, within the older adult population, there is often an imbalance between nutrients required for healthy ageing and nutrients consumed, leaving many older adults with micronutrient deficiencies and malnutrition risk (Nowson 2007). Nutrient Reference Values

(NRV's) for protein, riboflavin, vitamin B6, vitamin D and calcium are higher in the older age groups (Ministry of Health 2005). However, by 80 years of age, average food intake has decreased by 30% (Chapman 2004). This decrease in nutrient intake leaves older adults at a high risk of reduced lean muscle, bone mass, cognitive decline, low immunity, slow wound and illness recovery and overall increased mortality risk (Chapman 2004, Nowson 2007). Furthermore, many of these illnesses and anabolic resistance result in reduced independence and need for care in residential homes, often resulting in older adults being at even higher nutrition risk (Greacen 2014).

Malnutrition is a state which can be functional or a result of disease. The European Society for Parenteral and Enteral Nutrition (ESPEN) defines malnutrition as "a state resulting from lack of intake or uptake of nutrition that leads to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease" (Cederholm 2017). The ESPEN guidelines provide two alternative sets of diagnostic criteria for malnutrition. Firstly, a body mass index (BMI) <18.5 kg/m2 in accordance with the underweight definition provided by WHO. Alternatively, the combined finding of weight loss (mandatory), and at least one of either reduced BMI (using age-dependent cut-offs), or reduced gender-dependent fat-free mass index (FFMI).

Screening for nutrition in older adults

Early detection of nutrition-risk can lower the impact on the individual and the health system. Malnourished patients have higher healthcare usage and expenditure and cost 47% more than well-nourished patients (Martínez-Reig 2017). Many tools are currently available for screening. Body Mass Index (BMI) uses weight and height to calculate if a person is underweight, a healthy weight, overweight, or obese. However, there are many significant limitations to using BMI as a sole marker for weight assessment, mainly because it does not take a person's muscle mass into account (Willis 2017). Although a BMI calculation is easy, it can only contribute to an overall nutrition risk assessment and cannot be used as a sole indicator. Thus, a variety of nutrition screening tools have been created to predict a person's malnutrition risk accurately.

There are three main tools which have been validated and are accurate when used in a community setting; Mini Nutritional Assessment Short-form (MNA-SF), Malnutrition

Universal Screening Tool (MUST) and Seniors in the Community Risk Evaluation for Eating and Nutrition (SCREEN II) (Phillips 2010). The MNA-SF screening tool can identify malnutrition successfully and identify six-month outcomes, although the accuracy of their predictions can be low (Dent 2014). Low predictions is due to the MNA-SF being unable to associate a higher risk of poor outcomes with malnutrition risk (Dent 2014). However, when the MNA-SF is used to identify if a person is at risk of undernutrition, it does so accurately (De La Montana 2011). But, it is best followed up by the full MNA to ensure specificity and confirmation of risk (De La Montana 2011). The MUST tool shows a high sensitivity to malnutrition risk (Tripathy 2015). However, it relies only on body composition and food intake and requires a trained administrator (Tripathy 2015).

The SCREENII

The Seniors in the Community Risk Evaluation for Eating and Nutrition (SCREENII) screening tool is a validated questionnaire designed specifically to assess malnutrition risk in a community setting (Keller 2005). It is a self-administered 14 item questionnaire that examines food security/access, social environments, dietary intake and anthropometry to give an overall score that assesses an individual's risk of nutrition using a point system. An abbreviated version, SCREENII-AB was developed by ranking the 14 items in SCREENII for prediction of nutrition risk and deducing them to eightmain items through regression. The eightmain items to predict nutrition risk in SCREENII AB are change in weight, skipping meals, appetite/satiety, swallowing ability, servings of fruit and vegetables, intake of fluid, social mealtimes and meal preparation (Keller 2005). Each item is scored between 0-8, with the maximum score being 48, and scores <38 signifying nutrition risk. SCREENII-AB was validated using a dietetian (Keller 2005) which included biochemical tests, anthropometric measures and three 24-hour Multiple Pass Recalls (MPRs). The dietetic assessment resulted in a score from one (low nutrition risk) to ten (high nutrition risk). These scores were then compared to the participants SCREENII and SCREENII-AB scores (Keller 2005). It was found 90% of the individuals indicated by SCREENII-AB as being at high nutrition risk were assessed to be at high nutrition risk by a dietetian assessment (Keller 2005). SCREENII-AB is reliable, valid, and was deemed to be the most appropriate tool to be incorporated into a postal questionnaire for older community-dwelling adults.

There have been multiple studies using SCREENII in NZ to identify older adult's malnutrition risk. A study with 937 participants found 49% Māori were at malnutrition risk whilst 38% of non-Māori were at risk (Wham 2015). A Christchurch study of 152 older adults found 54% of participants were at risk (Watson 2010), and a North island study found 52% of their 108 participants were at high nutrition risk (Wham 2011). These worrying statistics of a high proportion of our community-dwelling older adults continue (Wham 2011, McElnay 2012, Wham 2015).

Malnutrition risk is an important stage of the malnutrition continuum. Like many states of health, it is crucial to identify when a person is at risk. In the 2015 LILACS NZ study, 49% of Māori and 38% of non-Māori who were community-dwelling were identified by SCREENII as being at high nutrition risk (Wham 2015). This study was only able to include data from individuals who can complete the form individually. Due to this, underestimation is exceptionally likely as many of those who are unable to read and write independently are also likely to be unable to prepare/cook their food. This indicates the extremely high prevalence of older adults at high nutrition risk within the NZ community (Wham 2015).

The following table (Table One) provides an overview of previous studies reporting the prevalence of nutrition-risk among community-dwelling older adults in New Zealand.

Table One: Previous nutrition risk research amongst community-living older adults in New Zealand

Study Author (et al 200x)	**Location**	**Study design**	**Participants**	**N**	**Mean age (years)**	**Nutrition Risk (%)**	**Tool**
(Wham 2014)	New Zealand	Randomised controlled trial.	Community-dwelling older adults	3480	>75 (over 65 if Māori)	62 %	Australian Nutrition Screening Initiative (AnSi).
(Wham 2015)	New Zealand (north Island only)	Cross sectional analysis LiLACS NZ	Community-dwelling older adults	937	85	49% of Māori 38% of Non-Māori	SCREENII
(Chatindiara 2018)	New Zealand	Cross sectional	Community-dwelling older adults	257	79	12%	MNA-SF
(Watson 2010)	New Zealand (Christchurch)		Community-dwelling older adults	152	70+	31.0% at high nutrition risk 23.0% at nutrition risk	SCREENII
(Wham 2011)	North island	Cross sectional analysis of a longitudinal cohort study	Community-dwelling older adults	108	Māori: 75-79 years Non Māori: 85+	52% at high nutrition risk	SCREENII

(Wham 2011)	New Zealand (Auckland)	Cross sectional analysis of a longitudinal cohort study	Community-dwelling older adults	51	80-85	31% high nutrition risk	SCREENII
(McElnay 2012)	New Zealand (Hawkes bay)	Cross sectional analysis of a longitudinal cohort study	Community-dwelling older adults	473	65+	32.8% at high nutrition risk 23.7% nutrition risk	SCREEN II
(Wham 2014)	New Zealand (Bay of plenty)	Cross sectional analysis of a longitudinal cohort study	Community-dwelling older adults	45	85-86	62% at a degree of nutrition risk	ANSI
(Wham 2015)	Bay of plenty and lakes region	Cross sectional analysis of a longitudinal cohort study	Community-dwelling older adults	655	Māori: 82.3 Non Māori: 84.6	49% of Māori 38% of Non-Māori	SCREENII

Why malnutrition is a problem for older adults

Malnutrition is a state where the person is not receiving all of the necessary nutrients. The body uses these nutrients to fight infections, diseases and carry out daily biological functions (Sutton 2016). Being in a state of malnutrition creates consequences for both the individual and the health system.

For the individual at nutrition risk, this can mean they are at higher risk of infection, cardiovascular disease, coronary heart failure, cardiogenic shock, cardiac arrest, acute kidney failure, acute respiratory failure, need for mechanical ventilation and overall mortality (Adejumo 2019) (Bajaj 2014, Cornia 2019) (Ringaitiene 2015, Clark 2018) (Agarwal 2018, Morris 2018, Wei 2018). Health-Related Quality of life (HRQoL) is a crucial factor for successful ageing in the final years of our older adult's lives. A study that analysed effects of chronic conditions on HRQOL within 2000 community-dwelling older adults found; 71.1% had a loss of mobility, 88.7% loss of self-care, 79.4% were unable to do their usual activities, 53.2% were in pain/discomfort, and 72.6% experienced anxiety/depression (Guitierrez 2016). The onset of these diseases alone will likely result in hospitalisation, but hospitalisation becomes extended when the person is also malnourished. Those who are malnourished have a longer length of hospital stay and a higher institutionalisation rate than those who were not malnourished (Kirushnan 2017, O'Shea 2017). In any context of illness, the literature agrees that malnutrition averagely results in a 3.41-day extended length of stay (LOS) compared to well-nourished older adults (Jean-Claude 2012, Kirushnan 2017, Adejumo 2019). Not only are malnourished patients single stays much longer, but general malnourishment is also a significant predictor of unplanned re-admission to a hospital within 30 days of discharge (Mogensen 2017). Re-admission into hospitals impacts the individual and puts increasing stress on the health care system and creates increased expenditures. Furthermore, repeated admissions and increased LOS can lead to decreased muscle strength, poor functional improvement and an a further increased risk of pneumonia and other communicable diseases (Shen 2011). This circularity leads to further increased dependence and healthcare reliance in a hospital setting and once discharged into the community.

The current literature indicates malnutrition risk in unwell, older adult populations directly correlates with increased length of stay in hospitals, increased rate of unplanned readmission, decreased independence once discharged, and an overall increased mortality rate than those

in a well-nourished state. This impacts the individual and, consequently, creates further financial and resource burden for the DHB's and families as care requirements increase.

The key health and social covariates of malnutrition affect

It is imperative that, with increasing years of life, comes increasing life in years. To enable this, we need to understand what enhances life quality for older adults and how successful ageing can be obtained. Public health initiatives define successful ageing as older adults residing within the community who are living well, ageing well and feel respected. However, successful ageing is defined differently within individuals, culture, beliefs, upbringing, goals, family and social networks. For example, Bangladeshi culture sees successful ageing as co-residing with extended family and caring for their age-related diseases (Amin 2017). Whereas successful ageing in western cultures is more commonly defined by the absence of disease and longevity of life (Amin 2017). Healthy ageing includes, but is not limited to; adequate physiologic state, life satisfaction and wellbeing, personal development and growth, inclusion in social support networks, participation within communities and self-reported successful ageing, as well as low physical and cognitive decline (Strawbridge 2002, Bowling 2006, Ouwehand 2007, Cosco 2013, Cosco 2014, Rowe 2015). The current study will look at how malnutrition outcomes affect aspects of successful ageing by looking at the following proxies: Physical health, Mental health, Depression, Social connectedness (loneliness, social integration) and Hazardous drinking.

The current literature discusses a wide range of key health outcomes that malnutrition can affect in older adults. The risk factors identified can be separated into two main groups: social/environmental factors and mental and physical health factors.

