Strategies to improve nutritional intake across a hospital and a Meals on Wheels service: The time is now

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70,600 words

Student declaration

I, Jacqueline Gail Krassie, declare that the PhD thesis entitled “Strategies to improve nutritional intake across a hospital and a Meals on Wheels service: The time is now” is no more than 80,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

I have conducted my research in alignment with the Australian Code for the Responsible Conduct of Research and Victoria University’s Higher Degree by Research Policy and Procedures.

All research procedures reported in the thesis were approved by the Mater Health Services Human Research Ethics Committee and Victoria University Human Research Ethics Committee (HREC 201335) for Chapter 3) and Victoria University Human Research Ethics Committee (HRE14-179) for Chapters 4, 5 and 6.

Jacqueline Gail Krassie  Date 20th December 2021

Acknowledgments

DEDICATION

To my parents who taught me life was a series of opportunities, encouraged me to explore the options, and instilled a deep respect for friendship.

To my three amazing children – Cassie, Alex and Tristan. Where would I be without you? You constantly challenge me, ground me, and cheer me on when I need a helping hand. Your quiet encouragement, listening and unconditional support, each in your own way, has meant more than I can say.

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Abstract

The impact of an ageing population and growing levels of chronic disease in the community are increasing demands across all sectors of the health care industry globally. Malnutrition impacts health outcomes, healthcare costs, and quality of life for individuals across health care sectors, and is acknowledged nationally and internationally as reducing the ability of older adults living in the community to retain their independence. The reasons for malnutrition involve a complex set of internal and external influences, including ageing, appetite, oral health, social and environmental factors. This thesis investigated the impact of interventions targeting the energy and protein intake within two healthcare sectors - hospital patients and Meals on Wheels (MOW) clients - in the Australian context.

The first study (Chapter 3) investigated the impact of a change from a traditional to a room service food service system, on energy and protein intake for patients. The study was conducted at a private, acute care hospital in Brisbane, Australia. The majority of patients were in hospital less than 4 days, and were on a normal diet. The risk of malnutrition was less than 12% for both groups. With room service, patients received their meal within 45 minutes of ordering their meal, compared with a traditional hot plating system where patients order their meals one day in advance. An analysis of meals consumed over a 24-hour period, by 50 patients pre-, and 47 patients post-room service, demonstrated an overall reduction in plate waste of 7 % ($p < 0.05$) post-room service. This outcome was observed at lunch, and dinner meals and, with respect to food categories, soup, hot starch, and vegetables ($p < 0.05$). In spite of these operational efficiencies, a reduction in plate waste, whether assessed as an absolute value or against a threshold of estimated energy and protein requirements, energy and protein intake was unchanged following the implementation of room service.

The second study investigates the impact of a social intervention on the nutritional intake of a cohort of eighty-three clients from MOW services in North and West Metropolitan Region of Melbourne, and Macedon and Geelong regions of Victoria. The results of this study are presented in three separate chapters. Participant

characteristics and meal utilisation patterns are detailed in Chapter 4, variables associated with nutritional intake in Chapter 5, and the impact of the social intervention on intake in Chapter 6. Results from the initial interviews with participants, including demographic details, meal ordering and utilisation information, and dietary intake data from three 24-hour recalls are reported in Chapter 4. While a single 24-hour recall has been utilised in other studies, this study expanded the food recall to 3 days for each participant, allowing for the variations in eating patterns, including weekdays and weekends, to be reflected in the assessment of intake. Participants were mainly well-nourished (84.3%), relatively independent with respect to making meals and shopping for groceries, and had regular social contact. All participants in the study ordered the main MOW meal, 93% ordered dessert, and 70% ordered soup, with meals frequently consumed over two or three meals. Over half of the participants reported throwing out meals (56.6%), with 14.9% of these giving MOW meals to a pet. In contrast to the level of discarding meals, the positive and negative feedback from participants was similar suggesting the need for further investigation to clarify the participant expectations regarding meal quality and service levels. Nevertheless, in this study, MOW meals contributed 30% of energy and 38% of participants' protein intake, and the total daily intake for participants met 82% of energy and 98% of protein requirements. These results provide valuable insight into existing issues, expectations, and have the potential to inform future system interventions.

Working with the participants profiled in Chapter 4, Chapter 5 investigated associations between the participant characteristics and nutrient outcome variables, and the participants understanding of MOW delivery as a social experience. Nutritional intake was higher for male participants, while the contribution of intake to energy requirements was greater for those who were with MOW for a longer time period increased ($p = 0.033$). The contribution of MOW to intake increased as the number of MOW meals per week increased, but declined with age. Interestingly, total energy and protein intake, and the contribution of energy to requirements, declined as the number of positive comments from participants increased. The vast majority of participants chatted with the delivery person (89%), and considered MOW meal delivery social (82%). Further research is needed to

understand client perceptions across a range of MOW groups, including those that are less healthy, independent and socially connected.

Chapter 6 reported on the impact of a 3-month program of social visits on energy and protein intake. Participants included in the initial stage of this study (Chapter 4), were randomly assigned to either the control group or one of two intervention groups, receiving six social visits every 2 weeks, or 3 social visits each month. During the three months of the project, for a variety of reasons, 10 of the original 83 participants (12%) withdrew. Dietary intake data from three 24-hour recalls was collected during interviews with each participant. Chapter 6 reported an increase in energy intake on MOW days compared with non-MOW days of 938 kJ ($p = 0.003$). This outcome is consistent with the observation reported in Chapter 5 where intake increased with the number of MOW meals received per week. However there was no impact on total intake of energy or protein for either intervention groups. As the study design did not require participants to consume a MOW meal on each day, participants varied their frequency of consumption of MOW meals, reducing the potential impact on the overall intake of energy and protein. The relatively well-nourished, independent and socially connected profile of this group of participants, in combination with small group sizes, may have impacted the results of this study. An important step in exploring the potential for social connection to impact nutritional intake, this study provides a baseline from which future studies can scaffold targeted strategies that explore the impact on quality of life and nutritional intake.

CONCLUSION

While the interventions reported in this thesis did not demonstrate an increased nutritional intake for hospital patients or MOW clients, the results extend our current understanding of the characteristics and behaviours related to meal consumption and utilisation necessary to inform the development of targeted interventions across these two health care sectors. The time is right to expand the focus of malnutrition research. There is an opportunity to undertake studies across the health care sectors, to develop interventions that acknowledge, identify and

address the needs of the individual, and service provider, and ultimately contribute to a continuum of nutritional care for the individual across the sectors.

Contents

Tables

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Abbreviations

ABS	Australian Bureau of Statistics
ACQS	Aged Care Quality Standards
ADA	American Dietetic Association
AIHW	Australian Institute of Health and Welfare
AIN	assistant-in-nursing
ALOS	average length of stay
AMOWA	Australian Meals on Wheels Association
ASPEN	American Society for Parenteral and Enteral Nutrition
BAPEN	British Association for Parenteral and Enteral Nutrition
BMI	Body Mass Index (kg/m^2)
BMOS	bedside menu ordering system
CADTH	Canadian Agency for Drugs and Technologies in Health
CBORD®	trade name of a computerised food service and diet management system
CVD	cardiovascular disease
DoMAP	Determinants of Malnutrition in Aged Persons
EE	energy expenditure
ED	emergency department
EMOS	electronic menu ordering system
ESPEN	European Society for Clinical Nutrition and Metabolism
F	female
FELANPE	Latin American Federation of Nutritional Therapy, Clinical Nutrition and Metabolism
FFMI	fat-free mass index
g	gram
GDP	gross domestic product
GLIM	Global Leadership Initiative on Malnutrition
HDHL	Healthy Diet for a Healthy Life
JPI	Joint Programming Initiative
kg	kilogram
kJ	kilojoule
LOS	length of stay
m	metre
M	male
MaNuEL	Malnutrition in the Elderly
MedPass	a system where a 2 cal/mL supplement is delivered to patients, in a 60 mL portion, at medication rounds, or as part of a mid-meal selective snack trolley offered between meals.
MET	Metabolic Equivalent of Task
MNA®	Mini Nutritional Assessment

MNA®-SF	Mini Nutritional Assessment- Short Form
MOW	Meals on Wheels
MST	Malnutrition Screening Tool
MUST	Malnutrition Universal Screening Tool
NA	nutrition assistant or diet aide
NRS-2002	Nutrition Risk Screening – 2002
NRV	nutrient reference value
NSQHSS	National Safety and Quality Health Service Standards
NSW	New South Wales
OECD	Organization for Economic Cooperation and Development
Older adult	aged 65 years and over, unless otherwise specified
ONS	oral nutrition supplements
PENSA	Parenteral and Enteral Society of Asia
PMT	protected meal times
RA	research assistant
RAC	residential aged care
RACGP	Royal Australian College of General Practitioners
RCT	randomised control trial
RDA	recommended dietary allowance
RDI	recommended dietary intake
SD	standard deviation
SNAQ	short nutritional assessment questionnaire
SWA	SenseWear™ Armband UK United Kingdom
UK	United Kingdom
USA	United States of America
WHO	World Health Organization

Chapter 1 Health care food services – the context

The integration of services to support individuals, including those living independently at home, into the health services, is an opportunity to provide continuous, comprehensive services that meet individual client needs, and maximise the opportunities for providing an optimal balance of care (WHO, 2000). The growing aged care population, combined with the association of age with malnutrition and increasing dependency, reinforces the need for strategies to identify, prevent and manage malnutrition and the allocation of resources across and between all health care sectors. Given the relationship between acute care, residential aged care and those living independently in the community, there is a need for a greater understanding of the potential benefit of programs that support maintaining the health of individuals as they move between health sectors to improve the effectiveness of the delivery of health services (Council on Federal Financial Relations, 2020). Consistent with a broad approach to the delivery of nutrition-related services in health care, the government focus on older persons living alone, the impact on health, and the need to link services to the locations where individuals are living, this thesis explores the impact of sector-specific interventions on nutritional intake:

- The impact of a hospital room service food service system on food waste and nutritional intake of patients.
- The impact of a social intervention on the nutritional intake of older persons living in the community, specifically Meals on Wheels clients.

While the studies could have been undertaken separately, as government policy had begun to acknowledge the impact of individuals, particularly older persons, moving between sectors on health outcomes, the decision was made to undertake both studies, and begin to explore potential inter-sector synergies.

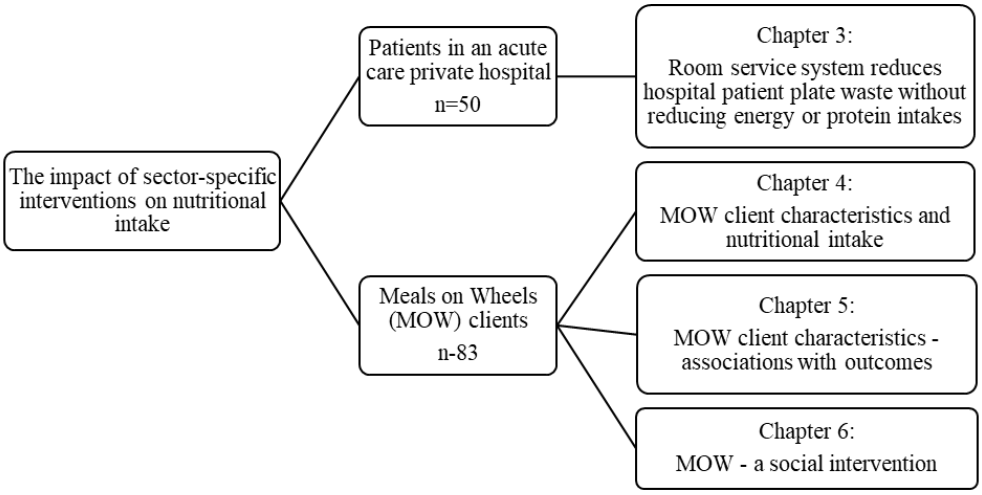

Figure 1.1: The overall aim of the thesis, participants, and study titles.
The figure above represents the aim of the thesis that was conducted across two sectors - a private, acute care hospital in Brisbane, Australia, and a MOW service in Melbourne Australia. An intervention study conducted on hospital patients is reported in Chapter 3. The study on MOW clients is reported over three chapters. Chapter 4 presents the baseline demographic and nutritional intake data. Chapter 5 reports the associations between client characteristics and outcome variables. Chapter 6 focusses on the impact of a social intervention on nutritional intake.

The remainder of this chapter explores the context of food services and nutrition within health care, specifically factors impacting the demand for services within and between health care sectors. Focussing on malnutrition, Chapter 2 summarises current knowledge including assessment, prevalence, contributing factors, impact, and interventions, informing the aims and objectives of the studies represented in this thesis.

1.1 Health care policy – increasing costs

An ageing population and growing levels of chronic disease in the community present increasing demands across all sectors of the health care industry globally. According to the Australian Institute of Health and Welfare (AIHW), the proportion of gross domestic product (GDP) spent on health in Australia was 9.6% in 2016, which is comparable to an average of 9.0% across all Organization for Economic Cooperation and Development (OECD) countries (AIHW, 2018). With Australia's health expenditure increasing faster than inflation, a government focus on reducing hospital costs is understandable (AIHW, 2016).

The AIHW has highlighted the significance of the ageing population on government expenditure and policy, reporting that population growth appears to have a greater role in driving the expenditure growth in the "older" age groups (AIHW, 2017), in Australia, which are recognised as those aged 65 years and over (AIHW, 2019a). Australia's population in 2017 was 24.6 million, and is projected to reach between 37.4 and 49.2 million by 2066 (ABS, 2018). Driven by declines in fertility and improvements in longevity, older people constitute an increasing share of the total population (WHO, 2015), which is a significant shift in the age cohort of the Australian population (AIHW, 2018). The proportion of people aged 65 years and over is expected to increase from 15% in 2017 to between 21% and 23% in 2066, with those aged 85 years and over projected to almost double, from 2% in 2017 to between 3.6% and 4.4% of the population in 2066 (ABS, 2018).

1.2 Population demographics - a clinical context

With life expectancy increasing, these later years bring reduced functioning and health (AIHW, 2018). Increased spending on health and aged-related expenditures including aged care are nominated as the most significant spending pressures by the Commonwealth Government, with those aged over 65 representing the highest cost per person, increasing again for those aged 80 and over (Commonwealth of Australia, 2015).

Greater longevity and a preference for living at home are reported as drivers of a decline in the use of residential aged care, and the increasing age of entry to aged care (Productivity Commission, 2015). As early as 2002, the Australian Government introduced a policy of "ageing in place" that allowed residents to stay in low-care facilities (hostels) when their dependency increased, eliminating the need for individuals to adjust to new surroundings, staff and co-residents (AIHW et al., 2002). A subsequent survey of 1,500 Australians aged 60 years and over undertaken by the Productivity Commission (Productivity Commission, 2015) reports that 83% of respondents prefer to "age in place*"* or live in their own home. According to the AIHW, those who prefer to live in a retirement village tend to be older (AIHW, 2019a), consistent with data presented by the Productivity Commission, who report mainstream housing as the dominant form of

accommodation for individuals up to 90 years of age (Productivity Commission, 2015). These data confirm the need for programs to manage the health status for those living in the home as well as in institutions.

This challenge associated with attempting to balance health care and public expenditure has been eloquently addressed in the *Final Report from the Royal Commission into Aged Care Quality and Safety*, where the commissioners cautioned that the transition to care for older persons living at home does not become an inadvertent means to reducing expenditure on providing care (Royal Commission into Aged Care Quality and Safety, 2021b).

1.2.1 Ageing – the impact

While the impact varies widely among individuals, changes that occur during ageing, including physiological, sensory, movement and cognitive, contribute to the individual's ability to function independently (WHO, 2015). Changes in appetite, dentition and social interaction, along with limited mobility, affect the ability to prepare meals and shop, which ultimately affects a person's dietary intake, and thus potentially increasing the risk of malnutrition (WHO, 2015).

Acknowledging that results vary with the screening tool used, location and health care setting, a recent review of 32 studies of older persons living in the community reports the prevalence rate of malnutrition of 8.5%, was higher in women, people aged over 80 years, and those with comorbidities (Volkert et al., 2020). Malnutrition, deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients (WHO, 2017b), has been associated with a negative impact on quality of life and activities of daily living, increasing the likelihood of dependence, as well as health care costs (Elia & Southampton, 2015). For older persons living in the community, increased health care costs have been associated with medical consultations, health care monitoring, treatments and hospitalisations, including readmissions and longer length of stay (Abizanda et al., 2016; Australian and New Zealand Society for Geriatric Medicine, 2009; Elia et al., 2016; Meijers et al., 2012; Wilson, 2013).

1.2.2 Ageing – living alone

Complicating the nutritional management of the older adults, social factors can influence the incidence of malnutrition, defined as "deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients" (WHO, 2017b). While the data on the impact of living alone on nutritional status are limited, a study of over 800 older persons in Turkey reports that the prevalence of malnutrition was higher among those living alone (7%) compared to those living with their families (4%), suggesting the need for further investigation into older persons living in the community, particularly those living alone as a potential risk factor for malnutrition (Kucukerdonmez et al., 2017). As 25% of Australians aged 65 years and over live alone in their own home, a trend that is reported to increase with age, particularly for women, further research is needed to provide further insight into the potential impact of living alone on health outcomes (De Vaus & Qu, 2015; Royal Commission into Aged Care Quality and Safety., 2019).

In Australia, the Productivity Commission, in their 2011 report, *Caring for Older Australians*, highlighted the need for aged care services to promote "independence, giving them choice, and retaining their community engagement", including choice in accommodation (Productivity Commission, 2011). Acknowledging the shifting residential base for older persons, the aged care system in Australia focuses on promoting "ageing in place through the linking of care and support services to the places where older people prefer to live" (Office of Parliamentary Counsel, 1997., 1997). To that end, the government policy sets the number of funded places to match the demand (AIHW, 2019a). Currently, 71% of Australians aged 65 and over are living at home without support services, while 22% are accessing some form of support at home, and 7% access residential aged care (AIHW, 2019a). Although the majority of services are provided to people living at home, the greatest proportion of spending is on residential aged care, representing an older aged group, with 59% aged 85 years or older (AIHW, 2019a).

While government policies in Australia are designed to provide choice, enabling individuals to stay in their own homes or by assisting them in residential care (Steering Committee for the Review of Government Service Provision, 2021), the preference for remaining at home for as long as possible can to influence

expenditure on health care services (AIHW, 2019a), as does the contribution of informal caregivers. In contrast to paid and/or professional carers, informal carers are defined by the Australian government as "people who provide care to those who need it within the context of an existing relationship, such as a family member, a friend or a neighbour" (AIHW, 2019a). This group in society is acknowledged by the WHO along with health and social service professions, as undertaking activities to "ensure a person who is not fully capable for self-care can maintain the highest possible quality of life, according to his or her individual preferences with the greatest possible degree of independence, autonomy, participation, personal fulfilment and human dignity" (World Health Organization, 2000). Given declining support from families, increasing life expectancies and the prevalence of dementia (a term for several mostly progressive diseases affecting memory, other cognitive abilities and behaviour, and that interfere with a person's ability to live independently) the WHO forecasts an additional economic burden associated with the provision of the level of care required to manage basic daily activities (WHO, 2017a).