Physical Health Outcomes of Nutrition Risk

Malnutrition leads to altered body composition, which has adverse effects on physiological function (Chang 2017). For example, older adults at nutrition-risk have an increased falls risk and fracture risk to not-at-risk (Chien 2014, Trajkov 2018). This reduced physiological function can impact the ability to carry out normal Activities of Daily Living (ADL) and reduce overall independence. ADL include things such as grocery shopping, cooking, gardening and socialising (Naseer 2015). This can leave our older adults relying on meal services to provide meals. However, the lack of quality from these food services has also

been identified as an individual risk factor for malnutrition (Craven 2018). Whilst both well nourishment and ADL independence are individually important factors in health-related quality of life when coexisting, they are stronger. Well nourishment and independence in ADL show a higher survival rate together (83.4%) than ADL independence (80.8%) and well nourishment (76.6%) do separately (Naseer 2015) (Appendix 1). Thus, indicating the importance of maintaining mobility through good nutrition to increase older adults' quality of life. The current literature suggests malnourished older adults are highly dependent on family, carers and the healthcare system. Linking nutrition risk with increased dependency levels and health costs will emphasise the need for malnutrition screening and prevention within our communities.

Current literature suggests that physical factors which our older adults at risk of malnutrition are the same as physical outcomes from malnutrition. Physical factors which put older adults at malnutrition risk include; low energy, decreased muscle mass, sarcopenia and frailty (Leonel 2017). These physical risk factors for malnutrition all affect an individual's independence and ability to buy, prepare, and cook foods for themselves. It has even been suggested that functional limitations in older adults may have a larger impact on nutritional risk than chronological age (Wham 2015). As we can see, malnutrition risk factors compound to make an outcome of malnutrition almost inevitable.

Recent NZ based literature indicates good nutrition is a crucial modifiable factor that may help to maintain independence, consequently increasing HRQoL (Wham 2015). However, this is a cyclical relationship as it has been identified that women with a lower HRQoL have a high nutrition risk (Wham 2015). The conditions that were found to correlate with the most significant decrease in HRQoL were those that affect an individual's independence, cognitive and functional impairment, and the diseases that are highly symptomatic and cause joint and respiratory issues (Guitierrez 2016). This is one of the most extensive studies to analyse how health affects community-dwelling older adults' quality of life. This study highlights that loss of independence is the primary cause of decreased HRQoL. Thus, to increase HRQoL, the focus must be on maintaining older adult's independence through nutrition to keep them within the community and feeling successfully aged.

Social Health Outcomes of Nutrition Risk

Mental illness is an area of health that affects all ages and all population groups, and prevalence in the NZ population is increasing. The relationship between malnutrition risk and overarching emotional problems is substantial. There are associations both ways; malnutrition risk contributes to mental illness development, and mental illnesses contribute to malnutrition risk (Naseer 2015). Mental illness and, more specifically, depression are severe health issues in older adults due to the populations increased predisposition to risk factors, i.e. living alone, health loss, loss of loved ones, cognitive decline and malnutrition (Trajkov 2018). In the 2018 NZ health survey, 8.6% of adults reported experiencing psychological stress recently, which is a 1% increase from the 2016/17 survey and a 2% increase from 2006/2007 (Ministry of Health 2019). Malnutrition risk contributes to mental illness development through both specific and direct pathways and indirect pathways. For example, malnutrition risk has been suggested to directly increase the likelihood and severity of older adults developing dementia due to various micronutrient deficiencies (Naseer 2015) (Appendix1). However, less specifically, malnutrition risk indirectly affects mental health as those suffering also usually have reduced strength, independence and mobility, which are all factors increasing the likelihood of depression (Guitierrez 2016). There is currently only one study linking nutrition risk (identified through a verified screening tool) and depression. The study found life satisfaction in older adults is positively associated with the mini nutrition assessment nutritional score and inversely related to the GDS depression score (Ghimire 2018) (Appendix 1). Thus, indicating life satisfaction declines as nutrition and health status decrease (Ghimire 2018). Other links made between nutrition risk and depression/anxiety in older adults have been found through increased depression being associated with the physical outcomes of malnutrition, i.e. difficulties standing up from a chair or extending the arms (Guitierrez 2016).

There is a lack of evidence as to whether malnutrition in older adults is directly correlated with negative mental health outcomes, or if these simultaneous outcomes are due to disease-related impairments in disease-specific populations. For example, among over 2500 adults over the age of 50 years living throughout Australia a study found that poor food security and low diet quality were associated with a decline in mental health (Russel 2016) (Appendix 1). However, combining a multitude of other factors, the decreased mental health in these participants was predicted to be due to the stress and social implications malnutrition has on

the individuals QoL rather than the nutritional state directly (Russel 2016). However, one recent disease-specific cohort study has mitigated disease-specific burden and has suggested the malnourished patients in their study were more likely to experience poor mental health and overall decreased QoL than well-nourished patients (Preis 2018). This study was the first of its kind to suggest the negative impact malnutrition has on mental health and QoL may be directly related to poor nutrition status (Preis 2018). Thus, the impact malnutrition risk has on social connectedness will be investigated to determine the impact on mental health.

The literature currently indicates that in older adults, strength and mobility leading to a lack of independence due to nutrition risk can be directly related to our older adults depression score and their impression of successful ageing (Altun 2015, Trajkov 2018). The link between under-nutrition and increased depression scores needs to be directly analysed to fill an important gap in the research which may show that depression may be a preventable disease though correct nutrition.

Loneliness is often experienced in older adults and can be described as feeling disconnected and emotionally isolated (Tomstad 2017). This feeling is a shared burden for older adults as they are exposed to many predisposing factors, for example, loss of a loved one, living alone, reduction in social activities and independence (Dahlberg 2015, Tomstad 2017). When interviewed, older adults do not report health conditions as factors that affect loneliness (Tomstad 2017). However, research has found the quality of health is one of the most important factors correlated with loneliness in community-dwelling older adults (Eloranta 2015). Other factors such as helplessness, reduced activity and need for a carer are not associated with loneliness (Tomstad 2017). However, increased nutrition risk has been associated as an outcome of loneliness many times (Ramic 2011, Tomstad 2012, Tomstad 2017). This appears to be due to the typical eating behaviours being a social event, meal times being a reminder of social isolation, and food being less palatable when eating alone (Tomstad 2012). Much of the research has also identified the inverse relationship of loneliness resulting in reduced food intake and consequently malnutrition (Ramic 2011). Sufferers of malnutrition often have reduced mobility and the ability to leave the house to socialise. This, combined with the lack of appetite often seen in malnourished people, collaborates to increasing loneliness due to malnutrition (Ramic 2011). The strong

relationship between nutrition risk and loneliness in the current literature indicates correlation; however, causation is yet to be determined.

While alcohol intake is commonly attributed to adverse health outcomes, the older adult population may experience some regular consumption benefits. Longitudinal studies completed with community-dwelling older adults have suggested that those who regularly consume alcohol had lower rates of depression (Hodge, Almeida et al. 2013) and had a higher overall health-related quality of life (Kaplan, Huguet et al. 2012). However, those who had more periodic bursts of binge drinking (more than nine drinks in a session) were found to have adverse health outcomes long term (Kaplan, Huguet et al. 2012). More recently, it has been suggested that socioeconomic status plays a key role in these "health benefits" attributed to moderate alcohol consumption (Towers, Philipp et al. 2018). Furthermore, a ten year study on community-dwelling older adults in NZ categorised drinkers into five categories (Szabó, Towers et al. 2021). They found either end of the extremes of drinking (moderately frequent, heavy drinkers, and infrequent, low quantity consumers) were more likely associated with poor health. Whereas "frequent and moderately frequent, low drinking" was associated with better health (Szabó, Towers et al. 2021). There is limited, conflicting messages on older adult's alcohol use in relation to malnutrition. Some studies suggest that drinking frequency does not change when malnutrition is prevalent (Mathew, Das et al. 2016, Streicher, van Zwienen-Pot et al. 2018, O'Keeffe, Kelly et al. 2019). Whilst others conclude alcohol consumption increases (Damayanthi, Moy et al. 2018). One New Zealand study, which analysed a community-dwelling population aged 74-85, found hazardous alcohol use increases parallel with malnutrition risk (Wham, Teh et al. 2011). This is concerning as those who are malnourished are already experiencing reduced health outcomes, and hazardous drinking in older adults is more likely to have adverse health effects due to increased alcohol-related comorbidities (Moore, Whiteman et al. 2007). Hazardous drinking is prevalent in 20% of 55-64-year-olds and 16% of 65-74-year-olds residing in NZ; thus, understanding the relationship alcohol has with varying prominent health conditions is essential.

What we still need to explore concerning malnutrition and older adults

From these studies, we can see that the literature comprehensively agrees that older adults at malnutrition risk are typically worse off in physical health and mental health. Furthermore, the current studies agree older adults at nutrition-risk are likely to have higher rates of

depression and loneliness than those who are not-at-risk. The relationship between hazardous drinking and nutrition-risk remains under debate. However, most of this existing research looks at cross-sectional data. None of the existing studies has researched the difference in health outcomes over time in older adults who are at-risk and not-at-risk.

A longitudinal analysis of the health and social outcomes of malnutrition is necessary to assess if the clear and present differences that exist between those at-risk of malnutrition and those not at risk get better or worse across time. If these outcomes deteriorate over time, it will be apparent that health professionals need to intervene as soon as possible to reduce malnutrition, as it leads to compounding factors if it continues. Suppose we find the differences between the groups get better over time. In that case, this indicates that health professionals can relax and not intervene because time seems to reduce the issues' urgency. If the differences between the two groups remain the same across time (not better, but not worse) then this is a good indication that time does not heal all wounds and we need to intervene with malnourished older adults as soon as we identify this as an issue.

Chapter 3: Research Manuscript

MALNUTRITION RISK: FOUR YEAR OUTCOMES FROM THE HEALTH, WORK AND RETIREMENT STUDY 2014 TO 2018

J.N. CURNOW, A.J. TOWERS, C.A WHAM,

Corresponding Author: C. Wham, School of Sport, Exercise and Nutrition, College of Health, Massey University, Albany Campus, Private Bag 102904, North Shore Mail Centre, Auckland 105, New Zealand. Email: c.a.wham@massey.ac.nz

Abstract:

Objectives: To determine four-year outcomes of community-living older adults who were identified as being at 'malnutrition risk' in the 2014 Health, Work and Retirement Study. Design: A longitudinal analysis of the 2014 and 2018 HWR cohort. Setting: New Zealand Participants: 1471 adults aged 49-87. Measurements: Nutrition risk was assessed using the validated Seniors in the Community: Risk Evaluation for Eating and Nutrition, abbreviated version (SCREENII-AB) by postal survey. Other measures included demographic, social and health characteristics. Physical and mental functioning and overall health-related quality of life was assessed using the 12-item Short Form Health Survey (SF-12v2). Depression was assessed using the verified shortened 10 item Center for Epidemiologic Studies Depression Scale (CES-D-10). Social provisions were determined with the 24-item Social Provisions Scale. Alcohol intake was determined by using the Alcohol Use Disorders Identification Test (AUDIT-C). Results: A third (33.9%) of the participants were at nutritional risk (SCREEN II-AB score ≤38). The direct effects of nutrition risk showed that significant differences between at-risk and not-at-risk groups at baseline remained at follow up. Over time, physical health scores an alcohol use scores reduced. Mental health improved over time for at-risk, whilst it remains static for the not-at-risk group. Time had non-significant interactions and small effects on all other indicators. Conclusion: The distinctions between the at-risk and not-at-risk groups remained the same and were not resolved with the passage of time, the only caveat being mental health. This highlights the importance of screening in primary care for targeted interventions because risk factors remain stable over time.

Key words: Nutrition risk outcomes, New Zealand, older adults, community

Introduction

Following worldwide trends, New Zealand is experiencing population ageing (Ministry of Health 2019). Both mortality and birth rates are declining, leading to an increasing older adult population. The New Zealand (NZ) older adult population has nearly doubled since 1981 (Statistics New Zealand 2013) and the 60 - 80 age group is expected to double again between 2013 and 2050 (Kowal 2014). However, declining mortality does not mean increased years of good quality life. Recent statistics showed men are living 80% of their life in good health, whilst women are only living 74% in good health (Ministry of Health 2016).

There is often an imbalance of nutrients required for healthy ageing and nutrients consumed, leaving many older adults with micronutrient deficiencies and at nutrition risk (Nowson 2007). Nutrient Reference Values (NRV's) for protein, riboflavin, vitamin B6, vitamin D and calcium are higher in the older age groups (Ministry of Health 2005. However, by 80 years of age average food intake has decreased by 30% (Chapman 2004). This decrease in nutrient intake leaves older adults at a high risk of reduced lean muscle, bone mass, cognitive decline, low immunity, slow wound and illness recovery and overall increased mortality risk (Chapman 2004, Nowson 2007). Early intervention in the malnutrition continuum through early screening may reduce negative consequences in the individual and healthcare spending.

The Seniors in the Community Risk Evaluation for Eating and Nutrition (SCREENII) tool is a validated questionnaire designed specifically to assess malnutrition risk in a community setting (Keller 2005). It is a self-administered 14 item questionnaire which examines food security/access, social environments, dietary intake, and anthropometry to give an overall score which assesses an individual's risk of nutrition. It uses a point system is used to identify those who are at high risk (<50 points), moderate risk (50 – 53 points) and low risk (>54) of malnutrition risk (Keller 2005). When this tool was validated, 90% of the individuals which SCREENII indicated as being at high nutrition risk, were at high nutrition risk (Keller 2005).

A multitude of studies in have used SCREENII in the community to investigate the prevalence of nutrition risk in NZ older adults. These studies have found between 31%-54% of community-dwelling older adults to be at some degree of moderate to high nutrition risk (Watson 2010, Wham 2011, McElnay 2012, Wham 2015). Whilst these studies investigate nutrition status and health related issues, none of them look at the long-term outcomes of

nutrition risk. The aim of this paper is to investigate the outcomes of nutrition risk in community dwelling older adults living in New Zealand.

Methods

Study design

This longitudinal cohort study used data from the 2014 and 2018 collections of the Health, Work and Retirement Study (HWR). The HWR study is a government-funded study established in 2006 to examine community-dwelling, healthy-ageing in older adults in New Zealand via a postal survey. The 2014 wave of data collection additionally evaluated nutrition status using SCREENII-AB. The results of the SCREENII-AB were then used to quantify participants nutrition risk. In 2018, the postal survey was sent to the participants again.

The study aim was to compare the four-year social and health-related outcomes among community-living older adults identified at malnutrition risk versus those not at malnutrition risk in the 2014 Health, Work and Retirement Study.

Participants and recruitment

As part of the Health, Work and Retirement Study participant recruitment was undertaken using equal probability random sampling from the 2006 electoral roll. The baseline for the current study was in 2014 when an enlargement of the participant pool occurred, using methods identical to the initial recruitment. Exclusion criteria were inability to contact, institutionalisation, or being deceased (Towers et al., 2015). The 2014 recruitment included an expanded age range (49 to 87) to ensure the population sample remained representative of the 50+ New Zealand population (Towers et al., 2015). Oversampling of Māori participants increased the likelihood of a more representative population sample and was based on the Māori-descent indicator on the electoral roll. This study excluded participants if they had not completed the SCREENII-AB nutrition assessment in the 2014 postal survey. The total number of participants in the current study was 2405 at baseline, with 1471 participants included in the 2018 four year follow up.

Ethical statement

The study was approved by the Massey University Human Ethics Committee (MUHEC) as a Low-Risk Research Project.

Measures

Demographic characteristics: We identified participants age through self-reported birth date. Key sociodemographic characteristics were categorised based on response to survey questions i.e., gender (male/female/gender diverse), marital status (partnered/unpartnered), education qualifications (None/secondary/post-secondary), household composition (living alone/living with others) and residential description (standalone or detached/joined to one or more other household/unit-or-villa in a retirement village/other including moveable dwelling, or rest home).

Physical and Mental Health: Participants completed a physical and mental functioning assessment using the 12-item Short-Form Health Survey (SF-12v2) (Ware et al., 2002). The SF-12 is a short version of the SF36 comprised of eight subscales and results in two Component Summary Scores, one for Physical health (PCS) and the other for Mental health (MCS) (Frieling 2013). The SF-12 has 12 questionnaire items and is scored and weighted to give an overall maximum score of 100 (Ware et al., 2002) with both PCS and MCS scores. Scores lower than 40 indicate poor health, whilst scores above 60 indicate perceived reasonable and better health (Ware et al., 2002). The SF-12 short-form version has been validated and is considered a reliable questionnaire in community-dwelling older adult populations worldwide, including China and the USA (Shu-Wen and Dong 2019, Shah and Brown 2020).

Depression: Respondent's depression was assessed using the verified shortened 10 item Center for Epidemiologic Studies Depression Scale (CES-D-10) (Anderson et al., 1994). This self-rated survey asks participants how often in the past week they have experienced symptoms of depression and loneliness. Scores range from 0-30, with any score above or equal to 10 indicating depression. This measure has been validated for community-dwelling older adults as sensitive and specific, and no discrimination in gender, race, ethnicity or education level (Irwin, Artin et al. 1999, Lee and Chokkanathan 2008, O'Halloran, Kenny et al. 2014, Malakouti, Pachana et al. 2015, Mohebbi, Nguyen et al. 2018).

Hazardous alcohol use: The WHO Alcohol Use Disorders Identification Test – Consumption sub-scale (AUDIT-C): (Bush, Kivlahan, McDonell, Fihn, & Bradley, 1998) was used to assess participant hazardous drinking with an added item 'Have you ever drunk alcohol in the

past?' to define lifetime non-drinkers from non-drinkers with a history of consumption. The classifications for alcohol consumption were lifetime abstainer, current non-drinker, light drinker (AUDIT-C score: 0-3), moderate drinker (AUDIT-C score: 4-7), and heavy drinker (AUDIT-C score: 8-12). Hazardous alcohol use was defined as an audit-C score of 8 or more. There is a lack of commonality in the scoring thresholds for the AUDIT C tool and it may overestimate hazardous drinking by 33% when used as a standard threshold for older adults (Towers, Stephens et al. 2011). . This must be kept in mind when interpreting the results from this study. The tool is best used as a screening tool for further screening as it is brief, easy to administrate, and produces generally sensitive results for screening for hazardous alcohol use in community dwelling older adults (Stewart, Hewitt et al. 2020).

Social Connectedness: Participants social provisions were assessed using the 24 item Social provisions scale (Cutrona and Russell 1987). This survey assesses the perceived existence of meaningful social connectedness and support using six main sub-scales, social integration, attachment, opportunity for nurturance, reassurance of worth, reliable alliance and guidance. Total scores range from 24 to 96, with higher scores indicating a more heightened perceived sense of social support. For the purpose of this study, the items "attachment" and "social integration" have been drawn from the scale to analyse older adults' sense of belonging and meaningful relationships, rather than overall social provisions (which also integrates social services and health care). The "attachment" subscale is analysed as and referred to as "loneliness" throughout this study. Each subscale has four items: two worded positively and two worded negatively, with each response having a weighted score. For example, a positive statement to assess loneliness is "I feel a strong emotional bond with at least one other person", and a negative statement is "I feel that I do not have close personal relationships with other people". A positive statement for social integration is "I feel part of a group of people who share my attitudes and beliefs" whilst a negative statement is "There is no one who shares my interests and concerns" (Cutrona and Russell 1987). Each statement is graded from one to four, one being "strongly disagree" and four being "strongly agree" (Cutrona and Russell 1987). The scores of the four statements for each subscale are added to analyse the individuals score for that subscale and can range from 4 to 16 (Cutrona and Russell 1987). The social provisions scale has been used worldwide and is recognised as an easy to use, reliable, and valid tool to assess social connectedness (Zaki 2009, Chiu, Motl et al. 2016).

Nutrition status: The 2014 HWR survey assessed participant nutrition status using the abbreviated Seniors in the Community Risk Evaluation for Eating and Nutrition questionnaire (SCREENII-AB) (Keller, Goy et al. 2005). The SCREENII-AB is self-administered and specifically designed for use amongst community dwelling older adults (Keller, Goy et al. 2005). The 8-item questionnaire assesses participant appetite, dysphagia, fruit and vegetable servings, fluid intake, meal sharing, meal preparation, meal skipping and weight change giving a score from 0-48. Scores below and equal to 38 indicate nutrition risk and scores above 38 deem an individual not at risk (Keller, Goy et al. 2005).

Statistical analysis

This study used IBM SPSS statistics (v21 for Mac) to analyse the data. Descriptive statistics described the following variables: age group, gender, relationship status, educational qualifications, household composition, residence type and malnutrition risk status (Table I).
Firstly, baseline differences were explored between the risk groups. Nutrition risk (SCREENII-AB) was categorised as not-at-risk (>38), and at-risk (≤38). Scale scores for SF-12 physical health, SF-12 mental health, CES-D, AUDIT C and items from Social Provisions were displayed as means for those at-risk and those not-at-risk. P values were used, and a Cohens d efficient was calculated to test for significant difference using a t-test (Table II).

Secondly, differences between 2014 data and 2018 data were explored for each scale score. Means and standard deviations for key outcome measures were calculated for at-risk and not-at-risk groups for 2014 and 2018 and displayed in graphs (figures 1-6).

Finally, outcome measures were analysed using separate repeated-measures multivariate analyses of variance (RM-MANOVAs) to assess statistical difference. The RM-MANOVA investigated the main effect of Time (two levels: 2014 vs 2018) and the interaction effect of being at nutrition risk (two levels: at risk vs not at risk) by Time (or Nutrition Risk*Time) on the outcomes of being at nutrition risk, which was indicated by four outcomes (i.e., SF-12 physical health, SF-12 mental health, CES-D, AUDIT C, social provisions subscale scores) (Table IV)

Results

An overview of the participants' sociodemographic characteristics categorised by nutrition risk status for men and women in 2014 HWR is provided in Table 1. From the survey, 2405 completed SCREENII-AB. Of the participants, 44.3% were men, 76.2% were partnered, and most (87.2%) lived in a standalone or detached house. Many participants (80.9%) lived with others: either a partner, child(ren), grandchild(ren), flatmate or boarder.

Overall, 33.9% of the participants were at nutritional risk (SCREEN II-AB score ≤38). The mean SCREEN II-AB score was 39.4, and women (36.77%) had a higher proportion of nutrition risk than men (30.17%). An overview of the participant's sociodemographic characteristics can be seen in Table I.

Table 1. Participants' sociodemographic characteristics categorised by nutrition risk in 2014.