The increasing pressure on informal carers was also highlighted in the recent Royal Commission into Aged Care Quality and Safety Report (Royal Commission into Aged Care Quality and Safety, 2021b), calling for recognition and support for these individuals who help the older person to remain connected to the community (Royal Commission into Aged Care Quality and Safety, 2021b). Meals on Wheels (MOW) is an example of an organisation that relies on a combination of volunteers and paid staff to provide meals, a wellbeing check and social support to older individuals living in the community (AMOWA, 2019). The high proportion, over 70%, of MOW clients living alone, reinforces the role of organisations such as MOW in addressing the social isolation issues that can impact on nutritional intake (Frongillo et al., 2010).

1.3 Healthcare sectors - practical issues

Malnutrition extends beyond older persons living in the community to all health care services defined by the Australian government, including hospitals, rehabilitation, respite care, independent living accommodation or residential aged

care (Aged Care Financing Authority, 2018). A framework developed for this thesis, Figure 1.2, represents the potential movements among these broad health care sectors relevant to older persons living in the community – whether hospital admissions, trips to emergency departments, respite care or a move to independent living accommodation, or permanent move to residential aged care (AIHW, 2020). The prevalence and management of malnutrition within each of these sectors, as well as the coordination of care plans between sectors, can impact operating expenditure, as well as the health and quality of life of individuals. (Royal Commission into Aged Care Quality and Safety, 2021a; WHO, 2015).

Historically, data has been collected on individual sectors, not accounting for how individuals use services within the health care sector. However, a body of work being undertaken by the AIHW refocuses the discussion on the continuum of care, examining the relationships between aged care and health care systems, specifically movements within the hospital and to and from aged care (AIHW, 2020). This change of direction can inform our understanding of the impact of these movements on service delivery (AIHW, 2020) and potentially the management of health conditions such as malnutrition.

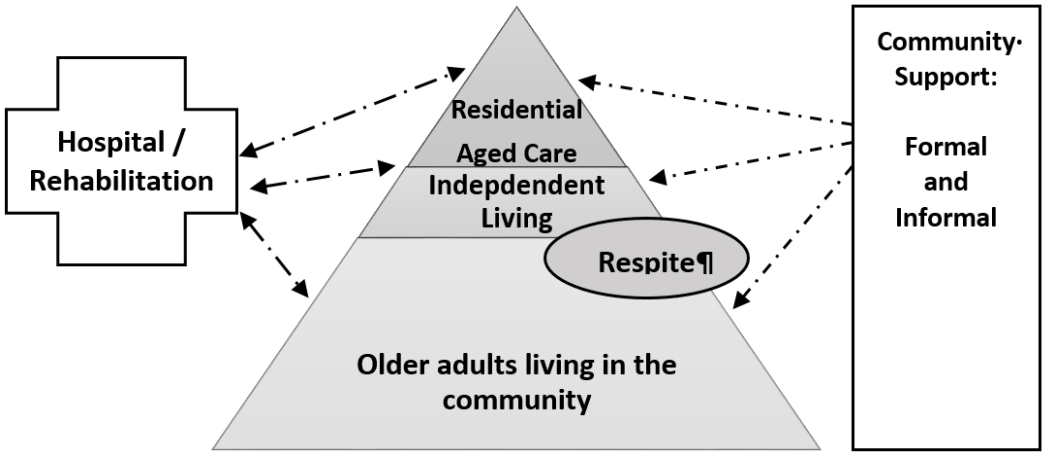

Figure 1.2 Relationship between health care sectors and older adults

This figure illustrates the interaction between the older person - whether living at home or in residential aged care - with services that contribute to their nutritional health, specifically during hospitalisation or support while at home such as Meals on Wheels.

1.3.1 Hospitals

As the second-largest expenditure in the Australian's health budget, $57.7 billion in 2017–18, the second largest expenditure for the Australian Government ($22.7 billion) and the largest recurrent expenditure in the health budget for state and territory governments ($29.9 billion) (AIHW, 2019b), public hospital budgets are carefully monitored (Cutler & Olin, 2017). Consequently, state and territory governments introduce health care reforms to improve health care efficiency and health outcomes, including strategies such as primary care reforms to reduce potentially unavoidable hospital readmissions (Cutler & Olin, 2017). Targeting strategies aimed at increasing food intake may reduce the average length of hospital stay and health care costs by improving nutritional intake and reduce the likelihood of malnutrition (Abizanda et al., 2016; Elia et al., 2016; Meijers et al., 2012; Renuka Visvanathan et al., 2003; Wilson, 2013). Hospital malnutrition was identified in the 1970s (Bistrian et al., 1974) and remains an issue with the prevalence of those "at risk" of malnutrition ranging from 28% in a review of 127 hospital studies (Volkert et al., 2020) to 32% of inpatients reported as undernourished in public hospitals in Australia (Agarwal et al., 2013). In the European Nutrition Day survey, fewer than half the patients finished their meals in hospital, with evidence suggesting a two-fold increase in the risk a patient dying during hospital admission if they eat only one-quarter of the food provided (Hiesmayr et al., 2009).

1.3.2 Residential aged care (RAC) to hospital/rehabilitation

Although the majority of aged care services are provided to individuals in a community setting, residential aged care (RAC) represents the greatest proportion of government expenditure on aged care. In 2017–18 the total cost to governments was $18.4 billion, with residential age care costing governments $12.1 billion in 2016–17 (AIHW, 2019a). While residential care is a long-standing accommodation option for older Australians, a number of recent reviews in Australia, most recently the Royal Commission into Aged Care Quality and Safety (Royal Commission into Aged Care Quality and Safety, 2021a), have highlighted quality issues, including the need for a reform of the management of nutrition programs for older persons living in residential aged care. A report on quality care data from re-accreditation surveys of residential aged care facilities published by the Australian Aged Care

Quality Agency reports that only 39% of residents said that they “always liked the food” (AIHW, 2019a). While there is no industry benchmark for food satisfaction surveys, providing food that appeals to only approximately four out of 10 persons is relatively low, suggesting meeting nutritional requirements for a large proportion of the residents is a challenge, particularly given the tendency for appetites to decline with age (AIHW, 2019a).

Observations from a study of 30 aged care facilities where the pooled prevalence rate of nutritional risk was reported at 17.5% (Volkert et al., 2020), reinforce the need to ensure the food offered to residents is appealing. The Australian Government has subsequently announced the inclusion of unplanned weight loss as one of three mandatory clinical indicators commencing July 2019 (AIHW, 2019a). The recent final report from the Royal Commission into Aged Care Quality and Safety reinforces malnutrition as an issue for the aged care sector, with submissions from clients, carers and professionals, detailing numerous descriptions of unappealing food, indicating a concerted effort will be required to improve service levels consistent with a program to address malnutrition (Royal Commission into Aged Care Quality and Safety, 2021a).

1.3.3 All health care sectors

The management of malnutrition within each health care sector is further complicated by the movement of individuals between sectors. The Australian Government reports that one in four RAC residents were admitted to hospital in 2011–12, with permanent aged care residents responsible for 9% of hospital admissions. (AIHW, 2014). By 2019, of the overnight stays for public and private hospitals in Victoria and Queensland, four in 10 had some funded residential and community-based aged care before or after admission (AIHW, 2020). The impact of these transfers between sectors is challenging for older, frail people, with recommendations calling for consistent communication between sectors, including discharge summaries and integrated systems to facilitate smoother transitions (AIHW, 2020). In their final report, the Royal Commission into Aged Care Quality and Safety identifies collaboration between the aged care system and the health care system, including specific clinical handover protocols when moving from hospital to residential aged care as essential to optimising the level of care for older

persons as individuals move between the sectors (Royal Commission into Aged Care Quality and Safety, 2021a).

The challenge of movements between sectors does not exclude older persons living in the community. Because the potential for re-admission rates to reveal communication breakdowns between acute and community care settings prompts service providers to improve communication (Global Access Partners, 2019), a strategy focused on nutritional health will be increasingly important, as older persons living in the community move to either residential aged care or hospital, sectors where a higher prevalence of malnutrition risk has been reported. While the prevalence of malnutrition for older persons in the community is generally considered lower than for those in hospital or RAC (Volkert et al., 2020), studies undertaken in Australia report that 16% of older persons attending a general practice were at risk of malnutrition (Winter et al., 2013), with the incidence increasing to 34.5% for older persons receiving home nursing care (Rist et al., 2012).

A proportion of older persons living in the community may already be receiving nutritional support from MOW or other support services, while a number may be living independently without external support. An admission to hospital or residential aged care will place these individuals in an environment with a greater level of malnutrition. Given the ageing population, there will be an increasing number of older Australians who require support to remain at home (AIHW, 2007; United Nations Department of Economic and Social Affairs Population Division, 2017). Data from 2004–05 indicate meal services, both home and centre based increased with age, from 15% of clients aged 65–74 years, to 29% of clients aged 85 years or over (AIHW, 2007). Recognising the role of existing resources such as MOW is important to the integration of services to support those living independently at home into the health service, including hospitals, if an optimal balance of care is to be achieved at a time when budgets are under pressure (WHO, 2000). “Social prescribing”, a practice that involves a GP referring patients to community activities and voluntary services, can support integration of services between sectors (Global Access Partners, 2019). This is an approach reflected in a strategy to address a broader perspective on health outcomes, including social

determinants (Global Access Partners, 2019). “Social prescribing” links traditional clinical practice with activities and support services within the community typically provided by local volunteer and community sectors, and is a practice supported by growing evidence of reduced health care demand and costs (Drinkwater et al., 2019), including the evidence of a positive association between loneliness and physician visits (Gerst-Emerson & Jayawardhana, 2015).

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Chapter 2 Malnutrition in healthcare today

2.1 Introduction

> Every careful observer of the sick will agree this that thousands of patients are annually starved in the midst of plenty, from want of attention the ways which alone make it possible for them to take food (Nightingale, 1860).

The need for strategies to encourage individuals who are unwell to eat was recorded by Florence Nightingale in 1860 (Nightingale, 1860). She recommended attention to the "timing of meals (impossible to take any solid foods before 11am)", for individuals to avoid being "engaged in business before or after eating", to "not feel rushed", and for carers to understand those who are unwell need support and guidance, as they are "not aware of their patterns, it is up to the carer to observe the pattern and manage the meals" (Nightingale, 1860). These observations made over 160 years ago remain relevant today, with the condition we now refer to as malnutrition, the subject of many scientific studies.

2.1.1 Malnutrition – early research

Hospital malnutrition achieved prominence in the 1970s following publication of *The Skeleton in the Hospital Closet* (Butterworth, 1974). In this article, Charles Butterworth, Professor of Medicine and Paediatrics and Chairman of the Council on Foods and Nutrition of the American Medical Association, proposed iatrogenic malnutrition as an issue in American hospitals, reporting five case studies, based on his own experience, as representative of the situation in hospitals, and challenging readers to review the nutrition-related practices at their hospitals (Butterworth, 1974). The following year, Bistrian et al. (1975) agreed malnutrition was "partially iatrogenic", but also preventable (Bistrian et al., 1975), subsequently calling for more studies to direct attention to hospital malnutrition (Bistrian et al., 1976).

Over 40 years later, malnutrition remains a challenge for all areas of health care. The following sections examine malnutrition in more detail, including definitions

and assessment, the extent of the issue across the health care sectors, contributing factors and the impact of malnutrition for health care.

2.1.2 Malnutrition definition

At the most basic level, malnutrition is defined as “any disorder of nutrition; it may be due to unbalanced or insufficient diet or due to defective assimilation or utilisation of foods” (Dorland, 2012). At a global level, The World Health Organization (WHO) refers to “deficiencies, excesses or imbalances in a person’s intake of energy and/or nutrient”, encompassing underweight and overweight, obesity and diet related non-communicable diseases (WHO, 2017b).

While these definitions provide a consistent baseline, a more precise, measurable definition is required to investigate the extent of the problem and the impact of potential interventions.

2.1.3 Measurable definitions

Early researchers relied on the WHO definition of protein energy malnutrition, serum albumin level below 3.5 g / 100 mL (Jelliffe, 1996) to demonstrate a correlation with mid-arm circumference to assess the incidence of malnutrition in surgical patients (Bistrian et al., 1974). Acknowledging the logistical challenge of obtaining serum albumin results for all patients, then alternate, non-invasive methods of assessing nutritional status were sought including triceps skinfold thickness, arm muscle circumference, reflecting physiologically important tissues, fat stores and muscle protein and circumference, respectively (Bistrian et al., 1976).

Research investigating the prevalence of malnutrition continued with a focus on developing a consensus statement to provide a basis for comparing results across populations and health care sectors (Jensen et al., 2009). In 2010, at a series of meetings held at the American Society for Parenteral and Enteral Nutrition (ASPEN) and European Society for Clinical Nutrition and Metabolism (ESPEN) congresses, the definition of malnutrition was progressed to account for the pathophysiology of disease that includes varying degrees of under- and over-nutrition and acute or chronic inflammation (Jensen et al., 2010). Focusing on the

inflammatory response, the definition was differentiated on the basis of "starvation", "chronic disease" and "acute disease", with further work required to determine and validate associated criteria including laboratory, functional, food intake or body weight criteria, and translation to validated diagnostic tools for clinical practice (Jensen et al., 2010).

Accepting the consensus agreed on in 2010, the Academy of Nutrition and Dietetics (Academy) and the ASPEN published the "Characteristics Recommended to Diagnose Malnutrition" (White et al., 2012). Considered a work in progress, the document featured patient-specific definitions based on aetiologies, including social and environmental circumstances, chronic illness and acute illness. Acknowledging adult malnutrition cannot be defined by one criteria, the recommended approach required two or more of five characteristics: energy intake, weight loss, loss of subcutaneous fat, localised or generalised fluid accumulation and diminished functional status as measured by hand grip strength (White et al., 2012).

Seeking a single international approach, in 2015, ESPEN published a consensus statement on the diagnosis of malnutrition, consistent with previous publications (Cederholm et al., 2015). The definition specified two options for assessing malnutrition, either:

- Body Mass Index (BMI) < 18.5 (kg/m^2)

or

- weight loss, together with either reduced BMI (age-specific) or a low fat free mass index (FFMI).
    - weight loss could be either > 10% of habitual weight indefinite of time, or > 5% over three months.
    - reduced BMI is < 20 or < 22 kg/m^2 in subjects younger and older than 70 years, respectively (low FFMI is < 15 and < 17 kg/m^2 in females and males, respectively).

In 2016, representatives from ASPEN and ESPEN, FELANPE (Latin American Federation of Nutritional Therapy, Clinical Nutrition and Metabolism) and PENSA (the Parenteral and Enteral Society of Asia) formed the Global Leadership Initiative on Malnutrition (GLIM), supported by a working group comprised of invited members to bring additional global diversity, and subsequently proposed a consensus on diagnostic criteria for malnutrition (Cederholm et al., 2018). The result was a two-step approach to diagnosis, including a screening tool that initially identified "at-risk" patients, followed by a comprehensive assessment framework incorporating phenotypic (weight loss, BMI, reduced muscle mass) and etiologic (food intake, disease) criteria to confirm the severity of the malnutrition (Cederholm et al., 2018).

Finally, with the focus shifting to older persons, another European initiative, the Joint Action Malnutrition in the Elderly (MaNuEL) Knowledge Hub launched a series of systematic literature reviews and observational studies to determine a unified approach to clinical practice and research with older persons. The result was an agreed definition based on an unintended striking loss of weight or a markedly low BMI, as well as an approach to screening, determinants of malnutrition, policies and education (Visser et al., 2017).

In spite of several recent consensus statements, the lack of a "gold standard" definition of malnutrition remains an ongoing issue for researchers (Seguy et al., 2020). Further research is required to address gaps in knowledge (Cederholm et al., 2018; Volkert et al., 2020) and regular reviews of proposed protocols will be required to ensure developments in the understanding of nutrition and disease are captured (Cederholm et al., 2018).

The following section summarises the tools available for assessing malnutrition risk, current knowledge, and gaps in knowledge with respect to the prevalence of malnutrition, factors associated with nutritional health and the impact of malnutrition on the management of health resources and on the individual.

2.1.4 Malnutrition risk assessment tools

To facilitate consistency in the diagnosis of malnutrition, a practical tool is required to diagnose individuals who are "malnourished" and those "at risk" of malnutrition. For individuals "at risk", early identification provides for further assessment, treatment if required (Cederholm et al., 2017), and the potential to minimise complications, poor health outcomes and associated health care costs (Elia et al., 2016).

As early as 2003, acknowledging the need for a predictive tool, researchers report available evidence was insufficient to validate a predictive tool for assessing malnutrition (Kondrup, 2003). During subsequent years a number of screening tools have been validated for use in a clinical and research setting (Cederholm et al., 2015). By 2015, ESPEN issued a consensus statement recommending individuals at risk of malnutrition be identified by validated screening tools (Cederholm et al., 2015). ESPEN defined screening for malnutrition as "a rapid process performed to identify subjects at nutritional risk and should be performed using an appropriate validated tool in subjects that come into contact with health services" (Cederholm et al., 2017). At the same time, ESPEN published a list of suggested tools for adults, featuring combinations of BMI, weight loss, food intake, disease severity and age, and validated by health care sector (Cederholm et al., 2017).

- Nutrition Risk Screening – 2002 (NRS-2002) (Kondrup, 2003).
- Malnutrition Universal Screening Tool (MUST) (Malnutrition Advisory Group (MAG): A Standing Committee of the British Association for Parenteral and Enteral Nutrition (BAPEN)., 2003).

For older persons the following screening tools were recommended:

- Mini Nutritional Assessment (MNA®) either in its full or short form (MNA®-SF)
- Malnutrition Screening Tool (MST), although this tool can be used for any adult age group (Ferguson et al., 1999).
- Short Nutritional Assessment Questionnaire (Kruizenga et al., 2005).

The launch of another European initiative, the MaNuEL Knowledge Hub in 2016 as part of the Strategic Research Agenda of the Joint Programming Initiative (JPI) A Healthy Diet for a Healthy Life (HDHL), brings together twenty-two research groups from seven countries gathering scientific knowledge, strengthening evidence-based practice, building a network of malnutrition experts, and connecting research and clinical practice, all focused on the prevention and treatment of malnutrition in older persons (Visser et al., 2017). With respect to nutrition screening for older persons, the MaNuEL Knowledge Hub identified 34 screening tools validated in 119 studies, 93 of which assessed the criterion validity of the tool, and 68 of these used either a clinical assessment by a nutrition trained professional, the Mini Nutritional Assessment Full-Form or the Subjective Global Assessment. The five tools with the greatest evidence of validity, based on study design and results are listed in Table 2.1 in the column detailing Health care sector – validation (Volkert et al., 2020). A separate scoring system was developed and applied to a possible 48 tools to assess for ease of use for older persons in different settings (Table 2.1 in the column detailing Health care sector – practical aspects) (Volkert et al., 2020).

The results of the MaNuEL initiative, providing guidance for clinicians and researchers in the selection of the most suitable tool for the population and the setting are summarised in Table 2.1.

Table 2.1 Malnutrition risk screening tools validated and assessed for practical aspects, by health care sector*

Malnutrition risk screening tool	Health care sector – validation	Health care sector – practical aspects
Seniors in the Community – Risk Evaluation for Eating and Nutrition Questionnaire Version Two (SCREEN-II) in the community	Living in the community	
The Malnutrition Universal Screening Tool (MUST)	Hospitals	
The Malnutrition Screening Tool (MST)	Hospitals	Hospitals
MNA®-SF		Hospitals
The Short Nutritional Assessment Questionnaire – Residential Care (SNAQRC)	Residential care	Residential care
The Nutritional Form for the Elderly (NUFFE)	Rehabilitation	Rehabilitation
DETERMINE		Living in the community

* As recommended by The MaNuEL Knowledge Hub (Volkert et al., 2020).

2.1.5 Summary

Although groups such as ESPEN and MaNuEL are leading an international consensus initiative on sector-specific malnutrition risk assessment tools, progress remains constrained by variations in criteria used to interpret results and the heterogeneity of the populations across countries and within health care sectors (Volkert et al., 2020).

The following section summarises prevalence data for "malnutrition" and "at risk" by the health care sector, and highlights factors that complicate the consolidation of research outcomes and the development of evidence-based strategies to improve nutritional outcomes.

2.2 Prevalence of malnutrition

The following presents a summary of prevalence data for malnutrition and malnutrition risk in hospitals, the community, residential aged care and other health care sectors. Given an ageing population and the health risks associated with ageing, data for older persons is presented separately. Factors contributing to discrepancies in prevalence data within sectors highlight the challenges associated when comparing and consolidating evidence to support policy development.

2.2.1 Hospital patients – "malnourished"

One of the first studies to assess the extent of hospital malnutrition reports a "striking" 50% of 131 surgical patients were "malnourished" (Bistrian et al., 1974). This conclusion, based on mid-arm circumference and serum albumin, initiated decades of research into hospital malnutrition and the search for an agreed method of assessing malnutrition (Bistrian et al., 1974). A recent cross-sectional, multi-centre study in the Netherlands using BMI, weight loss and nutritional intake as criteria, reports a prevalence rate of 23.8%, varying between wards from 10.3% in coronary care to 32.9% in the geriatric wards (Meijers et al., 2009). Using the MNA®, two recent studies on older adult patients report levels of malnutrition ranging from 22% (Cereda et al., 2016) to 38.7% (Kaiser et al., 2010). The range of results 22% to 38.7%, explained in part by differences in representation across

settings, and participant level of dependence; however, the heterogeneity of the studies using the MNA® is largely unexplained (Cereda et al., 2016).

2.2.2 Older hospital patients – "at risk of malnutrition"

The assessment tools can contribute to variation in prevalence rates. Focusing on patients aged 65 years and over, the combined percentage of patients "at risk" or "malnourished", using three screening tools, ranged from 40.3% – NRS (Nutritional Risk Screening); 45% – SGA (Subjective Global Assessment); 70% – MNA® (Mini Nutritional Assessment) (Bauer et al., 2005). In this study, there was significant association of all three tools with BMI ($p < 0.01$); however, the NRS results were significantly different from either of the other tools. Only the MNA® showed an association with length of stay and serum albumin ($p < 0.05$), further reinforcing the use of the MNA® for older populations (Bauer et al., 2005). Demonstrating need for tools that are easy to administer, Bauer et al. (2005) recommended the NRS as an alternative assessment tool when the required information for the MNA® is not able to be collected reliably (Bauer et al., 2005).

2.2.3 Older persons living in the community – "malnourished"

Malnutrition data reported for older adults living in the community is lower than for hospital patients, ranging from 0% (Bollwein et al., 2013; Kaiser et al., 2011) to 11% (Kiesswetter et al., 2020) and 17.2% (Streicher et al., 2018). The broad range can be accounted for in part by variations in the assessment tool. Using a combination of BMI and weight loss, the two German studies report the highest incidence of malnutrition, 11% (Kiesswetter et al., 2020) and 17.2% (Streicher et al., 2018), while the other study used the MNA® (Bollwein et al., 2013). Sampling technique was identified as a contributor to the zero incidence of malnutrition (Bollwein et al., 2013; Kaiser et al., 2011). Kaiser et al. (2011) observe their recruitment process that relied on individuals responding to a newspaper advertisement limited the cohort to healthy, independent and motivated individuals. Bollwein et al. (2013) refer to their small sample, n = 206, and lack of representativeness. Of the remaining studies using the MNA®, the incidence of malnutrition ranged from 3.1% to 7%. The highest result in this group was reported by researchers from Turkey, who studied 872 older individuals, reporting results separately for those living alone (7%) or with their family (4%) ($p < 0.05$), another

potential factor to be considered when assessing prevalence (Kucukerdonmez et al., 2017).

2.2.4 Older persons living in the community – "at risk of malnutrition"

Studies of older adults living independently in the community report a prevalence of those "at risk" of malnutrition ranging from 14.7% to 73%. The lowest prevalence, 14.7% (Kaiser et al., 2011) and 15.1% (Bollwein et al., 2013), represented the same studies that reported 0% "malnutrition", a potential reflection of sampling techniques, where Bollwein et al. (2013) limited participation to individuals a without cognitive impairment (mini mental state examination > 24 points), and a minimum age of 75, compared to 65 years for Kaiser et al. (2011). The Turkish study represented the highest "at risk" population, with results higher for those living alone, 73%, compared with those living with their family, 66% ($p < 0.05$) (Kucukerdonmez et al., 2017). An Australian study focused on older persons that had been hospitalised, also report a higher prevalence with 30% of older patients were identified as malnourished while 61% were at risk of malnutrition (Adams et al., 2008). The remaining studies report 31.9% (Kaiser et al., 2010), and 38.4% "at risk" (Visvanathan et al., 2003). In the latter study, participants were living in the community, but were recipients of domiciliary care services, introducing another sector variable with the potential to impact outcomes. Although the prevalence of malnutrition varied widely across the studies, the evidence supports ongoing research to clarify factors affecting malnutrition risk in support of strategies to prevent individuals progressing from "at risk" to "malnourished", and the consequent impact on health outcomes and cost (Cereda, 2012; van der Pols-Vijlbrief et al., 2014).

2.2.5 Residential aged care

Representing the greatest proportion of government aged care spending, the proportion of older persons accessing residential care in Australia is low, 7% (AIHW, 2019a). Five studies using either the MNA® or a combination of BMI and weight loss, assessed the prevalence of malnutrition in residential aged care from 13.8% to 23.4% (Cereda et al., 2016; Kaiser et al., 2010, 2011; Meijers et al., 2009). Similar levels of malnutrition (18.0% to 22.7%) were reported in a separate study of 214 nursing homes and 19,876 residents across Austria, the Netherlands

and Germany, where assessment involved either BMI, weight loss or reduced intake and BMI (Van Nie-Visser et al., 2014). Using the Subjective Global Assessment, 50% of residents in six residential aged care facilities in Australia were assessed as malnourished (Banks et al., 2007).

With the exception of the Banks (2007) study, while all results are lower than those observed in the hospital studies, the prevalence is higher than data reported for older persons living in the community, suggesting the level of risk increases as the level of dependence increases (Cereda et al., 2016; Kaiser et al., 2010). In contrast, a Swedish study where the MNA® was used to assess malnutrition in 166 residents, 30% were assessed as "malnourished", with 63% "at risk" of malnutrition (Törmä et al., 2013).

Reflecting on the high rates of malnutrition relative to other studies, the authors nominated ongoing restructure and increased demand on the aged care industry in Sweden as factors contributing to variations in outcomes. This same study (Törmä et al., 2013) also compared the same measures 10 years prior, where malnutrition was higher, 71%, with only 29% "at risk", and residents assessed with a "normal" MNA® score increased to 7% from 0%. In this case, the authors suggested the variation could have been impacted by an increased awareness and nutritional care, sampling from different municipalities, and a change in assessment tool, MNA® versus MNA®-SF. As was reported in the hospital setting where the prevalence of malnutrition varied across wards (Meijers et al., 2009), results for a cross-sectional, multi-centre study in the Netherlands, using BMI, weight loss and intake, report prevalence rates for malnutrition ranging from 13.3%, to 22.8% in psychogeriatric wards ($p < 0.001$) (Meijers et al., 2009). The variation in results from these studies demonstrates the sensitivity of the assessment of the prevalence of malnutrition to multiple variables, and the need for caution when drawing conclusions when variables are unable to be controlled.

2.2.6 Other settings

A meta-analysis across 240 studies provided setting-specific prevalence estimates, including the outpatient setting, where the prevalence of malnutrition, 6% (95% CI,

4.6–7.5), was significantly lower than the other sectors, but similar to that for older persons living in the community (Cereda et al., 2016).

Results across several studies in the "home care" sector ranged from 8.7% to 21.7%. Two cross-sectional studies report the highest results: 15.8% in Germany (Kiesswetter et al., 2020) and 21.7% in the Netherlands (Meijers et al., 2009), both of which used BMI and weight loss to assess malnutrition. For the studies using MNA® as the assessment tool, the results of a meta-analysis identified a lower prevalence of malnutrition, 8.7% (Cereda et al., 2016); however, because assessment tools varied for the other studies, without understanding the study and population-specific variables, the heterogeneity across the studies remains unexplained.

Focusing specifically on an older population, prevalence rates for two geriatric day hospitals of similar size in Germany report rates of malnutrition from 3.1% (n = 191) (Smoliner et al., 2013) to 18.9% (n = 180) (Kiesswetter et al., 2020). Because the former study excluded patients unable to attend the day clinic, higher-functioning adults were favoured, potentially biasing the sample to a healthier population, reinforcing the significance of study design on outcomes (Smoliner et al., 2013).

A systematic review and meta-analysis of 23 long-term care facilities reports a prevalence of malnutrition of 28.7% (Cereda et al., 2016). This systematic review and meta-analysis also assessed setting-related level of dependence, and although the level of dependence appeared to be an important determinant, heterogeneity in individual study results remained substantially unexplained (Cereda et al., 2016). The impact of the level of dependence; however, was reinforced, as the highest level of malnutrition was reported for the "rehabilitation" setting, where three studies using the MNA® report a consistently high prevalence of malnutrition, ranging from 29.4% (Cereda et al., 2016) to 40.8% (Kaiser et al., 2011) and 50.5% (Kaiser et al., 2010).

2.2.7 Summary – prevalence of malnutrition

In addition to standard definitions and assessment tools, the studies identified factors with potential to affect prevalence rates within sectors, including study design, sampling bias, structural and process variables, patient/ward area, living alone/with family, as well as government or industry restructure. While the prevalence of malnutrition is documented across all health care sectors, variations within sectors remains largely unexplained, affecting the ability to develop and implement policies, processes and interventions that minimise the impact of malnutrition. Although factors affecting the prevalence of malnutrition have not been clearly defined, the higher prevalence in hospitals and nursing homes, relative to older persons living in the community, reflects an increase in the incidence of malnutrition and risk of malnutrition as levels of independence (Kiesswetter et al., 2020; Volkert et al., 2019).

2.3 Factors associated with nutritional health

The call for an evidence-based unified approach to determining factors affecting health outcomes, including nutritional health, has been made by researchers (Schilp et al., 2012; Wilkinson & Marmot, 2003) and international organisations, including the WHO (2017), where the benefit of a unified approach to modifying predisposing factors to prevent decline in capacity for older persons is acknowledged (WHO, 2017b). While studies have provided insight into the factors associated with malnutrition, evidence is limited, and in some cases contradictory, reflecting the complexity of malnutrition in health care.

The following section provides an overview of research outcomes and issues with respect to a range of factors that have been associated with adult malnutrition.

2.3.1 Gender

In a prospective study of 1,120 participants aged 65–85 years, being female was one of several determinants statistically associated with an increased risk of developing undernutrition, a problem usually caused by a lack of food with inadequate amounts of specific nutrients (Schilp et al., 2011). One of the few studies to explore gender differences with respect to determinants or malnutrition

risk, Maseda et al. (2018) undertook a cross-sectional study of 749 older persons living in the community. Results for females indicated impaired social resources and decreased physical health as the strongest determinants of malnutrition risk, while being unmarried and unsatisfied with their health were the best determinants of malnutrition/risk of malnutrition for males (Maseda et al., 2018).

2.3.2 Hospitalisation/disease/comorbidities

Moderate evidence for hospitalisation as a determinant of malnutrition was reported in both a longitudinal meta-analysis undertaken by Streicher et al. (2018), and a systematic review published by van der Pols-Vijlbrief et al. (2014). Moderate evidence was also reported in a systematic review of 23 studies (O'Keeffe et al., 2019); however, the majority of the studies was assessed as having a high risk of bias and of a low quality, prompting the authors to identify the need for better, prospective cohort studies.

With respect to specific diseases, a European study of residential aged care reports an association between CVD and malnutrition (Van Nie-Visser et al., 2014). Aimed at identifying sector-specific risk factors for malnutrition in older persons, Kiesswetter et al. (2020) report associations for gastrointestinal and respiratory diseases for older persons living in the community, and respiratory disease only for Geriatric Day Hospitals. Kiesswetter et al. (2020) observed risk factors varied across sectors; however, in all four settings, the likelihood of malnutrition increased with the number of potential individual risk factors.

Research is complicated by factors such as health issues associated with ageing, including geriatric syndrome, where multiple underlying factors contribute to an inability to make a definitive diagnosis (WHO, 2017b). The health care system, where clinical guidelines focus on an individual disease, are not prepared to to recognise and manage impairments in older people with multiple morbidities (WHO, 2017b). Understandably, the evidence is also mixed with respect to malnutrition and the wide range of comorbidities. Two systematic reviews report comorbidities were *not* found to be associated with (O'Keeffe et al., 2019; van der Pols-Vijlbrief et al., 2014); while an earlier prospective study reports having two or

more chronic diseases was associated with an increased risk of developing undernutrition (Schilp et al., 2011).

2.3.3 Physical activity

Moderate evidence that physical activity is *not* a determinant of malnutrition was the conclusion of a systematic review of 23 studies and 30 potentially modifiable determinants (O'Keeffe et al., 2019). In contrast, a low level of physical activity was a risk factor for having a lower protein intake in a survey of 1,825 older adults in five EU countries (Hung et al., 2019). Similarly, difficulty walking stairs was a significant determinant of malnutrition for participants aged 75 years or older in a longitudinal study in the Netherlands (Schilp et al., 2011), with another study recommending walking and stair climbing be included when screening older adults at risk of malnutrition (Streicher et al., 2018). Consistent with the association between physical activity and malnutrition, exercise was identified as a potential strategy for increasing food intake in older persons (Morley, 2001).

2.3.4 Ageing

A meta-analysis of six community-based longitudinal data sets identified age as a determinant of malnutrition, consistent with studies on the process of ageing (Streicher et al., 2018). Ageing is typically accompanied by increasing frailty and multiple diseases that can impact on physical and mental functioning and the ability to live independently (Volkert et al., 2019). Sarcopenia, another common syndrome associated with ageing, is characterised by progressive and generalised loss of skeletal muscle mass, impacts on physical functioning as well as metabolic resistance to disease and stress that can lead to physical disability, reduced quality of life and, potentially, death (Cruz-Jentoft et al., 2010).

2.3.5 Appetite

Highlighting a particular risk for older persons in 1988, Morley et al. define the "true anorexia of ageing" (Morley & Silver, 1988). In the absence of a specific medical condition, anorexia of ageing is a syndrome that impacts directly on nutritional status by limiting intake and thus increasing the risk of malnutrition (Volkert, 2013). Acknowledging the impact of sarcopenia and loss of fat mass with ageing, changes in taste, smell, hormone levels, polypharmacy and depression are

some of the factors identified as factors contributing to the syndrome (Morley, 2012; Morley, 2001; Wilson & Morley, 2003). A study of 526 patients across three sectors in Italy reports an overall prevalence of anorexia of 21.2%, ranging from 3.3% for females living in the community to 33.3% for females in rehabilitation and acute wards (Donini et al., 2013). Prevalence was different between settings but not for gender (Donini et al., 2013).

Anorexic subjects were older, had higher comorbidities, a reduced number of teeth and swallowing issues, and were more dependent on others (Donini et al., 2013). Poor appetite was one of two significant determinants of an increased risk of incident of undernutrition in an early prospective study of 1,120 men and women aged 65–85 years (Schilp et al., 2011). Two systematic reviews report an association between malnutrition and poor appetite as either strong (van der Pols-Vijlbrief et al., 2014) or moderate (O'Keeffe et al., 2019); while all health care sectors in Europe, with the exception of nursing homes, provided evidence of an association between poor appetite and malnutrition (Kiesswetter et al., 2020). Given the range of factors impacting on appetite for older persons, the association between appetite and malnutrition is not unexpected.

2.3.6 Eating – oral health

With respect to dental health, van der Pols-Vijlbrief (2014) reports moderate evidence for an association between malnutrition and edentulousness. While toothache when chewing was identified as a determinant of the incident of malnutrition in a prospective study of 893 older adults in the Netherlands, the authors reinforced the need for further research on the association between oral health and the risk of malnutrition (Kiesswetter et al., 2019).

Research related to less specific oral health issues demonstrates the potential impact of definition, health care sector, and study design on outcomes. Investigating older persons across four sectors, O'Keeffe (2019) reports moderate evidence that chewing difficulties, mouth pain and gum issues are not determinants of malnutrition. Strong evidence for no association was reported in a systematic review of 28 studies limited to older persons living in the community with chewing issues (van der Pols-Vijlbrief et al., 2014). In contrast, difficulty eating was

associated with malnutrition in a cross-sectional study undertaken in older persons living in the community, but not for participants in the other three sectors, geriatric day hospitals, home care or nursing homes (Kiesswetter et al., 2019).

A lack of sufficient evidence from high quality studies is the major factor impacting a lack of a clear association between oral health and malnutrition (Van der Pols Vijlbrief et al., 2014; O'Keefe, 2019). In the absence of further evidence, where evidence-based determinants are potentially modifiable, a prevention strategy is recommended in preference to treatment with ONS or dietetic advice (Van der Pols Vijlbrief et al., 2014).

2.3.7 Social and environmental

With respect to global health, the WHO identified a number of social determinants of health, including social support, access to food, and transport (Wilkinson & Marmot, 2003). Eating is acknowledged as a social act, where appetite and intake can improve in the presence of company (Volkert et al., 2019). Reflecting on the impact of eating alone, a potential consequence of living alone, Paquet et al. (2008) investigated the impact of interpersonal exchanges on energy intake for 32 geriatric patients, reporting a positive association between the total amount of social interaction between patients and energy intake, providing support for studies exploring social interaction to suggest new approaches to improving nutrition intake (Paquet et al., 2008). Evidence to support an association with the risk of malnutrition was reported in a longitudinal study in the Netherlands with respect to loneliness and not having a partner (Schilp et al., 2011), and in a meta-analysis of six longitudinal data sets from the MaNuEL partners for unmarried, separated or divorced participants compared with married participants, but not for widowed participants (Streicher et al., 2018).