	All **n = 2405**	**At-risk (SCREENII-AB<38) n = 782 (33.9%)**	**Not at-risk (SCREENII-AB ≥38) n = 1528 (66.1%)**
Age (49-87) years M (SD)	66 (6.2)	65.8 (6.3)	66.2 (6.1)
Sex			
Male	1066 (44.3%)	308 (39.4%)	713 (46.7%)
Female	1339 (55.7%)	474 (60.4%)	815 (53.3%)
Ethnicity			
NZ European	1598 (71%)	459 (60.2%)	1139 (76.6%)
Māori	537 (23.9%)	252 (33%)	285 (19.1%)
Other	115 (5.1%)	52 (6.8%)	63 (4.2%)
Marital status			
Partnered	1805 (76.2%)	486 (63.4%)	1249 (82.9%)
Un- partnered	564 (23.8%)	281 (36.6%)	258 (17.1%)
Education			
No qualifications	500 (27.1%)	207 (27%)	257 (17%)
Secondary school	528 (28.6%)	169 (22.1%)	345 (22.9%)
Post-secondary	819 (44.3%)	390 (50.9%)	907 (60.1%)
Household composition			
Living alone	546 (19.1%)	200 (26.2%)	218 (14.4%)
Living with others	2315 (80.9%)	563 (73.8%)	1291 (85.6%)
Residence type			
Standalone or detached	2045 (87.2%)	641(86.3%)	1332 (90.5%)
Joined to one or more other household	207 (8.8%)	82 (11%)	112 (7.6%)
Unit/villa in a Retirement village	38 (1.6%)	12 (1.6%)	23 (1.9%)

Other including moveable dwelling, or rest home	56 (2.3%)	8 (0.54%)	5 (0.3%)
Hospital usage in 12 months			
Yes	811 (36.1%)	315 (41.4%)	496 (33.3%)
No	1438 (63.9%)	445 (58.6 %)	993 (66.7%)

SCREEN II-AB, Seniors in the Community: Risk Evaluation for Eating and Nutrition, Version II, abbreviated

Values are count (percent); Missing data: Percentages may not always add up to 100% for each column as there is missing data for approximately 4.6% of subjects across various questions/sub sections within the 2014 HWR questionnaire.

Exploring the baseline differences.

This section of results compares baseline differences between at-risk and not at-risk on key outcome measures. This will be done for each key outcome measures in turn. Table 2 outlines the key outcome measure scores at baseline (2014).

Table 2. Key outcome measure scores of at-risk and not at-risk groups in 2014.

	Scale scores		
	2014		
Health variables	**At-risk (SCREENII-AB<38) n = 782 (33.9%)** Mean (SD)	**Not at-risk (SCREENII-AB ≥38) n = 1528 (66.1%)** Mean (SD)	**Test for significant difference**
SF-12 Physical health	42.94 (11.06)	48.56 (8.27)	t=13.05; p=<0.001; d=0.61
SF-12 Mental health	46.25 (11.29)	52.29 (8.05)	t=14.09; p=<0.001; d=0.65
Depression	8.05 (5.15)	4.65 (3.80)	t=17.56; p=<0.001; d=0.79
Hazardous Alcohol use	3.37 (2.42)	3.57 (2.06)	t=1.81; p=0.07; d=0.09
Social Connections			
Attachment	12.67 (2.35)	13.76 (2.09)	t=11.34; p= <0.001; d=0.50
Social Integration	12.7 (1.92)	13.6 (1.79)	t=10.93; p=<0.001; d=0.49

SCREEN II-AB, Seniors in the Community: Risk Evaluation for Eating and Nutrition, Version II, abbreviated, SF-12, 12-item Short Form Health Survey.

Significant differences between the 2 nutritional risk groups as determined by Independent samples t-Test (2-tailed)

Cohen's *d* values around 0.2 indicate a small effect size, values around 0.5 indicate a medium effect size, and values around 0.8 indicate a large effect size.

Codes: p=<0.05 = significant difference d= effect size

At baseline, those who were at nutrition-risk had poorer scores for SF-12 physical and mental health than those not-at-risk (p=<0.001; d=0.61; p=<0.001; d=0.65) (Table 2). This group were also found to have higher depression scores (p=<0.001, d= 0.61) (Table 2). Cohens d result indicates that the differences in physical and mental health, and depression between the risk groups, had a medium effect.

In 2014, neither groups alcohol use was scored as hazardous (at-risk 3.37, not-at-risk 3.57). There was no significant difference in hazardous alcohol use at baseline between the nutrition-risk and not-at-risk groups (p=0.07) (Table 2). This null effect is supported by a very low Cohens d co-efficient. At baseline, the at-risk group had lower scores for social connections than the not-at-risk group (p=>0.001) (Table 2). Specifically, both "attachment" and "social integration" scores were significantly higher for not-at-risk than for at-risk, with medium effect sizes.

Exploring differences between baseline and four- year follow-up.

The difference between baseline scores and follow up scores for those participants who were categorised in 2014 as (a) at-risk and (b) not-at-risk for malnutrition were assessed. We did not explore change over time in risk categorisation; instead, the intent was to understand the chronic outcomes of malnutrition categorisation in 2014. Figures 1 to 6 illustrate change over time for at-risk and not-at-risk groups for each of the key outcome measures.

Over the four year follow up period, the nutrition-risk group scores for SF-12 physical health showed an overall deterioration (Table 2, figures 1, 5 & 6, Appendix 2). The SF-12 mental health scores increased over the four year follow up (Figure 2). Similarly, the not-at-risk group depression scores had increased, whilst the at-risk group scores remained similar to baseline (Figure 3).

The at-risk group hazardous drinking dropped marginally from baseline to follow up, whilst the not-at-risk group scores dropped more considerably over the 4 years. Over the four year follow up, both Attachment and Social Integration marginal means remained parallel between the at-risk and not-at-risk groups (Figures 5 & 6, Appendix 2).

Figure 1:

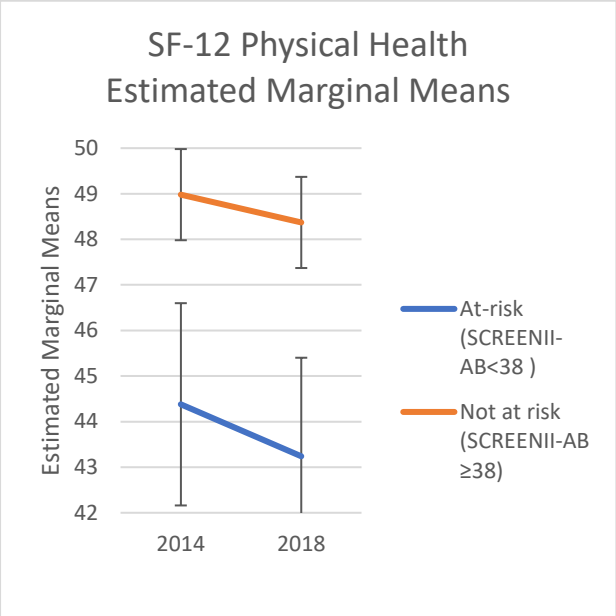


Figure 2:

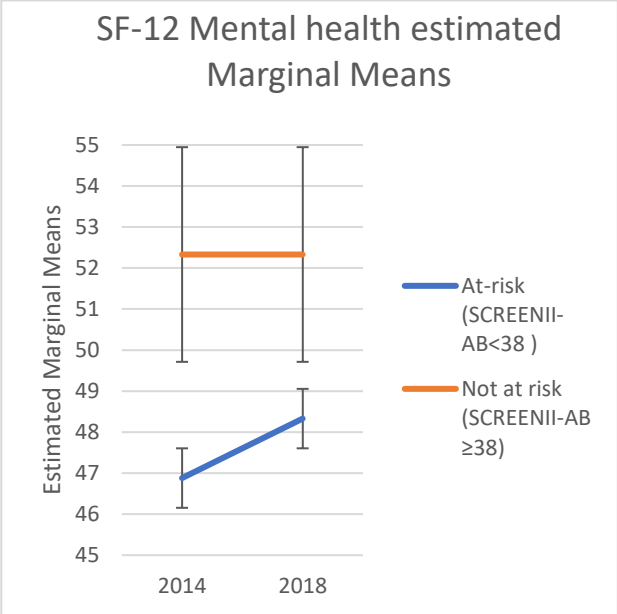


Figure 3:

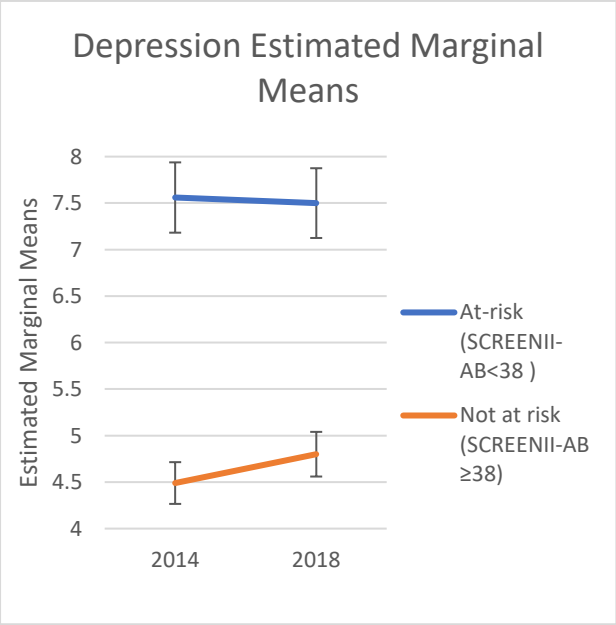


Figure 4:

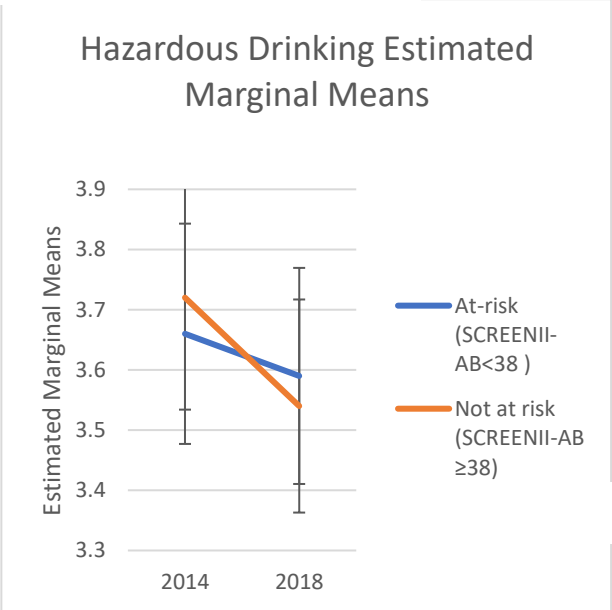


Figure 5:

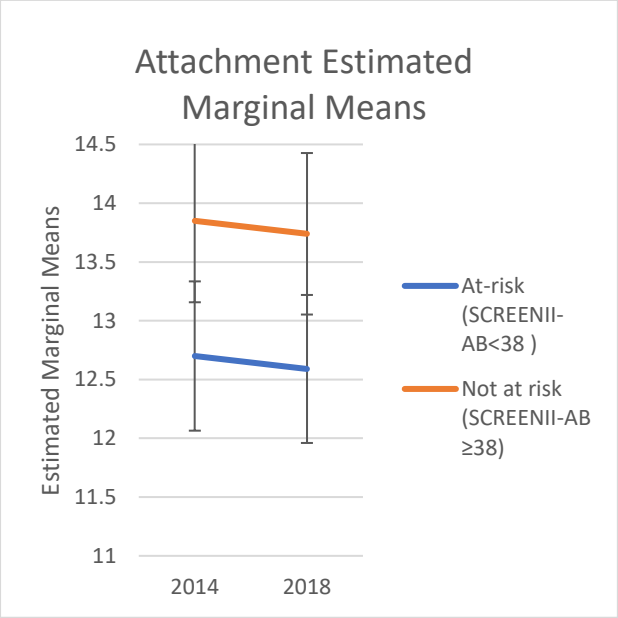
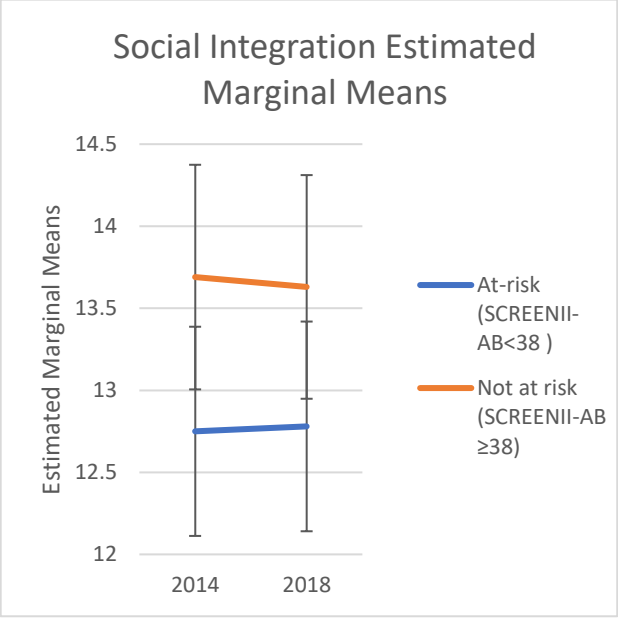


Figure 6:



Assessing statistically significant change

Whilst Figures 1-6 suggest a significant change in sub-scores over time and differential effects for nutrition risk groups, it wasessential to assess if these differences were significantly different.

An RM-MANOVA was undertaken to assess the differences in key scores between baseline and outcome for these two groups. This analysis explored the effect of time (baseline to follow up), nutrition risk (at-risk and not-at-risk) and the potential interaction between time and nutrition risk. The results of this analysis are presented in Table 3.

First, the direct effects of nutrition risk showed that significant differences between at-risk and not-at-risk groups at baseline remained at follow up. Second, the direct effect of time showed a significant change in the scores for SF-12 Physical health, SF-12 Mental Health and hazardous alcohol use. Over time, physical health scores and hazardous alcohol use scores reduced, and mental health scores increased. Further, effect size indicators suggested the difference in physical health and mental health between nutrition risk groups was large. Third, there was a significant time*nutrition risk interaction effect on SF-12 mental health and non-significant interactions and small effects on all other indicators (Table 3). Specifically, while mental health increased over time for not-at-risk, it remained static for the at-risk group.

Table 3. Univariate main and interaction effects: nutrition risk

Effect	**Univariate Outcome**	***N***	***df***	***F***	***p***	$\eta^2 p$
Time	SF-12 Physical health	1471	1, 1469	13.65	<0.001	0.009
	SF-12 Mental health	1471	1, 1469	8.14	0.004	0.006
	Depression	1471	1, 1469	1.195	0.275	0.001
	Hazardous Alcohol use	1471	1, 1469	12.08	0.001	0.008
	Attachment	1471	1, 1469	4.23	0.40	0.003
	Social Integration	1471	1, 1469	0.14	0.712	<0.001
Nutrition risk	SF-12 Physical health	1471	1, 1469	106.03	<0.001	0.67
	SF-12 Mental health	1471	1, 1469	112.43	<0.001	0.71
	Depression	1471	1, 1469	174.36	<0.001	0.106
	Hazardous Alcohol use	1471	1, 1469	0.004	0.952	<0.001
	Attachment	1471	1, 1469	113.52	<0.001	0.072
	Social Integration	1471	1, 1469	93.52	<0.001	0.06
Time*nutrition risk	SF-12 Physical health	1471	1, 1469	1.26	0.263	0.001
	SF-12 Mental health	1471	1, 1469	8.19	0.004	0.006
	Depression	1471	1, 1469	2.65	0.104	0.002
	Hazardous Alcohol use	1471	1, 1469	2.66	0.103	0.002
	Attachment	1471	1, 1469	0.008	0.929	<0.001
	Social Integration	1471	1, 1469	0.79	0.374	0.001

Discussion

This study explored whether people who are at-risk or not-at-risk for malnutrition differed in key health outcomes and whether these differences persisted over time. Specifically, it was hypothesised that low physical and mental health, high rates of depression, increased hazardous alcohol use and decreased social connectedness are associated with malnutrition risk in community-living older adults. Results of the current study support some of these hypotheses, but not all.

Differences between nutrition risk groups

Overall, at baseline and in the main analysis, the results highlight a difference between risk groups for every health indicator, except hazardous drinking.

Our 2014 data showed a difference in physical health between those at risk of malnutrition and those not-at-risk, with the at-risk having worse self-reported physical health. This finding reflects similar research in older adults using exactly the same measures of health in Australia (Craven, Pelly et al. 2018), Singapore (Yap, Niti et al. 2007), Sweden (Naseer and Fagerström 2015) and Taiwan (Wang, Liang et al. 2019). An Australian study found that participants SF-12 physical health scores independently accounted for 8.6% of the SCREEN II scores variance(Craven, Pelly et al. 2018). Similarly, a New Zealand cohort found that lower physical health-related quality of life is independently associated with community-dwelling older adults being at risk of malnutrition (Wham, Teh et al. 2015). These studies are associating poor physical health with malnutrition risk. However, their cross-sectional analysis makes it unclear if the relationship causes nutrition risk or if physical health is an outcome of nutrition risk. This lack of clarity in the relationship was common in the literature and makes this study unique as we explore these findings over time.

The baseline in the current study showed that the at-risk group had worse self-reported physical health and had significantly worse self-reported mental health. Once again, studies worldwide using the same measures as the current study agree that older adults at nutrition risk have lower self-reported mental health (Naseer and Fagerström 2015, Craven, Pelly et al. 2018) than not-at-risk groups. A recent cohort study found participants with worse nutrition scores had overall worse mental health and life satisfaction (Ghimire, 2018) which supports

the finding in the current study of the observed association between nutrition risk and poorer self-reported mental health.

As hypothesised, the 2014 data showed both social connections' subscales as worse for the at-risk group than the not-at-risk group. There is a lack of literature exploring this relationship using the same tool as the current study. However, there have been many links made in older adults between social isolation and malnutrition risk. A Lebanese study found 71% of older adults suffering from poor nutritional status reported social loneliness and isolation (Boulos, Salameh et al. 2017). Interestingly, there was no statistical significance between the frequency of sharing meals and malnutrition risk. This suggests social support comes in many forms, and even when looking at malnutrition risk, social support, in general, is essential, not only at mealtimes. This study's findings were supported by other extensive studies with similarly aged cohorts in Montreal (Karen, Christina et al. 2007) and the Netherlands (Schilp 2011). Controversially, a study conducted in the USA found no direct relationship between loneliness and nutritional status (Jung, Bishop et al. 2017). However, they did find a significant direct relationship between loneliness and depression, which was negatively related to nutritional status.

The hypothesis of increased alcohol use for the at-risk nutrition group was not supported. The baseline showed there was no significant difference in drinking between groups. Understanding our results of older adults drinking and nutrition risk is complex for a multitude of reasons. Firstly, there is not much research on older adults drinking, and what there is often focuses on acute drinking issues like misuse and dependence (Graham and Schmidt 1999, Sorocco and Ferrell 2006, Towers, Sheridan et al. 2017). Secondly, within the literature that does exist on alcohol and older adults, there is not much research on drinking and nutrition risk. However, two of the few studies which analysed alcohol usage and nutrition risk found a statistical difference between nutrition risk groups. Both studies agreed that those who are at nutrition risk are more likely to have light alcohol use (drink less than four times a week) than those who are not at malnutrition risk (Schilp 2011, Wham, Teh et al, 2015). This is not only different to our baseline findings, but it is also contradictory to our hypothesis. In this respect, this is one of the first studies to explore this in-depth.

Depression in older adults is, unfortunately, a common occurrence. We hypothesised that baseline depression would be more prevalent in those at malnutrition risk than that not-at-risk. The findings of the current study supported this hypothesis. This finding is widely supported throughout the world in similar studies with community-dwelling older adults. Depressive symptoms were higher in those at malnutrition risk in Japan (Yoshimura, Yamada et al. 2013), Singapore (Yap, Niti et al. 2007), Taiwan (Wang, Liang et al. 2019) and New Zealand (Wham, Teh et al. 2015). Although many of these studies used the Geriatric Depression Scale (GDS), this has the same specificity and sensitivity to the CES-D used in this study (Lyness, Noel et al. 1997). Thus, it is safe to compare results although scales are different. It has been found up to an 80% increase in depression scores in older adults at malnutrition risk compared to those not at risk (Wang, Liang et al. 2019). Although being at risk of malnutrition is strongly associated with depression, studies conclude that this relationship is heavily influenced by age as an additional factor (Yoshimura, Yamada et al. 2013). Thus, it is vital to keep this in mind as we analyse the changes over time.

In summary, the results of this study illustrate that there are fundamental differences in current health status between older adults who are at risk of malnutrition and those who are not. Specifically, those at risk of malnutrition consistently have poorer self-reported physical health, mental health and social connections. They also have higher rates of hazardous drinking and higher depression scores. These results suggest that nutritionists and other health professionals working with older adults should understand that those at risk of malnutrition are also at risk of other health conditions affecting their quality of life, alcohol use and reduced social connections. Thus, health professionals' interventions not only should address malnutrition but any other contributing factors and conditions.

Changes across time

Overall, the current study results showed that changes across time in health outcomes only occurred for physical health, mental health, and hazardous alcohol use. Our research shows that the baseline difference of self-reported physical health between the risks groups persists over time and the difference between at-risk and not at-risk actually increases. This is a unique finding, given that there was a paucity of research exploring this relationship over time. One longitudinal study completed in Canada found the only statistically significant outcome of nutrition risk over one year follow up was self-rated physical health, which

decreased over time in the at risk group. (Karen, Christina et al. 2007). Two large scale studies on community-dwelling older adults also found that those at nutrition risk are more likely to have lower self-rated physical health than those who are not-at risk (Johansson, Bachrach-Lindstrom et al. 2009, Schilp 2011).

Time has an unexpected effect on the groups in our study. We hypothesised that mental health would get worse over time for both groups; however, the results of the current study did not support this. The current research found the not-at-risk groups mental health remain the same as it was at baseline. Meanwhile, the at-risk groups' mental health improved at follow up. These results were unexpected, and there is not enough literature to interpret these findings adequately. For example, a Canadian longitudinal study explored mental health and nutrition risk over 12 months in community-dwelling older adults. Their participant's mental health remained stagnant, like our not-at-risk groups, at the one year follow up (Karen, Christina et al. 2007). However, they did not find the increase that we saw in the at-risk group. We cannot be sure if the Canadian study would have eventually seen an increase in mental health like ours did if the study had been over a longer period. Thus, this research is unique to its kind and more would need to be done to determine the reasons as to why the at-risk group does not get worse over time but in fact, improves.

Social connectedness (i.e. measures of loneliness and attachment) were both worse for the at-risk group over time than the not at-risk group in this study. Further, the gap between the two nutrition risk groups did not change over time. Further, the gap between the two nutrition risk groups did not change across time. This indicates that the passage of time does not alter the level of social connectedness between these two groups. This finding is supported by a large study with a similar population, which found the level of satisfaction in social support over a one year follow up remained the same for both groups (Karen, Christina et al. 2007).