In contrast, a systematic review across 28 studies report strong evidence for *no* association between protein energy malnutrition and few friends, living alone, feeling lonely, death of a spouse (van der Pols-Vijlbrief et al., 2014). A systematic review of 23 studies also report psychological distress, anxiety and loneliness are *not* determinants of malnutrition; however, the evidence was considered low, with the majority of studies of low quality with a high risk of bias (O'Keeffe et al.,

2019). Overall, these studies highlight the variability within the older population and the need for further studies to advise on the potential association between social connection and malnutrition.

2.3.8 Summary – factors associated with nutritional health

While there appears to be some growing consensus that age, particularly over 75–80 years, being female, and having a poor appetite are associated with malnutrition, the data continue to be confounded by variations across countries, health care sectors, health care systems and screening tools. Overall, the evidence is typically either insufficient or contradictory (Maseda et al., 2018; O'Keeffe et al., 2019; Schilp et al., 2011; van der Pols-Vijlbrief et al., 2014; Volkert et al., 2020). The "Determinants of Malnutrition in Aged Persons" (DoMAP) developed by the Joint Action Malnutrition in the Elderly (MaNuEL) project reflect the complexity of this aspect of malnutrition for older persons. As the population continues to age, there is an increasing need for "targeted modifiable determinants" to prevent and manage malnutrition for older persons (O'Keeffe et al., 2019; van der Pols-Vijlbrief et al., 2014). The research recommends continued investigation of factors associated with malnutrition to support the development of reliable, valid interventions to reduce the impact of malnutrition on health care resources and quality of life (Hung et al., 2019; Kiesswetter et al., 2019; Maseda et al., 2018; O'Keeffe et al., 2019; van der Pols-Vijlbrief et al., 2014; Volkert et al., 2020).

2.4 Impact of malnutrition

Malnutrition has been associated with a negative impact on quality of life and activities of daily living as well as health care costs (Elia & Southampton, 2015). The following section outlines the impact of malnutrition on the individual and health care expenditure.

The WHO has referred to malnutrition as a major problem for older adults, often represented as reduced cognitive ability and ability to care for oneself leading to becoming more dependent, and potentially the start of an ongoing decline in the quality of life (WHO, 2017b). A report on the cost of malnutrition in the UK, prepared on behalf of British Association for Parenteral and Enteral Nutrition

(BAPEN) and the NIHR Biomedical Research Centre, represented the reality of the negative impact of malnutrition on body function including muscle weakness, loss of energy, fatigue and poor coordination which, in turn, understandably, impact negatively on activities of daily living (Elia & Southampton, 2015). Although the ageing process cannot be stopped, these debilitating complications can be delayed.

Rather than the absence of disease, the WHO public health framework guidelines focus on maximising the individual's intrinsic capacity, their physical and mental capability and functional ability, to support quality of life (WHO, 2017b). Malnutrition, considered one of the early indicators (WHO, 2017b), is in turn associated with a lack of appetite, the anorexia of ageing and the quality of the ageing process (Morley, 2012). However, as these early markers are often not acknowledged, treated or monitored, the opportunity to delay the ageing process is missed.

While it can be difficult for the older individual to recognise and acknowledge the decline (Volkert et al., 2019), relatives and health-care professionals have been nominated as playing an important role in identifying undernutrition, which in turn assists in managing the consequent risk of infection, hospitalisation, reduced quality of life and mortality (Arvanitakis et al., 2008). The belief that there is no treatment available can present a further barrier to family and friends, reducing the likelihood they will seek assistance (Arvanitakis et al., 2008). Ensuring health professionals and community organisations, along with friends and relatives are aware of malnutrition and the impact on health and wellbeing is necessary to ensure a "continuum of care" can be created for our older adults (Arvanitakis et al., 2008; WHO, 2017b).

In addition to reducing the quality of life for the individual, malnutrition has a direct impact on the cost of health care across the sectors (Correia & Waitzberg, 2003). A retrospective study of 709 hospital patients, aged 50.6 (± 17.3) years from 25 Brazilian hospitals, report a significantly higher incidence of medical complications for malnourished patients (Correia & Waitzberg, 2003). Higher readmission rates (Agarwal et al., 2013; Arvanitakis et al., 2008; Elia & Southampton, 2015), and an increased length of hospital stay (Agarwal et al., 2013;

Arvanitakis et al., 2008; Correia & Waitzberg, 2003; Elia & Southampton, 2015; H. Kruizenga et al., 2016; Visvanathan et al., 2003; Weinsier et al., 1979) for malnourished patients not only interrupt the individual's ability to enjoy life, they also impact directly on the cost of health care, with more frequent, and longer hospital admissions. A prospective study of 288 frail older clients receiving home help services, demonstrated a strong association of weight loss with the probability of institutionalisation (Payette et al., 2000), reflecting an impact on the residential aged care sector. The cost impact of malnutrition was identified in a position statement issued by the Australian and New Zealand Society for Geriatric Medicine in 2007, where under-nutrition was reported as common, increasing with frailty in older persons, and associated with poor health outcomes and increased health care costs (Visvanathan, 2009).

Reinforcing the message, a forum held in Brussels concluded under nutrition-related disease in older persons was an economic burden for most countries (Arvanitakis et al., 2008). Although the research investigating the cost of malnutrition is limited, the results are consistent. A systematic review of research involving older persons living in institutions or the community reports higher health care costs for those assessed as malnourished referring to GP consultations, hospitalisations and health care monitoring as well as treatment (Abizanda et al., 2016). In an attempt to measure the actual cost of managing malnutrition, the results of a survey of nursing homes in the Netherlands reports the additional cost €8,000 ($12,245 AUD) per patient "at risk" and €10,000 ($15,306 AUD) for "malnourished" patients (Meijers et al., 2012); while in a retrospective study of 25 Brazilian hospitals, costs for malnourished patients were increased up to 308.9% (Correia & Waitzberg, 2003).

Finally, acknowledging the need for more evidence-based information to refine costs, the proportion of health activity in the UK due to malnutrition for 2011–12 was estimated at £19.6 billion ($35.15 billion AUD), or 15% of the total UK expenditure on health care, with older persons accounting for the majority of the cost (Elia & Southampton, 2015). While these estimates vary with respect to the costing methodology, the magnitude of the expenditure confirms the potential for a

reduction in recurrent health care costs as a potential positive outcome of ongoing research (Visser et al., 2017).

The knowledge that malnutrition has a negative impact on quality of life and health care costs (Norman et al., 2008; van der Pols-Vijlbrief et al., 2014) prompted calls for early diagnosis, treatment, and ideally, prevention (Volkert, 2013; Streicher et al., 2018). Given the estimated cost of malnutrition, even a small saving would make a significant contribution to the budget, not to mention the benefit to the quality of daily life for individuals (Elia & Southampton, 2015). While the incidence and impact of malnutrition in the health care industry has been documented, as outlined in Chapter 1, a number of factors including an ageing population, the continued focus on living in the community, the likelihood of living alone, as well as the challenges being addressed in the provision of services to residential aged care, suggest the incidence of malnutrition will continue, if not increase, along with the demand for management strategies for those in institutional care and living in the community.

2.5 Policy - Standards and guidelines

In order to assess the future needs it is important to understand current strategies in place to address the identification and management of malnutrition in health care sectors. The following section outlines the regulations, guidelines and practices related to food and nutrition across the three health care sectors – hospitals, residential aged care and older persons living in the community.

2.5.1 Hospitals

With respect to nutritional health, including malnutrition, hospitals in Australia are subject to accreditation standards that define the quality of patient care. The Australian Commission on Safety and Quality in Health Care (the commission), an independent statutory authority, developed the National Safety and Quality Health Service Standards (NSQHSS) (Australian Commission on Safety and Quality in Health Care, 2017) that require the food service to demonstrate they ensure patients' *nutritional needs*, are identified, met and monitored, and assistance with eating is provided where required. Complementing this national standard, state-

specific food and nutrition standards and guidelines address menu standards including the nutritional content, choice and portion size. The *Queensland Health Nutrition Standards for Meals and Menus* are an example of standards that have been successfully implemented throughout the state (Queensland Health Statewide Foodservices Network Food Service, 2018).

2.5.2 Residential aged care

The *Aged Care Act 1997*, the law that covers government-funded aged care including quality of care and individual rights is supported by the Aged Care Quality Standards (Australian Commission on Safety and Quality in Health Care., 2017). While these standards are more outcome based than the prescriptive state-based standards and guidelines for hospitals, there remains a requirement to ensure meals are "varied and of suitable quality and quantity", a statement clarified in supporting documentation that requires "enough nutrition and hydration to maintain life and good health and reduce the risks of malnutrition and dehydration" (Australian Commission on Safety and Quality in Health Care, 2017). Notwithstanding these requirements, the Royal Commission into Aged Care Quality and Safety Interim Report refers to "dreadful food, nutrition… leading to widespread malnutrition" (Royal Commission into Aged Care Quality and Safety, 2019) indicating the management of food, nutrition and malnutrition in the aged care sector could be subject to changes in the future.

2.5.3 Older adults living in the community

Older persons living independently in the community manage their own meal choices, with nutritional support from a dietitian available on referral from a general practitioner. For those living in the community who require support for meal preparation or grocery shopping, options currently include either informal carers or in-home carers funded by Commonwealth support programs. Alternatively, prepared meals can be sourced from either retailers, commercial suppliers of prepared meals or recipe-ingredient packages, or from government-funded Meals on Wheels organisations.

The Australian Meals on Wheels Association (AMOWA), the peak body for state and territory organisations, represents volunteers and local communities and

provides a link with funding bodies, regulators and sponsors (Oppenheimer et al., 2014). Providing strategic direction for services, AMOWA remains focused on helping frail older people and younger people with disabilities and their carers to stay in their homes by extending the service beyond the provision of meals, to include an opportunity for social interaction and the potential to monitor a person's health and wellbeing …"More than a meal". (AMOWA., 2021).

In 2013, the Commonwealth Department of Health funded a project to review the status of Meals on Wheels in Australia to identify service delivery implications to ensure meal services under the new Commonwealth Home Support Program (CHSP) and meet the objectives of the program. The review confirmed the importance of the nutritional element of the MOW service, and the equally important role of supporting clients' social needs and providing a monitoring function. Future opportunities include ensuring a flexible, creative and client-centred approach to service delivery that can adapt to the more diverse needs of the clients and support individuals to live independently in the community (Oppenheimer, 2014).

In 2016 AMOWA obtained funding from the Australian Government Department of Social Services (now the Department of Health) and published the *National Meal Guidelines: A Guide for Service Providers, Caterers and Health Professionals Providing Home Delivered and Centre Based Meal Programs for Older Australians* (AMOWA, 2016). This long-awaited document, replaces the original national standard published in 1977 (Commonwealth Department of Health, 1977) as well as several state standards, providing the industry with a coordinated approach to service delivery. With a focus on individual choice and nutrition, the guide provides nationally consistent advice to support service providers in creating a flexible approach that ensures the unique demographics of each service can be accommodated. While the new guidelines have not changed the nutrient goals for delivered meals – one-third of their energy requirements and one-half of their protein requirements for the day, the guide provides a flexible approach to optimising service outcomes for the clients, as well as highlighting the negative impact of unintentional weight loss for clients, and providing specific guidelines for managing malnutrition (AMOWA, 2016). Acknowledging the

contribution of delivered meal services, in 2020 the Australian government provided a $1.2 million grant to support future emergency response capability and an additional $40 million in government support under the Commonwealth Home Support Program (AMOWA, 2020).

2.5.4 Summary – policies and guidelines

While the health care industry maintains a number of accreditation programs for food and nutrition services, malnutrition continues to be an issue across all sectors. Ongoing reviews of policy and regulatory audits will be important steps in managing, and ideally reducing, the incidence of malnutrition.

2.6 Strategies in the workplace

In 1974, Butterworth published a list of 14 "undesirable practices" related to hospital malnutrition he believed could benefit from "acknowledgement and common sense solutions" (Butterworth, 1974). With malnutrition remaining a constant in health care, a number of system-related strategies to improve intake and address malnutrition have been implemented across various health care settings with mixed results. An overview of research into each of the process steps in the food service system is presented from the patient perspective, starting with the patient selecting their menu, through to production/fortification, meal assembly – delivery, and the provision of oral supplements.

2.6.1 Menu ordering in hospital

The patient's first encounter with food service involves placing their meal order. In a traditional paper-based system, meals are ordered on a paper menu, typically the day before service. Assistance from staff may or may not be provided. Recent innovations in menu ordering have focused on utilising technology, potentially reducing the time between meal ordering and delivery, and allowing patients to order according to their appetite and, where possible, avoid interruptions (Maunder et al., 2015) (McCray, Maunder, Norris et al., 2018).

Two recent systematic reviews of electronic meal ordering systems (EMOS) (MacKenzie-Shalders et al., 2020; Prgomet et al., 2019) identified five studies

investigating electronic bedside menu ordering systems (BMOS), including three Australian studies reporting on nutritional intake (MacKenzie-Shalders et al., 2020). Two hospital studies investigated a "staff-directed" BMOS whereby nutrition assistants (NA) discussed diet-compliant menu options with the patient, and entered their selections on a mobile device (McCray, Maunder, Norris et al., 2018; Maunder et al., 2015). Both studies report an increase in total energy and protein intake, as well as intake as a percent of estimated daily requirements (Maunder et al., 2015; McCray, Maunder, Norris et al., 2018). An increase in NA time with patients, from 0.33 to 3.5 minutes per patient per day, confirmed an increase in staff-patient interaction (Maunder et al., 2015). While the BMOS systems and processes were similar at both hospitals, the study by McCray et al. (2018) had also changed the menu from a 14-day to a seven-day cycle and introduced contemporary menu items, variables that may have affected the outcomes (McCray, Maunder, Norris et al., 2018).

A third study investigated a patient-directed BMOS where menu options are viewed and entered by patients on electronic terminals at their bedside, using a touch screen and/or mouse and keyboard (Barrington et al., 2018). This study reports an increase in energy and protein intake compared to the paper menu system, with patients more likely to receive the food they ordered and choose food they liked (Barrington et al., 2018). In contrast with the staff-directed BMOS, with the electronic terminal, patients now have 24-hour access to menu ordering, and the ability to place orders up to 1 hour before a meal, offering the patient a further level of flexibility (Barrington et al., 2018). Although the menu in the Barrington study (2018) remained unchanged pre- and post-BMOS, the variety of mid meal selections was increased to include oral nutrition supplements (ONS) and snacks, introducing another system variable to be considered when comparing studies.

While these studies support BMOS to improve intake, they also highlight the potential variations across systems and study design, and the need for a consistent approach to research in this area to confirm potential benefits and optimise resource allocation (Mahoney et al., 2009; MacKenzie-Shalders et al., 2020; Dijxhoorn et al., 2019).

2.6.2 Production and fortification

A systematic review of articles published between 1996 and 2015 identified 10 articles that investigated and report a positive impact of energy and/or protein enrichment of foods on the intake for hospital patients (Mills et al., 2018). Of the four RCTs included in the review, one compared an enriched and standard menu, reporting an increased intake of both energy and protein; however, no impact in meeting 75% of protein requirements, or functional condition (Munk et al., 2014). However, a concurrent change to the ordering and assembly-delivery system may have contributed to the results of this study (Munk et al., 2014). Two RCTs offering variations of protein-enriched bread and yoghurt "throughout the day" report an increased protein intake but not energy (Stelten et al., 2015; van Til et al., 2015), with patients in one study achieving a protein intake of 1.2 g/kg per day (van Til et al., 2015). Rather than a standardised menu, the final RCT compared a fortified menu with ONS, reporting an increased energy and protein intake, as well as improved triceps and arm circumference, and MNA® score (Cots, 2013).

Only one of the remaining six studies included in the systematic review, Mills (2018) reports an increase in the intake of both energy and protein with an enriched menu (Loreﬀalt et al., 2005), with all other studies reporting an increased intake of only one nutrient (Barton et al., 2000; Beelen et al., 2017; Gall et al., 1998; Olin 1996). It is worth noting that one of the studies included a second intervention, a comparison with a standard menu and a hot breakfast adding 200 kcal and 12 g protein, resulting in an increase in both energy and protein intake (Barton et al., 2000). Focusing on non-meal options, the final study compared energy enriched snacks with ONS with (MedPass), a system where a 2 cal/mL supplement in a 60 mL portion was delivered to patients at medication rounds, or as part of a mid-meal selective snack trolley offered between meals (Campbell et al., 2013). A higher intake of energy and protein was reported with ONS and MedPass interventions relative to energy-enriched snacks (Campbell et al., 2013).

Focusing on protein intake only, a RCT of 147 patients ≥ 65 years, incorporated a range of protein-enriched products to replace standard menu items, or as additions to the menu (Beelen et al., 2018). The protein intake for the intervention group, relative to the control group, was 1.5 versus 1.2 g/kg/day, with 79% of patients in

the intervention group reaching a protein intake of 1.2 g/kg/day compared with 48% in the control group (Beelen et al., 2018). The study included details of menu items enriched with protein from plant and/or animal sources, such as soy and dairy, including fortified bread (6.3–7.9 g / 35 g), cakes (9.9 g / 65 g), dairy drinks, fruit juices (10.1–10.6 g / 150 mL), ice cream (10 g / 100 mL), mashed potato (10.5 g / 150 g), meat (18.9 –22 g / 80 g), meat snack (12.4 g / 50 g), and soup (10.1 g / 100 mL) (Beelen et al., 2018). Protein-enriched products accounted for approximately one-third (31 g) of total protein intake in the intervention group, with, surprisingly, enriched bread products and fruit juices contributing on average 12 g and 7 g of protein per patient per day (Beelen et al., 2018). The authors suggested that, because patients were allowed to select items from an extensive menu of protein-enriched products, rather than products being specifically allocated a food or beverage, the product range and method of delivery of fortified products could be factors affecting intake (Beelen et al., 2018).

A study of multiple interventions combining a modified ordering system with fortified meals reinforced the potential role for fortification (Dijxhoorn et al., 2018). The FoodforCare system involved offering patients six meals per day, including a selection of three small protein-rich dishes, with the utilisation of nutrition assistants who were specifically trained in hospitality and product knowledge to assist patients and recommend protein-rich meals (Dijxhoorn et al., 2018). Compared with a standard three-meal-per-day service, patients receiving the FoodforCare service improved mean daily energy intake relative to requirements at Day 1 and Day 4 (Dijxhoorn et al., 2018). Finally, patients offered a protein-enriched menu in combination with individualised diet counselling increased their energy and protein intake (Munk et al., 2017). The potential for fortification of MOW meals to increase nutrient intake was demonstrated in a study undertaken in the Netherlands where the provision of protein-enriched meals resulted in a higher energy and protein intake, with no (negative) impact on overall taste between samples (Ziylan et al., 2016). A study of 29 nutritionally at-risk older persons living in the community, shows the provision of protein and energy fortified, compared with the standard, MOW meals, results in comparable improvements in nutritional and functional status, quality of life, and hospital admissions, including length of stay. Considering the fortification of MOW meals more broadly, a

systemic review that included 19 studies was able to conclude the provision of protein-enriched bread or snacks in addition to meals, as well as increasing the number of meals consumed during short intervention periods, contributed to improved intake of energy and protein, an intervention considered worthy of further investigation (IJmker-Hemink et al., 2020).

In spite of variations in study design, products, levels of fortification and methodology, all studies report an increased intake, highlighting the potential for fortification to improve intake. This outcome is consistent with the ESPEN guideline, where the use of fortified foods and ONS are supported by "strong evidence" for the prevention and treatment of malnutrition (Cederholm et al., 2017).

2.6.3 Meal assembly and delivery systems

The impact of food service interventions on outcomes, including clinical outcomes, has been the focus of a number of publications, including three systematic reviews. The methodological quality of nine non-randomised studies, chosen from a possible 33 studies reporting on clinical outcomes, was assessed as "positive" QoR (quality of research) and acceptable for inclusion in a systematic review (Dijxhoorn et al., 2019). Simultaneously, a report published by the Canadian Agency for Drugs and Technologies in Health (CADTH), a not-for profit organisation tasked with providing objective evidence to assist health care decision makers in Canada to optimise outcomes, incorporated the Dijxhoorn (2019) review and the associated studies, as part of their evaluation of the clinical effectiveness of hospital food service system interventions (DeJean & Farrah, 2019). The third, an earlier systematic review, focuses on eighteen studies investigating point of service (POS) food service systems, nine of which report on energy intake (Mahoney et al., 2009). The studies discussed below are included in one or more of these reviews, and provide an overview of interventions measuring the clinical impact of meal assembly and delivery processes. For the purposes of this discussion, the interventions have been classified as a bulk system, Steamplicity® or room service.

2.6.4 Bulk systems

This system dates back to the first hospitals where bulk food was transported to an open ward to be plated (assembled), often by nurses, and delivery to the patient bedside. Typically, these bulk systems are compared with centralised systems, where meals are ordered by patients, typically the day before service, and plated in a central kitchen prior to delivery to the patient. Comparing a central plating and a bulk system, and retaining the current menu, recipes and ordering process, two studies demonstrated an increased intake of energy and protein (Wilson et al., 2000), and volume of food with the bulk system (Goeminne et al., 2012). The authors suggested plate presentation, flexibility in portion size (Wilson et al., 2000) and the ability of patients to change their order at the point of service (Goeminne et al., 2012; Wilson et al., 2000) as factors contributing to the improved intake.

In contrast, a small study of 31 patients reports an increase in patient satisfaction, but was unable to demonstrate an impact on intake of either energy or protein when the centrally plated meal system was changed to enable patients to see and smell the food on offer and interact with staff as the meal was plated from a trolley at the point of consumption (Hartwell & Edwards, 2003). Introducing multiple factors, a larger study reports the energy and protein intake for patients with the lowest energy intake could be increased by changing from a pre-plated meal system with a fixed menu to a bulk system for the evening meals only (Freil et al., 2006). In this case, a combination of three factors contributed to the improvement: an increase in the energy density of the food, providing a menu choice and training the hospital staff (Freil et al., 2006).

2.6.5 Steamplicity®

Utilising microwave technology, the Steamplicity® system offers an extensive list of meal options as pre-plated meals that are reheated immediately prior to delivery to the patient, allowing patients to order their meal close to the meal time (Edwards & Hartwell, 2006). A few studies comparing the Steamplicity® with different systems, report mixed results with respect to intake. Compared with a centrally plated cook chill system, where meals were ordered a day in advance and reheated after assembly, patients provided with Steamplicity® meals consumed an increased amount of food; however, nutrient intake was not recorded (Edwards & Hartwell,

2006). In contrast, relative to a bulk system where meals were also ordered in advance (time not specified), a study of 57 patients consuming Steamplicity® meals did not meet their energy requirements and ate less energy (Hickson et al., 2007). It is worth noting the reliability of the comparison in this latter study is affected by the inclusion of a data set from a previous study, and a number of assumptions related to requirements and intake made between two studies, reducing the strength of the comparison (Hickson et al., 2007).

2.6.6 Room service

A room service model offers patients a restaurant-style menu, and the opportunity to order meals any time, typically, from 0700 to 1900. The order is processed in a central kitchen and the meal delivered within 45 minutes of the order being placed. Established in the US in the early 2000s, the first hospital room service system was commissioned in Australia in 2013. This system, including variations to the original model, have since been implemented by a number of private, and some public hospitals in Australia. Positive clinical outcomes have been reported in a number of studies; however, the absence of studies with a high quality rating and the heterogeneity of the data continues to complicate comparisons (Dijxhoorn et al., 2019; Prgomet et al., 2019; Young & Farra, 2019). The following summarises studies reporting clinical outcomes.

A positive impact on intake following the implementation of room service was first reported in two studies, both at paediatric hospitals (Kuperberg et al., 2008; Williams, 1998). At a 48-bed paediatric hospital in the US, patients' intake of energy increased with the change to room service from a centrally plated system, where patients ordered their meal the day before service (Williams, 1998). In a study published ten years later, a Canadian paediatric hospital serving 800 meals per day changed from a system where orders were placed two days in ahead from a limited menu selection, with chilled meals reheated prior to delivery patients, to room service, where patients could now design their own sandwiches, wraps, pizzas and pastas, and call in their order within a two-hour window, which were delivered within 45 minutes (Kuperberg et al., 2008). Reporting the results by meal, the study demonstrated an increased intake of energy and protein at the lunch meal (Kuperberg et al., 2008).

Variations to either the standard room service or comparative models were subsequently reported in three studies (Larsen & Toubro, 2007; Sathiaraj et al., 2019; Munk et al., 2014). A Danish study compared a traditional system with a central kitchen, fixed meal times and a fixed menu, with the exception of a buffet breakfast and lunch (Larsen & Toubro, 2007) with a room service system. Based on self-reported food intake record, this study reports an increase in energy associated with an increase in fat intake and reduction in carbohydrate, but no impact on protein intake. The increased energy intake was only observed for patients BMI > 25 kg/m^2 (Larsen & Toubro, 2007). A cross-sectional study of oncology patients in India compared their traditional system with fixed meal times and a seven-day menu with trayed meals, with a variation to a room service menu using a spoken BMOS for meal ordering from an all-day menu that included midnight snacks (Sathiaraj et al., 2019). With the room service model, patients increased their protein and energy intake and gained weight (Sathiaraj et al., 2019).

In another Danish study, 84 patients at nutritional risk participated in a single-blinded randomised controlled trial. In this study, the provision of meals did not change with patients choosing their meals from a buffet service, three meals per day, with in-between meal options including microwaveable meals, cakes, biscuits, cheese and ONS (Munk et al., 2014). The system intervention retained the current system, but added a supplementary room service component featuring a menu of 23 energy and protein-fortified small dishes (Munk et al., 2014). Patients could order, by phone, as many of these small dishes as they liked, at any time between 0700 and 2000, and the small meal would be delivered to their bedside within 20 minutes (Munk et al., 2014). The result was an increase in protein intake, as well as the number of patients achieving ≥ 75% of their protein requirements (Munk et al., 2014). While the mean energy intake did not increase with the new system, energy intake according to body weight was higher (Munk et al., 2014). The authors suggested this unexpected result may have been a function of an increased focus on intake for patients in the control group as a result of the recording of intake (Munk et al., 2014).

Another three studies compared similar room service models with a traditional food service system, where patients ordered their meal the day before service and

received a trayed meal at a fixed meal time (Doorduijn et al., 2016; McCray, Maunder, Barsha et al., 2018; McCray, Maunder, Krikowa et al., 2018). No significant difference was reported between the room service system, "At Your Request", and the traditional system (Doorduijn et al., 2016). It is worth noting that in this study, intake was measured using food lists recorded twice per week by nurses, and only in a sub-group of patients requiring an energy- and protein-rich diet (Doorduijn et al., 2016). The other two studies utilised retrospective quality assurance data, in a pre-post study design, where the room service model included a "build your own" menu concept and a selection of short-order item (McCray, Maunder, Krikowa et al., 2018; McCray, Maunder, Barsha et al., 2018). Both studies, a private and a public hospital, report a positive impact on energy and protein intake, as well as nutritional intake as a percentage of estimated requirements (McCray, Maunder, Krikowa et al., 2018; McCray, Maunder, Barsha et al., 2018).

2.6.7 Food Service System Interventions - A summary of previous research

A positive impact on nutritional intake was demonstrated in studies that featured a meal ordering system close to the meal time (BMOS/EMOS) and production systems involving food fortification. Meal assembly and delivery system interventions also indicated the potential for clinical improvements, by varying a range of system components. Interestingly, a number of the system interventions reporting a positive impact on intake incorporated a meal ordering variation that reduced the time between ordering and meal delivery and flexibility in meal timing, including bulk systems (Goeminne et al., 2012; Wilson et al., 2000), room service (Kuperberg et al., 2008; McCray, Maunder, Barsha et al., 2018; McCray, Maunder, Krikowa et al., 2018; Sathiaraj et al., 2019; Williams, 1998), and a room service menu offering fortified snacks and ONS (Munk et al., 2014). While the three reviews identified the potential for interventions to improve clinical outcomes, they also report the need for large, methodologically sound studies to address inter-study heterogeneity of the interventions and outcomes that increase the risk of bias and reduce the uncertainty of the outcomes (Young & Farra, 2019; Dijxhoorn et al., 2019; Mahoney et al., 2009).

2.6.8 Mealtimes – protected meal times (PMT) and feeding assistance

Studies investigating food service system interventions associated with the meal time, protected meal times and feeding assistance, have produced mixed results. Protected Meal Times (PMT) refers to a system designed to minimise interruptions during patient meal times. This is particularly relevant in the hospital setting where frequent, unscheduled interruptions by various staff occur during the day often interrupt a meal time resulting in a missed or partially consumed meal (Porter et al., 2017). With the aim of improving intake by supporting the consumption of food, in 2004 the Hospital Caterers Association recommended a policy of PMT, defined as "periods when all ward based activities (where appropriate) stop to enable nurses, ward based teams, catering staff and volunteers to serve food and give assistance and support to patients" (Hospital Caterers Association, 2004).

In spite of attracting considerable attention by researchers, controversy remains regarding the potential to increase intake and potentially reduce malnutrition (Roberts, 2018) often reflecting study quality issues (Porter et al., 2017). In 2013, a systematic review of the impact of several models-of-care, including PMT, reports the majority of published studies were excluded from the review as they were observational, without blinding, increasing the risk of bias (Wade & Flett, 2013). The one study included in the review reports no improvement on energy intake, with an unexplained decrease in protein intake (Hickson et al., 2011). The authors suggested a lack of policy, promotion, communication and education in the implementation of PMT, calling for further structured research to confirm the impact of PMT on intake (Hickson et al., 2011). A pre-post study of 254 older, medical in-patients compared multiple interventions – PMT, AIN (assistant-in-nursing), and PMT with AIN – with each other (Young et al., 2013). Post-intervention, participants were more likely to achieve adequate energy intake, with no difference observed between interventions (Young et al., 2013). A second study found no association between PMT and intake, generating a call for further studies to explain factors impacting on inpatient intakes (Palmer & Huxtable, 2015). Subsequent reviews between 2017 and 2020 failed to provide additional support for the role of PMT in improving intake (Dijxhoorn et al., 2020; Porter et al., 2017; Roberts, 2018).

Providing assistance to patients at meal times can involve tasks ranging from positioning the patient to opening packages (Walton, 2012). Examining the role of dietitians in food service. Walton (2012) identifies feeding assistance, including the management of packaging, setup and assistance, as areas where dietitians could contribute to a team-based approach to service improvement and ultimately nutritional intake (Walton, 2012). An observational study of older patients in a geriatric ward identifies 70% of patients required assistance; however, three out of nine totally dependent patients did not receive any assistance at mealtimes (Tsang, 2008). While a number of contributing factors to the absence of support were noted, including lack of staff, patients falling asleep and refusing meals, system issues related to delayed diet changes, the result was a negative impact on dietary intake, as the system was not designed to meet the needs of the unwell older patients (Tsang, 2008).

A systematic review reports that, while the overall quality of the evidence was low, those studies investigating feeding assistance found a mean improvement in energy and protein intake (Wade & Flett, 2013). Further support for feeding assistance was provided in a cross-sectional study where patients sitting up (positioning) at mealtime and receiving timely assistance at mealtime (within 10 minutes) were associated with good intake (Young et al., 2016).

Although PMT and feeding assistance are action points in the Council of Europe resolution: Food and Nutritional Care in Hospitals (Council of Europe Committee of Ministers, 2003), there is a lack of consistent evidence to demonstrate a clinical impact of PMT (Hickson et al., 2011). While more evidence is required, the existing studies suggest focusing on mealtime assistance, rather than PMT, may produce a greater impact on nutritional outcomes (Porter et al., 2017; Young et al., 2016).

2.6.9 Oral nutrition supplements

The strongest evidence for strategies to improve intake and treat malnutrition involve ONS (Nieuwenhuizen et al., 2010). This body of research underpins the WHO's guidelines for interventions for malnutrition for older people at a primary health care level that recommended "oral supplemental nutrition with dietary

advice should be recommended for older people affected by undernutrition" (WHO, 2017b).

The ESPEN *Guideline on Clinical Nutrition and Hydration in Geriatrics* documents 83 evidence-based recommendations for clinical nutrition and hydration in older persons for application across all settings (Volkert et al., 2019). The guidelines recommend ONS be offered to malnourished older persons, with the qualification for older persons living in the community that ONS be offered when dietary counselling and food fortification are not sufficient (Volkert et al., 2019). In all cases ONS are to provide at least 400 kcal/day including 30 g or more of protein/day (Volkert et al., 2019). The following explores some of the research on ONS with a particular focus on the variables that continue to present challenges to the management of malnutrition.

2.6.10 ONS – institutional sector

While the ESPEN guidelines recommend at least 400 kcal/day and 30 g or more of protein/day, other studies have produced successful outcomes with reduced nutrient levels. An early study offering residents of a long-term care facility, who had experienced weight loss, demonstrates a positive significant impact on energy, protein and micronutrient intake when residents were provided with a supplement containing 200 kcal and 15 g protein per day, compared with residents provided with a "snack" three times/day (Turic et al., 1998). A recent review of RCTs investigating the effect of dietary counselling and ONS on older persons, concludes ONS > 250 kcal/day combined with dietary counselling resulted in a positive outcome for both weight gain and energy intake (Reinders et al., 2019). Reflecting the heterogeneity of the health care sector, the increase in energy intake was observed to be greatest for women, older participants and those with lower BMI (Reinders et al., 2019).

The multifactorial nature of malnutrition, while reinforced in a number of studies, presents conflicting messages. While reinforcing the potential for ONS to enhance nutritional intake as long as compliance is sufficiently high, a review of treatment options highlights the complexity associated with ensuring nutritional adequacy, presenting a framework identifying 37 factors affecting food intake, classifying

them as either personal, food or environmental (Nieuwenhuizen et al., 2010). The assessment led researchers to highlight the personal factors affecting intake for older persons, and recommend smaller volumes of energy/nutrient dense formulations to optimise outcomes, consistent with recommendations for ONS and fortification (Nieuwenhuizen et al., 2010).

In contrast, one of the few studies to report on the potential for supplements replacing meals, Turic (1998) notes that the supplement did not replace intake from meals, but rather, added energy and nutrients. Acknowledging the lack of research on ONS and appetite, a recent study of older, malnourished persons living at home, reports a significant improvement in appetite, for the group prescribed ONS, even though they had lower appetite and health status relative to the control group at baseline (Seguy et al., 2020).

In an attempt to determine the most effective method for providing ONS, a comparison of three system options reports mixed results, highlighting additional factors impacting on optimising nutritional intake (Campbell et al., 2013). Although compared with a mid-meal trolley, energy and protein intakes relative to requirements were higher, patient satisfaction was lower and costs higher with the traditional and MedPass systems (Campbell et al., 2013). In the absence of a single preferred option, the authors concluded a potential benefit from a flexible approach to options for providing nutritional support (Campbell et al., 2013).

In spite of the research supporting the use of ONS for the treatment of older persons in health care institutions, there is a lack of evidence for older persons living in the community (Visvanathan et al., 2003). Acknowledging the mixed research outcomes with respect to ONS, “The MaNuEL Toolbox” (Visser et al., 2018) recommendations include combining both ONS and dietary counselling wherever possible to provide optimal treatment for malnutrition, in conjunction with the *EPSEN guideline on clinical nutrition in geriatrics* (Volkert et al., 2019).

Acknowledging the potential for ONS to improve intake and nutritional status, a number of exercises have been undertaken, each of them quantifying the costs benefit of ONS in the treatment of malnutrition. Cost savings were demonstrated in

a systematic review examining the impact of standard (non-disease specific) ONS in the hospital setting on outcomes including reduced mortality, complications and length of stay (Elia et al., 2016). While acknowledging further research is needed, undertaking a systematic analysis of the cost of disease-related malnutrition in the UK in 2007, the BAPEN reports a net cost saving through ONS in care for orthopaedic patients, older adults and prior to surgery (Russell, 2007). A subsequent economic analysis in the UK in 2015 replicated the outcome for nutrition support using ONS, ETF (enteral tube feeding) and PN (parenteral nutrition) in a population of malnourished subjects, reporting a cost saving ranging from £119,000 – £432,000 ($216,549 – $786,128 AUD) per 100,000, depending on the model used (Elia & Southampton, 2015).

A prospective multicentre observational study of 191 malnourished, not "at-risk", older persons living at home, demonstrates the potential impact of the ONS on health care costs, including variations in nutrient density (Seguy et al., 2020). Providing ONS consistent with the ESPEN guidelines, ≥ 400 kcal/day and ≥ 30 g protein/day, reduced the risk of hospitalisation, without affecting the cost of health care (Seguy et al., 2020). However, health care costs were reduced if the intake was increased to ≥ 500 kcal/day (Seguy et al., 2020). Increasing the daily intake of either protein to ≥ 30 g or energy to ≥ 500 kcal/day, further reduced the risk of hospitalisation three and five times respectively (Seguy et al., 2020). While these outcomes are consistently positive, the ongoing financial pressures facing the health care sector demand more high quality clinical trials and prospective, evidence based studies across all health care sectors (Elia et al., 2016; Elia & Southampton, 2015; Russell, 2007).

While the malnutrition conversation continues, the heterogeneity of the health care sector continues to challenge confirmation of solutions and cost benefit analysis.

2.7 Aims, research questions and objectives

The current chapter highlights a number of challenges facing the management of malnutrition across the health care sectors. Across the health care sectors, the ageing population (Australian Bureau of Statistics, 2018) and the trend for older

persons to remain in their own home (AIHW, 2019a; Productivity Commission, 2015), have increased pressure on budgets for services provided to support older persons, not only in residential aged care (Commonwealth of Australia, 2015) and public hospitals (Cutler & Olin, 2017), but also those living in the community (Reinders et al., 2019).

Poor nutritional health has been identified as one of the factors affecting length of stay in hospital, and therefore health care expenditure (Agarwal et al., 2013; Elia et al., 2015; Elia & Southampton, 2015). A number of studies have identified the potential for nutritional interventions to reduce length of stay, reporting the opportunity not only to manage costs, but also to improve clinical outcomes and quality of life for individuals (Visser et al., 2017).