There is currently a paucity of literature not only the relationship between malnutrition and hazardous drinking but also in longitudinal studies. The most comparable study is looking at the effect hazardous drinking has on the incidence of malnutrition longitudinally, rather than the effects malnutrition has on hazardous drinking. Similar results to this study were found; that no alcohol use was associated with malnutrition, whereas light alcohol use was not (Johansson, Bachrach-Lindstrom et al. 2009). This indicates that light alcohol use not only is

not an outcome of malnutrition over time but may also be preventative from nutrition risk in community-dwelling older adults.

We hypothesised that depression would be worse for the at-risk group than the not-at-risk group. The longitudinal results showed that at baseline, the at-risk group were significantly more depressed than the not-at-risk group, and this result remained the same across time. The results for depression reflect the results we found for general mental health. This was unexpected and, unfortunately, there is a lack of literature to explain possible reasons for this. One study analysed malnutrition risk with low handgrip strength. They found malnutrition-risk and low handgrip strength as individual factors did not lead to depression. However, when both factors were compared synergistically, they found higher depressive symptoms after a four year follow up (Wang, Liang et al. 2019). However, depressive symptoms can also be the cause of malnutrition as it often decreases appetite. Longitudinal cohort studies in The Netherlands (Schilp 2011) and Sweden (Johansson, Bachrach-Lindstrom et al. 2009) found a direct incidence of malnutrition in depressed, community-dwelling older adults. Thus, we can speculate that time is not a factor that influences depression in older adults, but more likely other factors that influence the likelihood of depressive symptoms.

In summary, this study results illustrate that as time progresses, the baseline differences between the risk-groups for most health outcomes remain the same. Furthermore, both groups self-reported physical health significantly decreased over time. The only exceptions being; mental health, which increased over time in the nutrition risk group, and hazardous drinking, which decreased for the at-risk group and remained the same for the not-at-risk group. When health professionals are treating older adults, they must recognise the importance of early detection of malnutrition by regularly screening older adults. Early detection can then result in early inventions, reducing the onset of health conditions this study has suggested do not get better.

Interaction of nutrition risk and time on health outcomes

This study indicates that the only difference in health outcomes across time associated with the nutrition risk group was mental health. Specifically, the at-risk group self-reported mental health improved over the 4 year follow up period, and the not-at-risk group decreased. Whilst there were minor effects of time on other indicators, none were considered statistically

significant. There are currently no other studies that have looked at the health outcomes of time associated with nutrition risk, making this study the first of its kind and, thus, is difficult to interpret the results. It was particularly interesting that the effect of time and nutrition risk had the same small effect size on SF-12 physical health as it did on social connectedness. Meanwhile, it had an ever so slightly more significant effect on decreasing depression and hazardous drinking. This was the opposite of what we hypothesised. A potential explanation for this unexpected improvement in mental health for the at-risk group could be the effect of interaction with supporting health services (Penning 1995). However, this explanation contrasts with our finding that the at-risk group had poorer social connections at baseline and across the rest of the study. Therefore, if there is an effect of health services, the participants in the current study aren't seeing it has a social connection, but as a service.

To conclude, this study's baseline analysis found older adults at malnutrition risk have worse self-reported physical and mental health, higher rates of depression, lower social connectedness, and higher rates of hazardous drinking compared to those not-at-risk. Follow up over time suggested that most of the distinctions between at-risk and not at-risk groups remained the same and were not resolved with the passage of time. The only caveat being mental health. This was the first study to analyse the direct impact of time and nutrition risk as a combined factor, which had a direct influence on increasing mental health. This large study suggests that older adults at nutrition-risk need to be identified early and have intervention strategies in place as soon as possible. Without them, most aspects of health will not improve.

Chapter 4: Conclusion and Recommendations

4.1 Brief overview

This study aimed to determine four-year health-related outcomes of community-living older adults who were identified as being at 'malnutrition risk' in the 2014 Health, Work and Retirement Study. The study explored the health outcomes of 1471 participants, 33.9% of whom were identified as being at nutrition-risk using SCREENII-AB.

Three main findings have been found. Firstly, a baseline analysis concluded that older adults in this study had worse self-reported physical and mental health, higher rates of depression, lower social connectedness, and higher rates of hazardous drinking when at-risk of malnutrition, compared to those not-at-risk. Secondly, the direct effect of time showed a significant change in scores for self-rated physical and mental health and hazardous alcohol use in both risk groups. Across the four year follow up period, both risk groups physical health scores reduced, and mental health scores increased. Meanwhile, the at-risk groups hazardous drinking reduces, and the not-at-risk groups hazardous drinking remained stagnant. Further analysis found the difference in physical health and mental health between nutrition risk groups at baseline, and follow up, is very large. Thirdly, there was a significant time and nutrition risk interaction effect on self-reported mental health only. Specifically, while mental health increased over time for the not-at-risk group, it remains static for the at-risk group. These results all indicate the importance of regular screening and early detection of malnutrition risk in older adults, so interventions can be in place early and reduce adverse long term health outcomes.

It is vital to understand that most of the distinctions between the at-risk and not-at-risk groups remained the same and are not resolved with the passage of time. The only caveat being mental health. This suggests that nutritionists and other health professionals need to target their interventions immediately because these will not change. The risk of not intervening will be expressed in long term health care costs for a group that does not get better by themselves.

4.2 Contribution to health

While the results of this study add to the copious amounts of research on malnutrition-risk and reduced health outcomes for older adults, it also creates new findings on the effects time

has on these outcomes. The results highlight the importance of early dietetic intervention for older adults living in the community when they are at malnutrition risk. Without intervention, the effects on health are ongoing and will not change. For an early intervention to be possible, regular nutrition screening of community-dwelling older adults by GP's is recommended. Without screening, malnutrition-risk is likely to be identified late, and effects may already be experienced.

4.3 Strengths

A significant strength of this research is the large population sample, which was inclusive of many geographical areas of New Zealand. In 2014 (baseline), the age range for this study 49-87, which ensured the population sample used in this study was representative of the NZ population. Robust sampling techniques were used as well as the multitude of validated tools; CES-D, SF-12, AUDIT-C, 24-item Social provisions scale and the nutrition screening tool SCREENII-AB, which is explicitly validated for community-dwelling older adults. There was opportunity to access data from a multitude of variables and over two time points over 4 years.

4.3 Limitations

Due to this study being reliant on questionnaires, there are potential inaccuracies in self-reports due to differing perceptions, memory, and accurate recollection (Barber 2013). The participants who have; cognitive impairments, poor literacy skills, difficulty reading or writing, and reliance on a scribe are suspectable to bias. This study being reliant on a literacy level may have led to lower participation of those in low socioeconomic groups. Therefore, stratifying for this population group is essential.

Due to this study's nature being reliant on postal surveys being completed and returned, we could not detect mortality as an outcome of nutrition risk. The literature indicates this is a likely outcome of nutrition risk over time; however, we were unable to further look into this.

SCREENII-AB is a validated nutrition screening tool for older adults in NZ. However, the alternate, abbreviated SCREENII questionnaire is not yet validated in New Zealand; thus caution must be taken when comparing this studies results to other research.

4.5 Recommendations for further research

This research has opened up more areas of future research opportunities for community-dwelling older adults in NZ. Future research needs more targeted information on nutrition and health outcomes that is not biased by self-report questionnaires requires the use of clinical measurement tools. Furthermore, exploring the distinctions between malnutrition-risk and mental health over time would create clarity around the unexpected findings from the current study.

Bibliography

Adejumo, A., Adejumo, K., Adegbla, O., Chinedozi, I., Ndansi, J., Akanbi, O., Onyekusi, N., Akinbolaji, O. (2019). "Protein-Energy Malnutrition and Outcomes of Hospitalizations for Heart Failure in the USA." The American Journal of Cardiology 123(6).

Agarwal, E., Ferguson, M., Banks, M., Vivanti, A., Batterham, M., Bauer, J., Capra, S., Isenring, E. (2018). "Malnutrition, poor food intake, and adverse healthcare outcomes in non-critically ill obese acute care hospital patients." Clin Nutr 38(2).

Altun, F., Yazici, H. (2015). "The Relationships Between Life Satisfaction, Gender, Social Security, and Depressive Symptoms Among Elderly in Turkey.".

Amin, I. (2017). "Perceptions of Successful Aging among Older Adults in Bangladesh: An Exploratory Study.".

Bajaj, A., Stone, K., Peters, K., Parimi, N., Barrett-Connor, E., Bauer, D. (2014). "Circulating Vitamin D, Supplement Use, and Cardiovascular Disease Risk: The MrOS Sleep Study." The Journal of Clinical ENdocrinology & Metabolism 99(0).

Barber, T. X. (2013). Pitfalls in human research: Ten pivotal points, Elsevier.

Boulos, C., P. Salameh and P. Barberger-Gateau (2017). "Social isolation and risk for malnutrition among older people." Geriatrics & Gerontology International 17(2): 286-294.

Bowling, A., Liffe, S. (2006). "Which model of successful aging should be used? Baseline findings from a British longitudinal survey of aging." PubMed.

Cederholm, T., Barazzoni, R., Austin, P., Ballmer, P., Biolo, G., Bischoff, S, C., Compher, C., Correia, I., Higashiguchi, T., Holst, M., et al. (2017). "ESPEN guidelines on definitions and terminology of clinical nutrition. ." Clinical Nutrition 36(49 - 64).

Chang, S., F. (2017). "Frailty Is a Major Related Factor for at Risk of Malnutrition in Community-Dwelling Older Adults." Journal of Nursing Scholarship 49(1).

Chapman, I., P. (2004). "Endocrinology of anorexia of ageing. ." Best Pract Res Clin Endocrinol Metab 18(3): 437-452.

Chatindiara, I., Williams, V., Sycamore, E., Ritchter, M., Allen, J., Wham, C. (2018). "Associations between nutrition risk status, body composition and physical performance among

community-dwelling older adults." Australian and New Zealand Journal of Public Health.

Chien, M., Guo, H. (2014). "Nutritional Status and Falls in Community-Dwelling Older People: A Longitudinal Study of a Population-Based Random Sample." PLoS One.

Chiu, C.-Y., R. W. Motl and N. Ditchman (2016). "Validation of the Social Provisions Scale in people with multiple sclerosis." Rehabilitation psychology 61(3): 297.

Clark, L., N., Helm, M, C., Higgins, R., Lak, K., Kastenmeier, A., Kindel, T., Goldblatt, M., Gould, J, C. (2018). "The impact of preoperative anemia and malnutrition on outcomes in paraesophageal hernia repair." Surgical Endoscopy 32(11).

Cornia, A. (2019). "Low Intake of Vitamin E Accelerates Cellular Aging in Patients With Established Cardiovascular Disease: The CORDIOPREV Study." The Journals of Gerontology 74(6).

Cosco, T., D., Prino, A, M., Perales, J., Stephan, B, C, M., Brayne, C. (2013). "Lay perspectives of successful ageing: A systematic review and meta-ethnography. ." BMJ.

Cosco, T., D., Prino, A, M., Perales, J., Stephan, B, C, M., Brayne, C. (2014). "Operational definitions of successful aging: a systematic review." PubMed.

Craven, D. L., Lovell, G. P., Pelly, F. E., Isenring, E. (2018). "Community-Living Older Adults' Perceptions Of Body Weight, Signs Of Malnutrition And Sources Of Information: A Descriptive Analysis Of Survey Data " J Nutr Health Aging 22(3).