Malnutrition is prevalent across all health care sectors (Cereda et al., 2016; Reinders et al., 2019; Volkert et al., 2020) and is expected to continue due to ageing of the population. As older persons increasingly live alone, particularly women (Royal Commission into Aged Care Quality and Safety, 2019), malnutrition has been reported as an issue compared to those living with families (Kucukerdonmez et al., 2017). Today's ageing population, where large numbers of older people experience multiple morbidities, combined with a traditional health care structure where clinical care guidelines typically focus on a single condition, will require innovative strategies to improve the health status of individuals with co-morbidities (WHO, 2015).

In addition to the challenge multiple health care sectors bring to the management of malnutrition, the movement of individuals between sectors creates a further complication (AIHW, 2014). With older persons wanting to remain in their home, and comorbidities increasing with age, admissions to hospital can be expected to increase for older persons (AIHW, 2007), a development prompting the Royal Commission into Aged Care Quality and Safety to identify the need for an interface with the acute health care sector, and also with respect to formal and informal carers in the community (Royal Commission into Aged Care Quality and Safety, 2019). As long as the incidence of malnutrition in hospitals remains an issue, there is the potential for individuals to return home, or to residential aged

care, with reduced nutritional status, creating a demand for support across the sectors.

Overall, the ageing population and the movement of individuals between health care sectors, combined with the continued evidence of malnutrition in each of the sectors, underlines the need for evidence-based strategies to reduce the impact on the nutritional health across all health care sectors, and the interface between sectors.

2.7.1 The focus of this thesis

Acknowledging the need for research across health care sectors, this thesis focuses on research questions that address the gaps in current research related to the management of malnutrition within two health care sectors where the movement of older patients is common: hospital patients and community living, specifically to clients of Meals on Wheels services. This multi-sector study begins to explore the heterogeneity across sectors and factors to be considered in study design that can extend outcome measurement of interventions beyond nutritional intake to the impact on malnutrition (Dijxhoorn et al., 2019).

The overall aim of this study is:

> To evaluate the impact of interventions targeting the energy and protein intake of hospital patients and Meals on Wheels clients in the Australian context.

The specific aims of the research program are to:

1. Determine the utilisation and consumption of meals in an acute care private hospital in Brisbane and Meals on Wheels services in North and West Metropolitan Region of Melbourne, and Macedon and Geelong regions of Victoria.
2. Assess the contribution of meals to energy and protein intakes and requirements for patients in an acute care private hospital in Brisbane and Meals on Wheels clients in North and West Metropolitan Region of Melbourne, and Macedon and Geelong regions of Victoria.

3. Identify factors associated with nutritional intake for MOW meals clients.
4. Assess the impact of an intervention on energy and protein intakes and requirements of hospital patients and MOW clients.

The aims, research questions and objectives by chapter are presented in Table 2.2.

Table 2.2 For each chapter in this thesis, the aims, questions, objectives and methodology

Chapter	Aim	Research question	Objectives of the research	Methodology
3	1	How do patients order and consume their meals?	Determine the ordering system and frequency of meal and mid meal ordering for hospital patients. Assess the plate waste for hospital patients.	Independent groups design. Participant demographic and 24-hour intake data collected from a convenience sample of adult patients in an acute care private hospital, pre- (n=50) and post room service (n=47).
	2	What is the contribution of meals to the nutritional intake and requirements of patients?	Assess energy and protein requirements of hospital patients. Determine the energy and protein intake of hospital patients. Calculate the contribution of meals to total daily energy and protein requirements for hospital patients.	
	4	Does an intervention increase nutritional intake for patients?	Assess the impact of a room service model on energy and protein intake of hospital patients.	
4	1	How do MOW clients order and consume their meals?	Confirm the client's length of time using the service, referral source, frequency of ordering, consumption pattern, and perceptions of the social aspect of the service.	Participants including 83 clients from a MOW service in Melbourne, Australia were interviewed in their homes to collect baseline demographic, MOW consumption and utilisation data as well as three 24-hour diet recalls.
	2	What is the contribution of MOW meals to the nutritional intake and requirements of MOW clients?	Assess energy and protein requirements of MOW clients. Determine the total energy and protein intake of MOW clients. Determine the energy and protein intake from MOW meals for MOW clients. Calculate the contribution of MOW meals to energy and protein intake and nutritional requirements of MOW clients.	
5	3	What client characteristics and MOW service parameters are associated with an increase in nutritional intake?	Examine the association between client characteristics and MOW service variables and: • total energy and protein intakes • contribution of MOW meals to intake • energy and protein requirements.	Data presented in Chapter 3 was analysed for associations between client demographics, characteristics and food related behaviours with outcome variables reflecting the focus of the MOW services, providing a nutritious

Chapter	Aim	Research question	Objectives of the research	Methodology
	3	Are any client characteristics or MOW service variables associated with MOW as a social time?	Examine the association between the client perception of MOW as a social experience and: • total energy and protein intake • contribution of MOW meals to intake • energy and protein requirements.	meal and a social contact.
	3	Is there an association between MOW client's risk of malnutrition and their level of social support and independence?	Examine the association between client's risk of malnutrition and: • amount of social support and frequency of visitors • preparation of meals and shopping for groceries.	
6	4	Does an intervention increase nutritional intake for MOW clients?	Assess the impact of a three-month program of social visits on energy and protein intake of MOW clients.	Participants from the study reported in Chapter 4 were allocated to an intervention or control group, and at the end of three months were visited in their home by the project officer to collect the same data collected at baseline including three 24-hour diet recalls (Chapter 4).

Chapter 3 Room service system reduces hospital patient plate waste without reducing energy or protein intakes

3.1 Abstract

Studies investigating the potential impact of meal ordering and delivery systems on hospital patients' nutritional intakes are limited. This observational prospective study focuses on the impact of the implementation of a room service system on plate waste, energy and protein intakes, and food ordering patterns related to meal times and food categories. The study sample included adult patients (pre n = 50 versus post n = 47) in an acute care, private hospital, with no association between participant demographics and characteristics including gender, age, length of stay, regular diet, or risk of malnutrition between groups.

Using a five-point visual scale to assess plate waste, an analysis of patient meals consumed over a 24-hour period, demonstrated an almost 7% reduction in plate waste across the 24-hour period ($p < 0.05$). Plate waste, food served to patients that remains uneaten, provides a measure of food consumed, and therefore nutritional intake. Providing further insight into eating patterns, this study reports a reduction in plate waste post-room service at lunch, and dinner, as well as for food categories – soup and hot starch and vegetables ($p < 0.05$). Ordering patterns were not affected by room service except for a reduction in the percentage of energy requirements ordered ($p < 0.05$). In spite of these operational efficiencies, whether assessed as an absolute value or against a threshold of estimated energy and protein requirements, energy and protein intakes were unchanged following the implementation of room service. While previous studies have demonstrated an increased intake of energy and protein following the introduction of a room service intervention, further research is needed to generalise the nutritional outcomes, and confirm the long-term outcomes of system interventions including length of stay and the incidence of malnutrition, particularly in high-risk patient populations.

3.2 Introduction

With Australia's expenditure on hospitals continually increasing, access to services, quality, funding and management are under constant review (AIHW, 2015). With an annual cost of food in Australian hospitals, excluding labour, reported at $486 million for 2013–14, the provision of food to patients in hospital has not escaped scrutiny (AIHW, 2015). The cost associated with the provision of food is affected by a range of factors including the amount of plate waste, or food delivered to patients that is not eaten. As food waste is estimated as ranging from 6% to 65% (Williams & Walton, 2011), there would appear to be an economic argument for a strategy to reduce plate waste.

With respect to the cost of food and nutrition services in the public health care system, the amount of food waste has been identified as a performance indicator for costs, where a 30% median plate waste for hospital food was reported in a recent review of the literature, referring only to food served to patients but not eaten (Williams & Walton, 2011). Similar levels of food waste from patient meals have been reported consistently throughout the literature including hospitals in the UK (Barton, Beigg, MacDonald, Allison, 2000; Sonnino & McWilliam, 2011) and Europe (Almdal et al., 2003). In addition to the management of recurrent expenditure, food waste data is also used in the management of clinical care, as the amount of food wasted, when deducted from the amount of food provided, determines the amount of food and nutrients consumed by patients (Barton, Beigg, MacDonald, Allison, 2000; Almdal et al., 2003). Hospital food services can impact on the nutritional status, because food that is not eaten does not provide nutrition as evidenced by research reporting high levels of food waste in hospitals have been associated with a reduced energy intake and, in some cases, the incidence of malnutrition (Barton, Beigg, MacDonald, Allison, 2000; Almdal et al., 2003; Dupertuis et al., 2003).

Formally acknowledged by the Council of Europe in 2003 (Council of Europe Committee of Ministers, 2003), malnutrition among patients in hospitals remains a global issue (Asiimwe et al., 2015; Kruizenga et al., 2003; Liang et al., 2009; Norman et al., 2008; Rasmussen et al., 2004; Tannen & Lohrmann, 2013;

Westergren et al., 2010), with 27% of patients in a European study considered to be “at nutritional risk” (Schindler et al., 2010). In 2010, public hospitals in Australia reported 41% of inpatients were “at risk” of malnutrition with 32% assessed as “malnourished” (Agarwal et al., 2012). Studies have repeatedly demonstrated that hospital malnutrition is associated with increased complications, length of stay in hospital, readmission rates and mortality (Agarwal et al., 2012; Asiimwe et al., 2015; Edington, Boorman et al., 2000). While the level of malnutrition can partly be explained by patients’ loss of appetite, disease state and nausea (Agarwal et al., 2012; Bauer et al., 2013; Hiesmayr et al., 2009; Norman et al., 2008; Tannen & Lohrmann, 2013), consistent with Florence Nightingale’s observations in 1860 of “thousands of patients being starved annually in the midst of plenty” (Nightingale, 1860), research has reported that the amount of food consumed by patients does not meet their estimated energy and protein requirements (Almdal et al., 2003; Dupertuis et al., 2003; Thibault et al., 2011). Furthermore, Nutrition Day survey results indicate that fewer than half the patients finished their meals in hospital (Hiesmayr et al., 2009), with evidence suggesting a two-fold increase in the risk of 90-day (Agarwal et al., 2013) or 30-day (Hiesmayr et al., 2009) in-hospital mortality for patients eating only one-quarter of the food provided in hospital.

In addition to reduced appetite and increased energy requirements associated with illness and recovery, a range of food system related factors have been identified as contributing to poor patient intake, including menu choice, meal timing, restrictive diets and food quality (Dupertuis et al., 2003; Kelly, 1999; Thibault et al., 2011). Targeting hospital food service systems that aim to reduce waste and increase food intake can improve nutritional status (Council of Europe Committee of Ministers, 2003; Dupertuis et al., 2003; Kelly, 1999; Thibault et al., 2011; Wilson et al., 2000; Kondrup, 2001). Such strategies will be particularly important with an ageing population, a group who are more likely to be undernourished on admission to hospital (Agarwal et al., 2013).

While only a few studies have investigated the impact of meal ordering and delivery systems on nutritional intake, satisfaction and recurrent costs, positive outcomes were reported with systems that focus on ordering systems and meal

assembly at the bedside (Goeminne et al., 2012; Munk et al., 2014; Wilson et al., 2000; Kelly, 1999; Maunder et al., 2013). One of these studies featured a supplementary menu of small fortified dishes available for patients to order by phone 24 hours per day, similar to a hotel-style room service (Munk et al., 2014). "Room service", a customer-focused approach adapted for food services in health care from the hospitality sector, has grown dramatically in the United States, and, in June 2013, was implemented in the first hospital in Australia, the Mater Private Hospital, Brisbane (McCray, Maunder, Krikowa et al., 2018). Described in a qualitative study of room service systems across four heterogeneous hospitals, a room service system features common to a hotel-style room service where a meal is ordered from a restaurant-style menu, and the tray is delivered to the room within 30 to 45 minutes. Typically in a hospital room service system, the same processes apply where the tray is assembled on-demand (rather than at a fixed meal time on tray conveyor), scripting is used to ensure consistent communication between staff and patients and hospital food service staff wear wait-staff uniforms (Sheehan-Smith, 2006).

Participants in the study reported an overwhelming advantage of room service reflected the patients' control over their food choices, where patients can order "what they want, when they want it" (Sheehan-Smith, 2006). The system is enhanced by technology-based menu ordering systems, ranging from patients phoning trained staff in a call centre within food services, to placing their order on electronic terminals at their bedside with a touch screen and/or mouse and keyboard, or, most recently, using an app on their mobile phone, providing a flexible ordering system that responds to individual needs.

While the room service model offers hospital patients a flexible and responsive meal service the impact on nutritional intake needs to be clarified. This study is aimed to investigate the impact of a room service system on plate waste and energy and protein intake compared to a traditional hospital meal ordering and delivery service, in an adult patient population in Australia.

3.3 Aims, objectives, study design, participants, outcomes and methods

3.3.1 Aims and objectives

The overall aim of this study is:

> To evaluate the impact of interventions targeting the energy and protein intake of hospital patients in the Australian context.

The specific aims of the study are to:

1. Determine the utilisation and consumption of meals in an acute care private hospital patients in Brisbane.
2. Assess the contribution of meals to energy and protein intakes and requirements for patients in an acute care private hospital in Brisbane.
3. Assess the impact of an intervention on energy and protein intakes and requirements of hospital patients.

The research questions and objectives of the overall thesis that are relevant to this chapter are outlined in Table 3.1.

Table 3.1 Research aims, questions, and objectives for this chapter

Chapter	Aim	Research question	Objectives of the research
3	1	How do patients order and consume their meals?	Determine the ordering system and frequency of meal and mid meal ordering for hospital patients. Assess the plate waste for hospital patients.
3	2	What is the contribution of meals to the nutritional intake and total daily requirements of patients?	Assess energy and protein requirements of hospital patients. Determine the energy and protein intake of hospital patients. Calculate the contribution of meals to energy and protein requirements for hospital patients.
3	4	Does an intervention increase nutritional intake for patients?	Assess the impact of a room service model on energy and protein intake of hospital patients.

3.3.2 Study design

This study was undertaken at the Mater Private Hospital in Brisbane, a 323-bed, acute care private hospital in Australia where, prior to room service, the food service system was a traditional model where meals are ordered the day before service, produced in bulk, plated hot prior to the meal time, and delivered to the bedside according to a pre-determined schedule. In this room service system, patients phone a call centre between 0630 and 1900 to place their meal orders. Trained staff check the order for compliance against dietary requirements, and enter the order on a computer system which transfers the order to production areas within the kitchen. The freshly prepared meals are delivered directly to the patient's room within 45 minutes.

Approval for the study was received from the Mater Health Services Human Research Ethics Committee and Victoria University Human Research Ethics Committee (HREC 201335).

3.3.3 Participants

The study is an independent groups design with 97 patients in total over the two survey periods. Plate waste and intake data, was collected three weeks prior to the room service implementation (n = 50). The same data was collected from a different patient cohort at the same hospital 14 weeks following the implementation of room service (n = 47) (Table 3.2). For both collection points, a convenience sample of patients was identified across the wards. The sample constituted all patients who agreed to participate, and were available to consume three meals over a 24-hour period. Patients who were under the age of 18, nil by mouth, fed enterally or parenterally, or receiving end-of-life care were excluded from the study. Patients who were admitted or discharged within a 24-hour period and therefore did not have the opportunity to eat the three meals of breakfast, lunch and dinner were also excluded. All interested patients were provided with an outline of the project – "Information to participants involved in research" (Appendix 3.1). Written informed consent was obtained from all patients who agreed to participate (Appendix 3.2).

Patient characteristics, including gender, age, diet and length of stay, were obtained from hospital records. A 'normal diet' type is assigned to patients who have no restrictions on their dietary intake. Diet type was obtained from hospital records pre-and post-room service. Malnutrition risk scores using a Malnutrition Screening Tool (MST) (Ferguson et al., 1999) were captured from hospital dietetic records. Individual energy requirements were estimated using a modified Schofield equation (Schofield, 1985) taking into account an activity and stress factor of 1.3. Estimated protein requirements were based on 1.3 g/kg body weight (Bauer et al., 2013), consistent with the hospital's policy.

3.3.4 Outcome – plate waste

Plate waste was assessed using an accepted, validated methodology that involves photographing individual patient meal trays in the kitchen prior to, and following the meal time (Sherwin et al., 1998). The use of digital photography provided the opportunity to visually confirm the food provided and estimate the food waste in order to calculate food consumed. Total daily food consumption was then derived from the difference between total food provided and food wasted. For mid meals, morning and afternoon tea, and supper. Food service staff delivering and collecting mid meals to patients recorded the items provided to each patient on the ward list, along with the amount left when they completed their collection round.

Two methods were used to analyse the plate waste data. Method 1 assessed total daily waste based on an average across plates for each person. This approach involves considerable averaging and potentially some loss of sensitivity. Method 2 avoided averaging across all plates for each patient, using an analysis that was more likely to be sensitive to the differences between treatments. Rather than averaging all meals across each person, the analysis accounted for multiple observations for each person, each day, preserving the structure of the data. For Method 2, plate waste data was broken down for each patient and each day according to meal times and food categories, producing a more detailed level of the data, which was used for additional analysis, and was potentially more sensitive than an analysis based on overall averages.

3.3.5 Outcome – energy and protein intakes and amounts ordered

The daily dietary intakes of both protein and energy were estimated for each participant from the total daily food consumption and calculated using FoodWorks Version: 7.0.3016 (Xyris software, Queensland, Australia) and AUSNUT 2013. Because recipes for menu items pre- and post-room service were not available to the investigator, estimates of energy and protein content were based on standard recipes in FoodWorks and commercial product nutrition information where available.

3.3.6 Method – statistics

For all patient characteristics, pre- and post-room service, the chi-squared test of association was used to test for the null hypothesis of association (Table 3.2).

For plate waste data for Method 1, means and standard deviations are reported. For statistical inference, the independent samples *t*-test was used to estimate the mean difference with a 95% confidence interval, to obtain a *p*-value to test the null hypothesis of no true mean difference. For Method 2, plate waste data were recorded as the estimated proportion wasted, which varied between 0 and 1. The analysis used a linear mixed model, which allows for the effects of multiple measurements being made on each patient. In this model the patient is considered a random effect, because there was likely to be important variation attributable to patients such as different patients having different appetites and different levels of waste, and for a given patient, multiple observations on a given day and variations in appetite during the day and from day to day. Each analysis reported is based on a linear mixed model which includes patient and day as random effects.

For the analysis of energy and protein intakes data, means and standard deviations are reported. For statistical inference, the independent samples *t*-test was used to estimate the mean difference with a 95% confidence interval, and to obtain a *p*-value to test the null hypothesis of no true mean difference. For the percentage of patients meeting 75% of their energy or protein requirement, a normal approximation for the comparison of percentages, and Fisher's exact test was used to obtain a *p*-value for testing the null hypothesis of no difference in percentages in the two groups.

3.4 Results

3.4.1 Participant characteristics

Results for the chi-squared test of association indicated that the data were consistent with the null hypothesis of no association, that the percentages for each characteristic are similar between the two groups, pre- and post-room service (Table 3.2). This study represents a relatively healthy hospital population, with participants under the age of 61 years representing the largest group (pre- 48%, post-room service 36%), and half the patients in hospital for three days or less (pre- 48%, post-room service 51%). The majority of patients were prescribed a normal diet, 64% pre- and 81% post-room service, and the risk of malnutrition was 12% or less for both groups.

Table 3.2 Participant characteristics for pre- and post-room service groups

Patient characteristic	**Description**	**Pre-room service (n = 50)**		**Post-room service (n = 47)**		***p*-value** [#]
		n	**%**	**n**	**%**	
Males		21	42%	20	43%	0.956
Females		29	58%	27	57%	
Age	20–60 years	23	48%	17	36%	0.452
	61–70 years	15	31%	16	34%	
	71 + years	10	21%	14	30%	
Length of stay	1 to 3 days	24	48%	24	51%	0.433
	4 to 14 days	22	44%	16	34%	
	More than 14 days	4	8%	7	15%	
Normal diet		32	64%	38	81%	0.064
MST screening	Score of 2 or more	6	12%	5	11%	0.833

[#] Chi-squared test of association.

3.4.2 Plate waste

The impact of system type, pre- and post-room service was measured using two methods:

- Method 1 - average of all plate waste data across all patients.
- Method 2 - plate waste data was organised for each patient, for each day, according to meal times and food categories, allowing an assessment of the impact of fixed variables on plate waste.

Plate waste – method 1

The initial analysis of the plate waste data, Method 1, based on an average across results for all patients indicated that, while there was a trend to a reduction in plate waste post-room service, the impact was not significant ($p = 0.424$) (Table 3.3).

Table 3.3 Plate waste pre- and post-room service for Method 1

Outcome measure	**Pre-room service**		**Post-room service**		**Mean difference (pre- and post-room service)**		
	(n = 50)		**(n = 47)**				
Total daily waste:	Mean	SD	Mean	SD	Estimate	95% CI	*p*-value [#]
Average percentage across ordered meals	16.1	14.6	13.4	17.5	2.6	−3.9, 9.2	0.424

Data are reported as N = number of participants, mean, SD = standard deviation, and an estimate the mean difference with a 95% confidence interval, and to obtain a *p*-value to test the null hypothesis of no true mean difference. # independent samples *t*-test.

Plate waste – method 2

For Method 2, plate waste data was organised for each patient, for each day, according to meal times and food categories. Three models are presented (Table 3.6), differing in terms of the explanatory variables or fixed factors:

- The overall effect of the food service system.
- The effect of the food service system and meal.
- The effect of the food service system and food category.

The number of items assessed by meal and system are presented in Table 3.4. No patients ordered supper post-room service.

Table 3.4 Number of food items assessed in the pre post-room service groups, by meal

Meal	Pre-room service	Post-room service
Breakfast	361	300
Morning tea	30	23
Lunch	340	187
Afternoon tea	22	22
Dinner	339	308
Supper	34	0
All	1126	840

The number of items assessed by food category and system are presented in Table 3.5.

Table 3.5 Number for each food categories used in this study

Food category	Food category inclusions	Number
Cereal	Cereal – hot cold, and milk for cereal	56
Dessert fruit snack	Dessert, fruit, prunes, yoghurt, cake, cheese and crackers, scone, muffin, muesli bar	427
Hot main protein	Hot main protein breakfast, lunch, and dinner	280
Hot starch vegetables	Hot starch and vegetables	220
Milk sugar	Milk and sugar for tea, coffee, cereal, garnish	824
Salad	Salad main and side salad	75
Soup	Soup	69
Supplements	Supplements	15
Total		**1,966**

Plate waste – method 2 – modelling

The overall tests for the explanatory or fixed variables for each of the three models are outlined in Table 3.6. An interaction between the type of system and each of the fixed variables was detected for Model 1 ($p = 0.043$) and Model 2 ($p = 0.004$), with a trend for Model 3 ($p = 0.070$).

- Model 1 focuses only on the system type, pre- or post-room service.
- Model 2 includes the impact of meal time as well as system type. Supper was excluded in the analysis for Model 2, as there were no observations for supper post-room service.
- Model 3 includes food category as well as system type. Supplements were excluded as there were very few observations in this category.

Table 3.6 Overall tests for the fixed factors in each of the three models

Model		Explanatory variables	F	df	*p*-value [#]
1	Main effect	Pre- or post-room service	4.17	1,157	0.043*
2	Interaction	Pre- or post-room service – meal	3.83	4,1599	0.004*
3	Interaction	Pre- or post-room service – food category	1.95	6,1845	0.070

[#] linear mixed model. * significant difference $p < 0.05$.

Plate waste – model 1: main effect of room service type

The analysis for Model 1 estimated the effect of room service on the plate waste, as the mean difference (pre- and post-room service) of 0.067, nearly 7% higher pre-room service ($p = 0.043$) (Table 3.7).

Table 3.7 Plate waste, pre- and post-room service, utilising Method 2, Model 1

Outcome measure	Pre-room service	Post-room service	Mean difference (pre-post-room service)		
	Mean	Mean	Estimate	95% CI	*p*-value [#]
Proportion plate waste	0.203	0.136	0.067	0.002, 0.132	0.043*

Data are reported as mean, and an estimate the mean difference with a 95% confidence interval, to obtain a *p*-value to test the null hypothesis of no true mean difference. #[#] linear mixed model. * significant difference $p < 0.05$.

Plate waste – model 2: interaction of room service type and meal

In Model 2, an interaction between type of service and meal time was detected ($p = 0.004$; Table 3.4), indicating the results are best characterised by the difference between system type for each meal. The estimated means for each meal show plate waste is reduced on average post-room service, at lunch ($p = 0.003$) and dinner ($p = 0.001$) (Table 3.8). The means are similar for breakfast, morning tea and afternoon tea**.**

Table 3.8 Plate waste for each meal, pre- and post-room service utilising Method 2, Model 2

Outcome measure proportion waste for:	Pre-room service	Post-room service	Mean difference (pre- and post-room service)		
	Mean^	Mean^	Estimate	95% CI	*p*-value [#]
Breakfast	0.157	0.134	0.023	−0.056, 0.102	0.568
Morning tea	0.018	0.090	−0.072	−0.252, 0.108	0.432
Lunch	0.241	0.116	0.125	0.042, 0.207	0.003*
Afternoon tea	0.005	0.096	−0.092	−0.283, 0.099	0.343

Outcome measure proportion waste for:	Pre-room service	Post-room service	Mean difference (pre- and post-room service)		
	Mean^	Mean^	Estimate	95% CI	*p*-value #
Dinner	0.279	0.145	0.134	0.055, 0.212	0.001*

linear mixed model. * significant difference $p < 0.05$. ^ recorded as proportion.

Plate waste – model 3: interaction of service type and food category

Model 3 presents the interaction between systems for each food category ($p = 0.070$; Table 3.5). For all categories except salad, plate waste is lower on average post-room service, with differences of over 10% observed for soup ($p = 0.026$; Table 3.9), hot starch/vegetables ($p = 0.012$; Table 3.9) and cereal ($p = 0.119$; Table 3.9).

Table 3.9 Plate waste for each food category, pre- and post-room service utilising Method 2, Model 3

Outcome measure proportion waste for:	Pre-room service	Post-room service	Mean difference (pre- and post-room service)		
	Mean^	Mean^	Estimate	95% CI	*p*-value #
Soup	0.220	0.046	0.174	0.020, 0.329	0.026*
Cereal	0.158	0.025	0.133	−0.035, 0.301	0.119
Hot starch / vegetables	0.315	0.187	0.128	0.027, 0.230	0.012*
Milk and sugar for tea, coffee, cereal	0.215	0.136	0.079	0.006, 0.152	0.032*
Hot main protein	0.204	0.153	0.051	−0.041, 0.144	0.271
Dessert fruit snack	0.160	0.122	0.038	−0.045, 0.121	0.369
Salad	0.129	0.226	−0.098	−0.255, 0.060	0.221

linear mixed model. * significant difference $p < 0.05$. ^ recorded as proportion.

3.4.3 Nutritional intake

Tables 3.10 and 3.11 provide a comparison of the primary outcomes related to nutritional intake, pre- and post-room service systems. Post-room service, patients in this study ordered a lower percentage of energy requirements compared with pre-room service orders. However, there was no difference in the total daily energy (kJ) or protein (g) ordered or consumed (intake), pre- and post-room service (Table 3.10), the percentage of requirements met, or the percentage of patients meeting 75% of requirements, pre- and post-room service (Table 3.11).

Table 3.10 Outcome measures, intake-related, pre- and post-room service using Method 1.

Outcome measure	Pre-room service (n = 50)		Post-room service (n = 47)		Mean difference (pre- and post-room service)		
	Mean	SD	Mean	SD	Estimate	95% CI	*p*-value [#]
Percentage of energy requirement ordered	126.8	38.8	108.9	42.1	18.0	1.6, 34.3	0.032*
Percentage of energy requirement met	104.1	38.0	95.2	44.6	8.9	−7.9, 25.7	0.296
Percentage of protein requirement ordered	100.9	33.1	94.6	42.8	6.3	−9.2, 21.9	0.420
Percentage of protein requirement met	81.1	27.9	82.2	41.1	−1.1	−15.4, 13.9	0.878
Total daily energy ordered (kJ)	9743	2816	8538	3232	1205	−21.3, 2430.3	0.054
Total daily energy intake (kJ)	8011	2897	7533	3579	478	−841.0, 1796.4	0.474
Total daily protein ordered (g)	91.4	28.1	90.0	37.2	1.4	−11.9, 14.8	0.831
Total daily protein intake (g)	73.8	25.6	78.8	41.0	−5.0	−19.0, 8.9	0.472
Total daily energy ordered – breakfast (kJ)	2502	823	2602	1436	−100	−577.7, 377.7	0.678
Total daily energy ordered – lunch (kJ)	3152	1326	2409	2222	743	−2.6, 1489.3	0.051
Total daily energy ordered – dinner (kJ)	3056	1105	3065	1717	−9	−597.2, 578.6	0.975
Total daily energy intake – Breakfast (kJ)	2148	874	2291	1450	−143	−631.0, 345.0	0.561
Total daily energy intake – lunch (kJ)	2553	1264	2230	2178	323	−403.1, 1049.6	0.378
Total daily energy intake – dinner (kJ)	2277	1178	2584	1648	−307	−888.9, 274.6	0.297
Total daily protein ordered – breakfast (kJ)	22.1	10.5	22.7	15.7	−0.57	−6.01, 4.87	0.835
Total daily protein ordered – lunch (g)	30.6	14.0	27.3	24.8	3.27	−4.95, 11.49	0.430
Total daily protein ordered – dinner (g)	32.5	12.2	36.9	19.0	−4.45	−10.95, 2.06	0.178
Total daily protein intake – Breakfast (g)	19.0	9.6	20.4	16.4	−1.34	−6.81, 4.14	0.628
Total daily protein intake – lunch (g)	24.4	12.0	25.2	24.3	−0.81	−8.67, 7.05	0.838
Total daily protein intake – dinner (g)	24.1	13.4	30.5	18.2	−6.40	−12.89, 0.09	0.053

Data are reported as mean, SD = standard deviation, and an estimate the mean difference with a 95% confidence interval to obtain a *p*-value to test the null hypothesis of no true mean difference. [#] independent samples *t*-test. * significant difference $p < 0.05$. Data were analysed using Method 1 as described in section 3.4.2.

Table 3.11 Outcome measure, 75% of requirements met, pre- and post-room service using Method 1.

Outcome measure	Pre-room service	Post-room service	Difference in percentages (pre- and post-room service)		
	(n = 50)	(n = 47)			
	%	%	Estimate	95% CI	*p*-value [#]
75% of energy requirement met	72.0	61.7	10.3	−8.4, 30.0	0.388
75% of protein requirement met	58.0	57.4	0.6	−19.1, 20.2	> 0.95

Data are reported as N = number of participants, and an estimate the percentage difference with a 95% confidence interval to obtain a *p*-value to test the null hypothesis of no true mean difference. [#] The *p*-values are from Fisher's exact test. Data were analysed using Method 1 as described in section 3.4.2.

3.5 Discussion

3.5.1 This is the first study to report on the impact of a room service system on plate waste per day, by meal, and by food categories, as well as energy and protein ordered and consumed per day, by meal and as a percentage of requirements. This study shows that changing from a traditional hot meal assembly system with fixed meal times, where patients ordered meals the day before service, to a room service system, reduced total plate waste as well as at lunch, dinner, and for soup, hot starch and vegetables, without impacting energy and protein intake. The potential impact of meal ordering and delivery systems on plate waste and nutritional intake for hospital patients are limited (Goeminne et al., 2012; Kelly, 1999; Maunder et al., 2015; Munk et al., 2014; Wilson et al., 2000) including those involving Room (Doorduijn et al., 2016; Kuperberg, Mager, Dello, 2009; Kuperberg et al., 2008; Larsen & Toubro, 2007; McCray, Maunder, Barsha et al., 2018; McCray, Maunder, Krikowa et al., 2018; McLymont et al., 2003; Sathiaraj et al., 2019; Williams, 1998). Plate waste

The significant reduction in total plate waste observed in this study with the introduction of room service was assessed using Method 2, accounting for multiple observations for each participant, preserving the structure of the data, and permitting a more detailed analysis. This reduction in plate waste is consistent with two previous studies reporting a reduction in plate waste for room service (McCray, Maunder, Krikowa et al., 2018; McCray, Maunder, Barsha et al., 2018), and other studies where the impact of room service on food waste was reflected as a reduction in the number of meal trays per patient per day (Kuperberg et al., 2008;

Williams, 1998), or the elimination of duplicate meal trays and "late" meals, ordered after the meal service (McLymont et al., 2003). However, in these previous studies, data was averaged across plates for each patient, resulting in considerable averaging and a potential loss of sensitivity. The potential for variations in data organisation and analysis to impact outcomes is further demonstrated by the two methods used for assessing plate waste in this study. Utilising an average percentage waste across plates for each patient (Method 1), a reduction in plate waste following the introduction of room service was not observed in this study. With Method 2, an approach that accounts for multiple observations per person on a particular day, a more sensitive analysis of differences between treatments, total plate waste post-room service reduced from 20.3% to 13.6%. While significant, this reduction of nearly 7%, is lower than that reported in a previous study at the same hospital included in this study, the Mater Private Hospital Brisbane (McCray, Maunder, Krikowa et al., 2018), as well as a co-located public hospital, the Mater Hospital Brisbane (McCray, Maunder, Barsha et al., 2018). While the reduction in plate waste was significant, the impact of a 7% reduction in a meal, or approximately 25 g of food, is unlikely to make a substantial impact on energy or protein intake.

Both previous Mater studies assessed each of the individual food items remaining on the plate to calculate overall plate waste, reporting a reduction in plate waste post-room service of 17% at the Mater Private Hospital Brisbane (McCray, Maunder, Krikowa et al., 2018) and 13% at the public campus, Mater Hospital Brisbane (McCray, Maunder, Barsha et al., 2018) (Table 3.12). While all three studies conducted at the Mater group used a five-point visual scale to assess all edible products over a 24-hour period, several factors further complicate the comparison among the three studies. While the current study reports observational data collected by a single investigator, over a five-month period, the two previous studies used retrospective data collected over a 2½ year period, by dietetic students completing their food service internship placements (McCray, Maunder, Barsha et al., 2018; McCray, Maunder, Krikowa et al., 2018), introducing a risk related to changes in hospital activity over time, and the potential for inconsistency in estimating food quantities. Participation in this study was limited to patients consuming three meals in a 24-hour period, ensuring consistency across the

sample, whereas the McCray studies specified a "minimum 24-hour consecutive period including all meals and snacks", without a requirement for a minimum number of meals per day (McCray, Maunder, Barsha et al., 2018; McCray, Maunder, Krikowa et al., 2018), creating the potential for variability in the level of meal counts within the sample. Finally, variations in the data source may have contributed to the variation in plate pre-room service for the private hospital, 16% versus 29% (Table 3.12). In this study, data was collected from direct observation of trays collected during the study period. For the previous room service study, as audit data were not completed for the Mater Private Hospital, Brisbane, pre-room service data results from audits at the Mater (Public) Hospital, Brisbane were used, introducing the potential for a hospital-specific influence (McCray, Maunder, Krikowa et al., 2018).

Table 3.12 Comparison of study design and plate waste results

Publication	Study design	Plate waste			
		Pre-room service	**Post-room service**	**Variation pre-post**	***p*-value**
Chapter 3 – Method 1 private hospital	Prospective observational Independent samples *t*-test	16%	13%	3%	0.424
Chapter 3 – Method 2 private hospital	Prospective observational Linear mixed model	20%	14%	6%	0.043*
McCray 2018 – Mater Private Hospital Brisbane (McCray, Maunder, Krikowa et al., 2018)	Retrospective QA data Independent samples *t*-tests and x^2 analyses	29%	12%	17%	< 0.001*
McCray 2018 – Mater Hospital Brisbane (Public) (McCray, Maunder, Barsha et al., 2018)	Retrospective QA data Independent *t*-tests	30%	17%	13%	< 0.001*

* significant difference $p < 0.05$.

Plate waste – meal time and food category

Although the pre-room service plate waste in this study (20%) was relatively low compared with the median plate waste of 30% reported across a sample of 32 hospitals (Williams & Walton, 2011), the introduction of room service still reduced

plate waste by 7% overall, most profoundly at lunch and dinner , using Method 2, Model 2. This outcome is consistent with the largest reduction in activity post-room service in this study at lunch, where food item counts reduced from 340 pre-room service to 187 post-room service, and at dinner, where counts reduced from 339 to 308 (Table 3.4). Using Method 2, Model 3, results for plate waste by food category in this study were consistent with the meal time results, as plate waste for lunch and dinner menu items post-room service decreased for soup (~17%) and starch/vegetables (~13%), with the hot main protein component and dessert unchanged (Table 3.5). The multiple measures of plate waste presented in this study, overall, by meal, and by food category provided unique insight into intake patterns and plate waste, reinforcing the importance of understanding all aspects of intake patterns (Barrington et al., 2018; Barton et al., 2000; Goeminne et al., 2012; Maunder et al., 2015).

In spite of representing the meal with the most activity (361 pre-and 300 food items post-room service) (Table 3.5), breakfast presented the lowest plate waste, both pre- and post-room service, consistent with previous studies, where patients were more likely to consume the breakfast meal (Agarwal et al., 2012; Maunder et al., 2015; Williams & Walton, 2011; Grieger 2007). In this study, the consistency of breakfast results pre- and post-room service may have been impacted by the offer of a hot breakfast pre- and post-room service, albeit with increased choices post-room service. Further research is required to confirm the impact of variables such as menu choice and overnight fasting. Nevertheless, the clinical significance of these results is highlighted in a study for "nutritionDay" in 2009, where the likelihood of being malnourished increased 2.9 (CI 1.1–7.6, $p = 0.026$) times for patients consuming less than half of their breakfast (Bauer et al., 2011).

Plate waste – summary

While the outcomes from this study are not necessarily generalisable, these results highlight the potential benefit from benchmarking total plate waste data, and categorising plate waste by meal and food category to provide an evidence base for targeting site-specific strategies to improve patient outcomes.