Craven, D. L., F. E. Pelly, G. P. Lovell and E. Isenring (2018). "Nutrition Risk Measured Online in Community-Living Older Australians." Journal of nutrition in gerontology and geriatrics 37(3-4): 241-254.

Cutrona, C. E. and D. W. Russell (1987). "The provisions of social relationships and adaptation to stress." Advances in personal relationships 1(1): 37-67.

Dahlberg, L., Andersson, L., Mckee, K. J., & Lennartsson, E. C (2015). "Predictors of loneliness among older women and men in Sweden: A national longitudinal study." Aging & Mental Health 19(5).

Damayanthi, H. D. W. T., F. M. Moy, K. L. Abdullah and S. D. Dharmaratne (2018). "Prevalence of malnutrition and associated factors among community-dwelling older persons in Sri Lanka: a cross-sectional study." BMC geriatrics 18(1): 1-10.

De La Montana, J., Migues, M. (2011). "Suitability of the short-form Mini nutritional assessment in free-living elderly people in the northwest of Spain." Journal of Nutrition, Health and Aging 15(3).

Dent, E., Chapman, I., Ian, M., Piantadosi, C., Visvanathan, R. (2014). "Performance of nutritional screening tools in predicting poor six-month outcome in hospitalised older patients." Asia Pac J Clin Nutr 23(3).

Eloranta, S., Arve, S., Isoaho, H., Lehtonen, A., & Viitanen, M. (2015). "Loneliness of older people aged 70: A comparison of two Finnish cohorts born 20 years apart." Archives of Gerontology and Geriatrics 61(2).

Firebaugh, C., M., Moyes, S., Jatrana, S., Rolleston, A., Kerse, N. (2018). "Physical Activity, Function, and Mortality in Advanced Age: A Longitudinal Follow-Up (LiLACS NZ)." Journal of Aging and Physical Activity 26.

Frieling, M., Davis, W. and Chang, G., 2013. *The SF-36v2 and SF-12v2 health surveys in New Zealand: norms, scoring coefficients and cross-country comparisons*. Ph.D. Statistics New Zealand.

Ghimire, S., Baral, B, K., Karmacharya, I., Callahan, K., Mishra, S, R. (2018). "Life satisfaction among elderly patients in Nepal: associations with nutritional and mental well-being." Health Qual Life Outcomes.

Graham, K. and G. Schmidt (1999). "Alcohol use and psychosocial well-being among older adults." Journal of Studies on Alcohol 60(3): 345-351.

Greacen, M. (2014). Nutritional assessment of older New Zealand adults in Auckland residential care homes. Master of Dietetics, University of Otago.

Guitierrez, C., Rubio, A., Borda, M., Ternent, R., Laverde, F., Trujillo, D. (2016). "Perception of health-related quality of life using the EURO-QOL in older adults in Bogotá, Colombia." European Geriatric Medicine 7(4).

Hodge, A., O. P. Almeida, D. R. English, G. G. Giles and L. Flicker (2013). "Patterns of dietary intake and psychological distress in older Australians: benefits not just from a Mediterranean diet."

Irwin, M., K. H. Artin and M. N. Oxman (1999). "Screening for depression in the older adult: criterion validity of the 10-item Center for Epidemiological Studies Depression Scale (CES-D)." Archives of internal medicine 159(15): 1701-1704.

Jean-Claude, M., Emmanuelle, P., Juilette, H. (2012). "Clinical and economic impact of malnutrition per se on the postoperative course of colorectal cancer patients." Clinical Nutrition 31(6).

Johansson, Y., M. Bachrach-Lindstrom, J. Carstensen and A. C. Ek (2009). "Malnutrition in a home-living older population: prevalence, incidence and risk factors. A prospective study." J Clin Nurs 18(9): 1354-1364.

Jung, S. E., A. J. Bishop, M. Kim, J. Hermann, G. Kim and J. Lawrence (2017). "Nutritional Status of Rural Older Adults Is Linked to Physical and Emotional Health." Journal of the Academy of Nutrition and Dietetics 117(6): 851-858.

Kaplan, M. S., N. Huguet, D. Feeny, B. H. McFarland, R. Caetano, J. Bernier, N. Giesbrecht, L. Oliver and N. Ross (2012). "Alcohol use patterns and trajectories of health-related quality of life in middle-aged and older adults: a 14-year population-based study." Journal of studies on alcohol and drugs 73(4): 581-590.

Karen, C. R., W. Christina and P. Hélène (2007). "Predictors of Nutritional Risk in Community-dwelling Seniors." Canadian Journal of Public Health / Revue Canadienne de Sante'e Publique 98(4): 331-336.

Keller, H., R. Goy and S. Kane (2005). "Validity and reliability of SCREEN II (Seniors in the community: risk evaluation for eating and nutrition, Version II)." European journal of clinical nutrition 59(10): 1149-1157.

Keller, H., Goy, R., & Kane, S. L. (2005). "Validity and reliability of SCREEN II (Seniors in the Community: risk evaluation for eating and nutrition, Version II)." European Journal of Clinical Nutrition 10.

Kirushnan, B., B., Rao, B, S., Annigeri, R., Balasubramanian, S., Seshadri, R., Prakash, K, C., Vivek, V. (2017). "Impact of Malnutrition, Inflammation, and Atherosclerosis on the Outcome in Hemodialysis Patients." Indian J Nephrol 27(4).

Kowal, P., Towers, A., Byles, J. (2014). "Ageing across the Tasman Sea: the demographics and health of older adults in Australia and New Zealand." Australian and New Zealand Journal of Public Health 38(4).

Lee, A. E. and S. Chokkanathan (2008). "Factor structure of the 10-item CES-D scale among community dwelling older adults in Singapore." International Journal of Geriatric Psychiatry: A journal of the psychiatry of late life and allied sciences 23(6): 592-597.

Leonel, S., Carmo, M., Martines, T., Miguel, P., Ester, M. (2017). "Frailty, body composition and nutritional status in non-institutionalised elderly." Enferm Clin.

Lyness, J. M., T. K. Noel, C. Cox, D. A. King, Y. Conwell and E. D. Caine (1997). "Screening for depression in elderly primary care patients. A comparison of the Center for Epidemiologic Studies-Depression Scale and the Geriatric Depression Scale." Arch Intern Med 157(4): 449-454.

Malakouti, S. K., N. A. Pachana, B. Naji, S. Kahani and M. Saeedkhani (2015). "Reliability, validity and factor structure of the CES-D in Iranian elderly." Asian journal of psychiatry 18: 86-90.

Martínez-Reig, M., Aranda-Reneo, I., Peña-Longobardo, L. M., Oliva-Moreno, J., Barcons-Vilardell, N., Hoogendijk, E. O., & Abizanda, P. (2017). "Use of Health Resources and Healthcare Costs associated with Nutritional Risk: The FRADEA Study." Clinical Nutrition.

Mathew, A. C., D. Das, S. Sampath, M. Vijayakumar, N. Ramakrishnan and S. Ravishankar (2016). "Prevalence and correlates of malnutrition among elderly in an urban area in Coimbatore." Indian journal of public health 60(2): 112.

McElnay, C., Marshall, B., O'Sullivan, J., Jones, L., Ashworth, T., Hicks, K., & Forrest, R. H. (2012). "Nutritional risk amongst community-living Maori and non-Maori older people in Hawke's Bay." Journal of primary Health Care (Online).

Ministry of Health (2005). Nutrient Reference Values for Australia and New Zealand: Including Recommended Dietary Intakes. M. o. Health.

Ministry of Health (2016). Health Loss in New Zealand 1990-2013: A report from the New Zealand Burden of Diseases, Injuries and RIsk Factors Study. Wellington, Ministry of Health.

Ministry of Health (2019). Annual Update of Key Results 2017/18: New Zealand Health Survey. Wellington, Ministry of Health.

Mogensen, K., M., Horkan, C, M., Purtle, S., Moromizao, T., Rawn, J., Robinson, M, K. (2017). "Malnutrition, Critical Illness Survivors, and Postdischarge Outcomes: A Cohort Study

." Journal of Parental and Enteral Nutrition 42(3).

Mohebbi, M., V. Nguyen, J. J. McNeil, R. L. Woods, M. R. Nelson, R. C. Shah, E. Storey, A. M. Murray, C. M. Reid and B. Kirpach (2018). "Psychometric properties of a short form of the Center for Epidemiologic Studies Depression (CES-D-10) scale for screening depressive symptoms in healthy community dwelling older adults." General hospital psychiatry 51: 118-125.

Moore, A. A., E. J. Whiteman and K. T. Ward (2007). "Risks of combined alcohol/medication use in older adults." The American journal of geriatric pharmacotherapy 5(1): 64-74.

Morris, N., Stewart, S., Riley, M., Maguire, G. (2018). "Differential Impact of Malnutrition on Health Outcomes Among Indigenous and Non-Indigenous Adults Admitted to Hospital in Regional Australia-A Prospective Cohort Study." Nutrients 10(5).

Naseer, M. and C. Fagerström (2015). "Prevalence and association of undernutrition with quality of life among Swedish people aged 60 years and above: Results of the SNAC-B study." The journal of nutrition, health & aging 19(10): 970.

Naseer, M., Forssell, H., Fagerstrom, C. (2015). "Malnutrition, functional ability and mortality among older people aged ≥60 years: A 7-year longitudinal study." European Journal of Clinical Nutrition 70(3).

Nowson, C. (2007). "Nutritional challenges for the elderly. ." Nutr Diet 64(4): 150-155.

O'Keeffe, M., M. Kelly, E. O'Herlihy, P. W. O'Toole, P. M. Kearney, S. Timmons, E. O'Shea, C. Stanton, M. Hickson and Y. Rolland (2019). "Potentially modifiable determinants of malnutrition in older adults: A systematic review." Clinical Nutrition 38(6): 2477-2498.

O'Halloran, A., R. Kenny and B. King-Kallimanis (2014). "The latent factors of depression from the short forms of the CES-D are consistent, reliable and valid in community-living older adults." European Geriatric Medicine 5(2): 97-102.

O'Shea, E., Trawley, S., Manning, E., Barrett, A., Browne, V., Timmons, S. (2017). "Malnutrition in hospitalised older adults: a multicentre observational study of prevalence, associations and outcomes.".

Ouwehand, C., De Ridder, D., Bensing, J, M. (2007). "A review of successful aging models: proposing proactive coping as an important additional strategy." PubMed.

Penning, M. J. (1995). "Health, social support, and the utilization of health services among older adults." The Journals of Gerontology Series B: Psychological Sciences and Social Sciences 50(5): S330-S339.

Phillips, M. B., Foley, A. L., Barnard, R., Isenring, E. A., & Miller, M. D. (2010). "Nutritional screening in community-dwelling older adults: a systematic literature review." Asia Pacific Journal of Clinical Nutriion 19(3): 440-449.

Preis, E., Fanz, K., Siegert, E., Makowka, A., March, C., Riemekasten, G., Cereda, E., Norman, K. (2018). "The impact of malnutrition on quality of life in patients with systemic sclerosis." European Journal of Clinical Nutrition 72.

Ramic, E., Pranjic, N., Batic-Mujanovic, O., Karic, E., Alibasic, E., & Alic, A. (2011). "The effect of loneliness on malnutrition in elderly population." Medical Archives 65(2): 92 - 95.

Ringaitiene, D., Ginelityte, D., Vicka, V., Zvirblis, T., Siplaite, J., Irnius, A., Ivaskevicius, J., Kacerguis, T. (2015). "Impact of malnutrition on postoperative delirium development after on pump coronary artery bypass grafting." Journal of Cardiothoracic Surgery 10(74).

Rowe, J., W., Kahn, R, L. (2015). "Successful aging 2.0: Conceptual expansions for the 21st century." Gerontol Series B Psychol Sci 593–596.

Russel, J., Flood, V, M., Yeatman, H., Wang, J, J., Mitchell, P. (2016). "Food insecurity and poor diet quality are associated with reduced quality of life in older adults." Nutrition & Dietetics Journal of the Dietitians Association of Australia.

Schilp, J., Wijnhoven, H., Deeg, D., & Visser, M. (2011). "Early determinants for the development of undernutrition in an older general population: Longitudinal Aging Study Amsterdam." British Journal of Nutrition. 106(5).

Shah, C. H. and J. D. Brown (2020). "Reliability and Validity of the Short-Form 12 Item Version 2 (SF− 12v2) Health-Related Quality of Life Survey and Disutilities Associated with Relevant Conditions in the US Older Adult Population." Journal of clinical medicine 9(3): 661.

Shen, H., Chen, H., Peng, L., Lin, M., CHen, L., LLiang, C., Lo, Y., Hwang, S. (2011). "Impact of nutritional status on long-term functional outcomes of post-acute stroke patients in Taiwan." Archives of Gerontology and Geriatrics 53(2).

Shu-Wen, S. and W. Dong (2019). "The reliability and validity of short form-12 health survey version 2 for Chinese older adults." Iranian journal of public health 48(6): 1014.

Sorocco, K. H. and S. W. Ferrell (2006). "Alcohol use among older adults." The Journal of general psychology 133(4): 453-467.

Statistics New Zealand (2013). "2013 Census QuickStats about people aged 65 and over."

Statistics New Zealand (2017). "Population prohections tables."

Stewart, D., C. Hewitt and J. McCambridge (2020). "Exploratory validation study of the individual AUDIT-C items among older people." Alcohol and Alcoholism.

Strawbridge, W., J., Wallhagen, M, I., Cohen, R, D. (2002). "Successful aging and well-being: Self-rated compared with Rowe and Kahn." Gerontologist. : 727-733.

Streicher, M., J. van Zwienen-Pot, L. Bardon, G. Nagel, R. Teh, C. Meisinger, M. Colombo, G. Torbahn, E. Kiesswetter and M. Flechtner-Mors (2018). "Determinants of incident malnutrition in community-dwelling older adults: a MaNuEL multicohort meta-analysis." Journal of the American Geriatrics Society 66(12): 2335-2343.

Sutton, J. L., Gould, R. L., Daley, S., Coulson, M. C., Ward, E. V., Butler, A. M., . . . Howard, R. J. (2016). "Psychometric properties of multicomponent tools designed to assess frailty in older adults: A systematic review." BMC Geriatr 16(1).

Szabó, Á., A. Towers, J. Sheridan and D. Newcombe (2021). "Ten-Year Trajectories of Alcohol Consumption in Older Adult New Zealanders." The Journals of Gerontology: Series B 76(3): 496-506.

Tomstad, S., Dale, B., Sundsli, K. (2017). "Who often feels lonely? A cross-sectional study about loneliness and its related factors among older home-dwelling people." International Juornal of Older People Nursing 12(4).

Tomstad, S. T., Söderhamn, U., Espnes, G. A., & Söderhamn, O (2012). "Lived experiences of self-care among older, home-dwelling individuals identified to be at risk of undernutrition." Journal of Multidisciplinary Healthcare 5.

Towers, A., M. Philipp, P. Dulin and J. Allen (2018). "The “health benefits” of moderate drinking in older adults may be better explained by socioeconomic status." The Journals of Gerontology: Series B 73(4): 649-654.

Towers, A., J. Sheridan and D. Newcombe (2017). The Drinking Patterns of Older New Zealanders: National and International Comparisons, Health Promotion Agency.

Towers, A., C. Stephens, P. Dulin, M. Kostick, J. Noone and F. Alpass (2011). "Estimating older hazardous and binge drinking prevalence using AUDIT-C and AUDIT-3 thresholds specific to older adults." Drug and alcohol dependence 117(2-3): 211-218.

Trajkov, M., Eminovi, F., Radovanovic, S., Dopsaj, M., Pavlovjc, D., Kljajic, D. (2018). "Quality of life and depression in elderly persons engaged in physical
activities ".

Tripathy, S., Mushra, J. C. (2015). "Assessing nutrition in the critically ill elderly patient: A comparison of two screening tools." Indian J Crit Care Med 19.

Wang, Y.-C., C.-K. Liang, Y.-H. Hsu, L.-N. Peng, C.-S. Chu, M.-C. Liao, H.-C. Shen, M.-Y. Chou and Y.-T. Lin (2019). "Synergistic effect of low handgrip strength and malnutrition on 4-year all-cause mortality in older males: A prospective longitudinal cohort study." Archives of Gerontology and Geriatrics 83: 217-222.

Wang, Y. C., C. K. Liang, Y. H. Hsu, L. N. Peng, C. S. Chu, M. C. Liao, H. C. Shen, M. Y. Chou and Y. T. Lin (2019). "Synergistic effect of low handgrip strength and malnutrition on 4-year all-cause mortality in older males: A prospective longitudinal cohort study." Arch Gerontol Geriatr 83: 217-222.

Watson, S., Zhang, Z. K., & Wilkinson, T. J. (2010). "Nutrition risk screening in community-living older people attending medical or falls prevention services." Nutrition and Dietetics 67(2): 84-89.

Wei, K., Nyunt, M., Gao, Q. (2018). "Association of Frailty and Malnutrition With Long-term Functional and Mortality Outcomes Among Community-Dwelling Older Adults Results From the Singapore Longitudinal Aging Study 1." JAMA 1(3).

Wham, C., A., Teh, R., Moyes, S., Dyall, L., Kepa, M., Hayman, K., Kerse, N. (2014). "The Bright Trial: What are the factors associated with nutrition risk?" Journal of Nutrition, Health and Aging 18(7).

Wham, C., A., Teh, R., Moyes, S., Dyall, L., Kepa, M., Hayman, K., Kerse, N. (2015). "Health And Social Factors Associated With Nutrition Risk: Results From Life And Living In Advanced Age: A Cohort Study In New Zealand (Lilacs Nz)." J Nutr Health Aging 19(6).

Wham, C., A., Teh, R., Moyes, S., Dyall, L., Kepa, M., Hayman, K., Kerse, N. (2015). "Health and social factors associated with nutrition risk: results from life and living in advanced age: a cohort study in New Zealand (LILACS NZ)." Journal of Nutrition, Health and Aging 19(6).

Wham, C., Carr, R., & Heller, F. (2011). "Country of origin predicts nutrition risk among community living older people." The Journal of nutrition, health and aging. 15(4): 253-258.

Wham, C., Redwood, K., & Kerse, N. (2014). "Validation of the nutrition screening tool 'Seniors in the Community: Risk Evaluation for Eating and Nutrition, version II'among octogenarians." The Journal of nutrition, health and aging. 18(1): 39-43.

Wham, C., R. Teh, S. Moyes, L. Dyall, M. Kepa, K. Hayman and N. Kerse (2015). "Health and social factors associated with nutrition risk: Results from life and living in advanced age: A cohort study in New Zealand (LILACS NZ)." Journal of Nutrition, Health & Aging 19(6): 637.

Wham, C., Teh, R. O. Y., Robinson, M., & Kerse, N. M. (2011). "What is associated with nutrition risk in very old age?" The Journal of nutrition, health and aging. 4: 247.

Wham, C., Teh, R., Moyes, S., Dyall, L., Kepa, M., Hayman, K., & Kerse, N. (2015). "Health and social factors associated with nutrition risk: Results from life and living in advanced age: A cohort study in New Zealand (LILACS NZ)." Journal of Nutrition, Health and Aging 6.

Wham, C. A., R. Teh, M. Robinson and N. Kerse (2011). "What is associated with nutrition risk in very old age?" The journal of nutrition, health & aging 15(4): 247-251.

Willis, H. (2017). "Causes, assessment and treatment of malnutrition in older people." Nutrsing Older People 29(2).

Yap, K. B., M. Niti and T. P. Ng (2007). "Nutrition screening among community-dwelling older adults in Singapore." Singapore medical journal 48(10): 911-916.

Yoshimura, K., M. Yamada, Y. Kajiwara, S. Nishiguchi and T. Aoyama (2013). "Relationship between depression and risk of malnutrition among community-dwelling young-old and old-old elderly people." Aging & Mental Health 17(4): 456-460.

Zaki, M. A. (2009). "Reliability and validity of the Social Provision Scale (SPS) in the students of Isfahan University." Iranian journal of psychiatry and clinical psychology 14(4): 439-444.

Appendices

Appendix 1: Previous nutrition risk research amongst community-living older adults .

	Malnourished or at risk?	Age	Participants	Follow up	Outcomes	Location
{Naseer, 2015	Malnutrition Risk	>60	1203	7 years	Mortality Dementia Activity of daily living Dependence Heart disease Diabetes	Sweden
{Ghimire, 2018 #9788}	Scale of nutrition	>60	289	None	Decreased life satisfaction Increased depression	Nepal
{Chien, 2014 #9787}	Malnourished, did not look into malnourishment.	>53	4440	1 year	Increased risk of falls	Taiwan
{Russel, 2016 #9786}	Mixed bag adults,	>49	2642	None	Reduced self-reported physical health Reduced self-reported mental health	Australia
{Wijnhoven, 2014 #9790}	Weight loss	>55	2645	3 years	Overall increased mortality	Netherlands

{Mamhidir, 2006 #9791}	Underweight/weight loss	>75	503	1 year	Weight loss continued over time.	Sweden
{Morris, 2018 #9794}	Malnourished.		608	6 months	Malnutrition was associated with higher mortality Increased acute disease severity Higher chronic disease prevalence	Australia
(Wei 2018)	Mixed (some frial + malnourished, not fril and malnourished)	>55	2804	12 years	Increased poor functional outcomes Increased mortality outcomes.	Singapore

Appendix 2: Health outcome scores for nutrition-risk and not-at risk-groups in 2014 and 2018.

	Scale scores			
42	At-risk (SCREEN II-AB<38) (n = 441)*		Not at risk (SCREEN II-AB ≥38) (n = 1030)*	
	2014 *M (SD)*	2018 *M (SD)*	2014 *M (SD)*	2018 *M (SD)*
SF-12 Physical health	44.38 (10.46)	43.24 (11.40)	48.98 (7.96)	48.37 (8.96)
SF-12 Mental health	46.88 (11.11)	48.33 (10.90)	52.33 (7.96)	52.33 (8.03)
Depression	7.56 (5.17)	7.50 (5.15)	4.49 (3.75)	4.80 (4.03)
Hazardous Alcohol use	3.66 (2.35)	3.59 (2.44)	3.72 (2.01)	3.54 (1.98)
Attachment	12.70 (2.40)	12.59 (2.23)	13.85 (2.06)	13.74 (2.01)
Social Integration	12.75 (1.9)	12.78 (1.98)	13.69 (1.88)	13.63 (1.88)

*number of participants differ from other tables as RM-MANOVA test excludes any participants who had missing variables on any of the scales.

SCREEN II-AB, Seniors in the Community: Risk Evaluation for Eating and Nutrition, Version II, abbreviated, SF-12, 12-item Short Form Health Survey.