3.5.2 Intake

Although this study reports a reduction in plate waste with the introduction of room service, the daily intake of energy and protein post post-room service remained unchanged (pre- 8,011.1 ± 2,896.5 kJ versus post- 7,533.4 ± 3,579.3 kJ; pre 73.8 ± 25.6 versus post 78.8 ± 41 g, energy and protein respectively), as did intake by meal (Table 3.10), and the percentage of energy and protein requirements met (Table 3.11). These reassuring results suggest room service can improve operational efficiency without compromising energy and protein intake. These results also need to be considered in the context of the cohort, where the adult patients were relatively young, not more than 30% were over the age of 70 years, half of the patients were in hospital for three days or less, the majority were on a normal diet, and were relatively healthy nutritionally, with not more than 12% at risk of malnutrition (Table 3.2).

The absence of an increased intake post-room service differs from other studies investigating the impact of a transition from a traditional pre-room service system where, as was the situation in this study, meal times were fixed, and patients were required to order their meals the day before service. The results from two earlier studies, implemented in paediatric hospitals in North American, both report an increase in intake, specifically total energy intake (Williams, 1998) and energy and protein intake at the lunch meal, with trends observed at breakfast and dinner (Kuperberg et al., 2008), along with an increase in patient satisfaction.

Positive results were also reported from a cancer hospital in India where, changing from a seven-day menu cycle and fixed meal times to room service, patients undergoing treatment increased energy and protein intake (Sathiaraj et al., 2019). While the outcome measures varied, a study in a cancer hospital in the US reports an increase in the percentage of patients consuming more than 50% of their meals post-room service, exceeding their study objective (McLymont et al., 2003). A study of cardiology patients reported an increased energy intake post-room service only for obese patients where the comparison included a buffet service for dinner pre-room service and a post-room service menu that highlighted menu items with 50% or more energy from fat, specifically for undernourished patients (Larsen & Toubro, 2007). Another study design variation may have influenced results for a

study in the Netherlands where no impact on intake was reported post-room service; however, intake data was based on food lists recorded by nursing staff, and only for patients on high energy, high-protein diets (Doorduijn et al., 2016) creating a potential bias, reinforcing the need to consider variations in study design when comparing outcomes.

Previous studies undertaken at the two Mater hospitals in Brisbane referred to above, also report an increased nutrient intake post-room service. At the Mater Private Hospital Brisbane (McCray, Maunder, Krikowa et al., 2018), both energy (5,464 kJ/day versus 6,644 kJ/day) and protein (52 g/day versus 66 g/day) intake, as well as energy and protein intake as a percentage of requirements (63% versus 75%; and 65% versus 85%, respectively) increased post room service (Table 3.13). This study was repeated at the Mater Hospital Brisbane, the co-located public hospital (Table 3.13). In addition to the use of audit data from the public hospital campus for the pre-room service intake at the Mater Private Hospital Brisbane, and the absence of a requirement of three meals/day for inclusion in the study discussed earlier with respect to plate waste, access to in-house recipes, and the variation in assessment of energy (kJ/kg specific to clinical sub-groups) may also have contributed to variations in outcomes. Total energy and protein intake in the current study was consistently higher than that reported for the McCray studies both pre- and post-room service (Table 3.13), possibly reflecting variations in the source of the data and the requirement for three meals/day.

Finally, the level of malnutrition risk was low in the current study, 12% pre- and 11% post-room service compared with the malnutrition prevalence rates published for the Mater Private Hospital Brisbane in 2016, 24% (McCray, Maunder, Krikowa et al., 2018). However, given the requirement for patients in the current study to consume three meals/day, a lower risk of malnutrition is not unexpected.

Table 3.13 Summary of energy and protein intakes and requirements met for this study, and the two previous studies undertaken at the Mater hospitals[1]

	Pre-room service		**Post-room service**		***p*-value**
	Mean	SD	Mean	SD	

	Pre-room service		Post-room service		*p*-value
Chapter 3	**(n = 50)**		**(n = 47)**		
Total daily energy intake (kJ)	8011	2897	7533	3579	0.474
Total daily protein intake (g)	73.8	25.6	78.8	41.0	0.472
Percentage of estimated energy requirement met	104.1	38.0	95.2	44.6	0.296
Percentage of estimated protein requirement met	81.1	27.9	82.2	41.1	0.878
Mater Private Hospital Brisbane (McCray, Maunder, Krikowa et al., 2018)	**(n = 85)**		**(n = 63)**		
Mean energy intake/day (kJ)	5464	2150	6644	2727	0.005*
Mean protein intake (g)	52.3	23.9	65.9	29.6	0.003*
Percentage of estimated energy requirement met	63.0	26.4	75.1	33.0	0.024*
Percentage of estimated protein requirement met	65.0	33.4	84.7	52.4	0.011*
Mater Hospital Brisbane (Public) (McCray, Maunder, Barsha et al., 2018)	**(n = 84)**		**(n = 103)**		
Mean energy intake/day (kJ)	5513	2112	6379	2797	0.020*
Mean protein intake (g)	52.9	23.5	73.9	32.9	< 0.001*
Percentage of estimated energy requirement met	63.5	26.1	78.0	36.7	0.002*
Percentage of estimated protein requirement met	69.7	35.7	99.0	51.0	< 0.001*

[1]McCray, Maunder, Barsha et al., 2018; McCray, Maunder, Krikowa et al., 2018. * significant difference $p < 0.05$.

3.5.3 Ordering

With respect to the energy or protein ordered per meal, the introduction of room service did not affect the result, with the exception of evidence of a non-significant trend to a reduction in total energy ordered per day, and energy ordered at lunch (Table 3.10). Although the percentage of energy requirement ordered following the introduction of room service was reduced, there was no impact on the percentage energy requirements met, an outcome that is consistent with the percentage of energy requirements ordered post-room service remaining excess to requirements (108.9%).

The reduction in the percentage of energy requirements ordered may be reflected in the reduced plate waste at lunch and dinner post-room service, suggesting ordering closer (45 minutes) to the meal time may result in the meal order more accurately reflecting the patient's appetite and food preferences at the time, resulting in a larger portion of the meal being consumed and a reduction in plate waste. The reduction in plate waste post-room service for soup , starch and vegetables, all menu items associated with the lunch meal, is consistent with this observation.

3.5.4 Limitations

The small sample size and lack of blinding, although somewhat managed by similarity in baseline characteristics, limited the power of the study. In addition, the strict inclusion criteria in this study of the need to consume three main meals within a 24-hour periods, may have resulted in the number of participants assessed as at nutritional risk (12% pre-room service; 11% post-room service) to be under-represented. Ideally, room service studies would be undertaken with larger cohorts that focus on a representative sample of the hospital patient demographic. The pre/post study design was a further limitation. A randomised control trial, the best practice study design, would not have been possible in this hospital setting due to the complications of implementing multiple electronic ordering, assembly and delivery systems. conducting the study at the same hospital within a short time period (five months). In this study, a degree of rigour was achieved with a study design that involved repeating the study at the same hospital within a short time period (five months), using a consistent methodology, the same investigator, and cohorts with similar demographics. For the purpose of comparing ordering patterns in this study, as room service eliminates the traditional "meal time", meal orders placed post-room service were allocated to meals align with typical meal and mid-meal times. This approach creates limitations when comparing outcomes by meal, as represented by the absence of supper orders post-room service necessitating the exclusion of supper from the analysis in this study.

Although the collection of data for meals prior to and following each meal was carefully monitored, consumption of food and beverages not ordered directly from food service, such as take-away meals or some mid meals, have not been included, presenting an opportunity for future investigations. In addition, delivery procedures

for mid-meals were such that the assessment of pre- room service waste was limited to verbal feedback from food service delivery staff. The early stage of the system implementation may have also impacted on the survey results. A previous study investigating the introduction of a novel supplementary menu, reveals that while there was no impact on intake initially, a time gradient did produce a significant impact on energy intake (Munk et al., 2013). Given the early stage implementation of room service at the time of this study, 14 weeks post-room service, follow-up studies using a consistent methodology are needed to confirm the impact of the change, as kitchen and ward staff routines adjust to accommodate the less predictable room service meal routines, and patients become familiar with room service options.

3.6 Conclusion

The results of this study investigating the impact of a room service system are promising, indicating the potential to reduce plate waste, while maintaining or improving intake. This study is a reminder of the importance of a standardised approach to measurement and study design highlighted in Chapter 2, as a strategy to ensure a comparison of results and coordination of recommendations for optimising outcomes.

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Chapter 4 Meals on Wheels – client characteristics and nutritional intake

4.1 Abstract

Although rates of malnutrition are lower than those reported for the hospital sector, poor nutrition for older adults living in the community is associated with functional, increased length of stay in hospital, readmission and risk of mortality . This study provides a profile of a group of 83 Meals on Wheels (MOW) clients, the demographics, characteristics, MOW meal ordering and consumption patterns and energy and protein intake. Participants in the study from Melbourne, Victoria, were primarily female (54.2%), with a mean age of 79.4 ± 10.8 years), and characterised by a comparatively low risk of malnutrition, with 15.7% malnourished, or at risk of malnutrition assessed using the MNA®-SF. Participants had regular social connections, with only 16% having contact with family or friends monthly or less. The vast majority of participants were relatively independent, being able to make their own meals without help (83%); however, the majority (63%), were unable to shop for groceries, or required assistance.

All participants in this study ordered the main MOW meal, 93% ordered dessert, and 70% ordered soup. Consumption of the meal components was frequently over two or three meals, with some participants swapping between lunch and dinner (9.6% to 16.9%). Surprisingly, over half of the participants reported throwing out meals (56.6%), with 14.9% of those giving MOW meals to a pet. In contrast, the positive and negative feedback from participants was similar suggesting the need for further investigation to clarify the participant expectations regarding meal quality and service levels. Nevertheless, MOW meals contributed 30% of energy and 38% of participants' protein intake, and total intake met 82% of energy and 98% of protein requirements. The characteristics and food-related behaviours documented for the MOW clients participating in this study may inform the development of targeted strategies to optimise the impact of the MOW service on nutritional outcomes, and contribute to maintaining the individual's independence.

4.2 Introduction

The study presented in Chapter 4 shifts the focus from hospital patients to older persons living in the community, specifically MOW clients. The impact of malnutrition on health and quality of life presented in Chapters 2 and 3 extends beyond the hospital setting to those living at home in the community, with older adults who are home-bound and less independent for any reason present an increased risk of under nutrition (not consuming enough energy to maintain current body weight) (Locher et al., 2008). The tendency for people to experience a decline in food and nutrient intake as they age can be exacerbated by psychological issues, social isolation and medical conditions, that can influence motivation to eat and limit food choice (De Castro, 1993; Locher et al., 1998; Morley, 2001; Morley & Silver, 1988).

As discussed in Chapter 2, weight loss, caused by inadequate energy intake, and impacted by the anorexia of ageing, comorbidities, poor oral health and social factors have been shown to predict a decline in functional status, with an increased incidence of institutionalisation and mortality in the home-bound population (Payette et al., 2000). Ensuring adequate nutrition and preventing unintentional weight loss in the home-bound population can be a significant factor in maintaining independence within the older population in the community, as well as reducing the cost of health care services (Locher et al., 2008).

A systematic review reports a malnutrition risk from 0% to 83% across 54 studies, where the authors conclude the wide range was influenced by the different assessment tools along with the heterogeneity of study samples (Hamirudin et al., 2016). During the last 10 years a number of international studies on older adults living in the community, all using the MNA®-SF screening tool (Kaiser et al., 2009), report a narrower range of malnutrition risk from 17% to 43% (Chang, 2016; Cuervo et al., 2008; O'Dwyer et al., 2009; Rist et al., 2012; Ülger et al., 2010; van den Broeke et al., 2018; Winter et al., 2013) consistent with a recent systematic review of malnutrition risk in community-dwelling older adults in Europe where, using the MNA®-SF, the prevalence of malnutrition varied from 8.5% for a high risk, increasing to 32.7% when a high and moderate risk of

malnutrition were combined (Leij-Halfwerk et al., 2019). A further complication in assessing malnutrition rates within the MOW population, the prevalence has been reported to vary across groups within the community, with the highest incidence with home care clients, followed by general practice patients, and those living in the community, highlighting the importance of nutritional assessment to be included as part of home care consultations (Schilp et al., 2012).

Although rates of malnutrition were lower than those reported for the hospital sector, the impact of poor nutrition is an issue for older persons living in the community. As early as 1995, Payette (1995) reports weight loss of > 5 kg as an important predictor of institutionalisation in a sample of 288 free-living older adults receiving home help services over a three-to-five year period. While noting poor nutrition as a potentially modifiable factor to mitigate the likelihood of institutionalisation, the need for evidence to support the realisation of this outcome was required (Payette et al., 1995). In 2005, Kyle (Kyle et al., 2005) reported length of stay in hospital was increased for those patients with adiposity and low muscle mass. A series of Australian studies have replicated the outcome and confirmed patient's screening positive for nutritional risk are at a higher risk of hospital readmission within 90 days (Luscombe-Marsh et al., 2014; Ulltang et al., 2013; Visvanathan et al., 2003), and experience more admissions to hospitals and emergency departments (Visvanathan et al., 2003), and greater weight loss (Visvanathan et al., 2003).

There is an expectation that community based care can reduce or delay high-cost, long-term residential care or hospital admission and allow individuals to remain in their home, benefits that will be multiplied as the population continues to age (Payette et al., 2000; Ryburn et al., 2009). Ensuring the nutritional health of those living in the community is monitored and maintained is a key strategy to support this goal.

4.2.1 MOW - The impact

For older individuals living in the community, the impact of Meals on Wheels services extends beyond the provision of a hot meal. The service has the potential to enhance functional ability, well-being, quality of life, and reduce hospitalisation.

Acknowledging these potential benefits, guidelines for MOW services are being refined to incorporate the latest nutritional knowledge in order to optimise outcomes. Global public health initiatives for older persons have endorsed the goal of ensuring functional ability is maintained for as long as possible, enabling aged citizens to live independently in the community (WHO, 2015). With an objective of helping people develop and maintain "a level of functional ability that enables well-being", the WHO public health framework for healthy ageing incorporates both intrinsic capacity of the individual and environmental characteristics that form the context of the individual's life (WHO, 2015). The framework details evidence-based interventions to manage common declines in capacity in older age, covering mobility, nutrition or vitality, vision, hearing, cognition and mood, as well as the risk of falls (WHO, 2015). Recommending nutrition assessments, and the use of oral supplements or nutrient-rich foods along with dietary advice for older people affected by undernutrition, the WHO guidelines present a practical approach to the role of nutrition in maintaining the ability to care for oneself, and mitigating the risk of becoming care-dependent (WHO, 2017b), an approach aligned with the policy of "empowering older people to retain control of their lives and make the choices that are in their best interest" (WHO, 2015).

Consistent with WHO guidelines, Meals on Wheels services in Australia and internationally are a key strategy to enhance the quality of life for the individual and support individuals to maintain their independence while living at home. For MOW this involves providing a nutritious meal, and a safety and wellbeing check, as well as promoting social cohesiveness by strengthening communities and helping locals (Oppenheimer et al., 2014). Changes in the role of the family, specifically the reduction in the capacity of the family to provide primary support for older person living in the community, reinforces the need for MOW services (Frongillo et al., 2010). This situation was demonstrated in a study of MOW clients in New York City, where a small, but not insignificant group of MOW clients had limited informal support, with none or few children, relatives or friends, and 51% reporting no close friends or neighbours to call on for assistance (Frongillo et al., 2010). In addition to needing emotional support in the form of someone to talk to, over one-third of the 1,505 MOW clients surveyed needed additional help with shopping, cooking and getting a ride, with MOW seen being able to provide some

form of daily contact and a resource to identify situations of need (Frongillo et al., 2010).

Supporting the delivery of nutritious meals in Australia, in 2016 the Australian Meals on Wheels Association (AMOWA) released the *National Meal Guidelines*, representing the principles of providing choice, variety and flexibility, and underpinned by the latest nutritional science and academic research (AMOWA, 2016). The guidelines have retained the macronutrient components from the 1977 *Commonwealth Department of Health Nutrition Guidelines for Meals on Wheels* (Commonwealth Department of Health 1977), with "Any combination of course options that provides up to one-half of the daily requirement for protein, up to one-third of the daily requirements for energy, fibre and most other nutrients, with the exception of calcium" (AMOWA, 2016) Consistent with the recommendations from recent reviews (Cederholm et al., 2017; Dijxhoorn et al., 2019; IJmker-Hemink et al., 2020), the guidelines include options for optimising nutritional outcomes through fortification and the provision of snacks (AMOWA, 2016).

In Chapter 3, evidence is presented supporting the role of nutrition in reducing patient length of stay in hospital. A study of patients in the US post-discharge, and receiving an average of 6.25 MOW meals per week, reported positive changes in self-report of health care utilisation, emergent care assessment and resolution of medication alerts (Cho et al., 2015). Utilising data from a regional claims database, a more recent study of 120 MOW clients recently discharged from an inpatient hospital stay or from an emergency department visit reports participants receiving MOW services, on average 6.19 meals per week, were less likely to experience emergency department visits and hospitalisations, and average length of stay per hospitalisation decreased (Cho et al., 2018). In a study investigating falls, a randomised parallel three-arm study of older adults on MOW waiting lists, reported daily deliveries of MOW may reduce the risk of falls, an outcome related to wellness, quality of life and independence (Thomas et al., 2018). These outcomes suggest the need for further studies to investigate the potential for MOW services to reduce health care utilisation and costs in various settings and levels of MOW meals utilisation.

4.2.2 MOW meals compliance – guidelines

The AMOWA *National Meal Guidelines* provide a common, measurable base from which MOW services can assess the nutritional adequacy of their meals, and against which the effectiveness of interventions can be compared (AMOWA, 2016). Favourable compliance outcomes were reported for Melbourne-based MOW service where a menu analysis at one site confirmed the potential to meet the guidelines, with the exception of protein and magnesium in vegetarian meals (Barrington et al., 2018), and another where meal samples were assessed as providing 21–39% of energy and 42–63% of protein standards (Arjuna, Miller, Soenen et al., 2018). In the absence of country-specific standards, two international studies assessed their MOW meals against the Australian standard (AMOWA, 2016). An Irish study evaluated a sample of 46 meals from eight MOW services reporting, on average, meals were compliant with energy and protein, providing 3008 ± 498 kJ, exceeding the requirements of one-third of energy and one-half of protein requirements, contributing 35–40% of the energy recommended dietary allowance (RDA) for males and 42–45% of the RDA for females and for protein, 67.5% of male requirements and 76.1% for women (O'Dwyer et al., 2009). However, an early study of MOW services in Hawaii raises a practical issue, observing that, although the nutrient content of the MOW meals complied with requirements, a positive impact on nutritional status can only be achieved if the meals are consumed, predicting the need for more data on meal intake (Shovic & Geoghegan, 1997). A similar outcome was reported in a Danish study where clients ordering only the hot meal (soup and dessert are optional), would meet the recommended energy requirements (Beck & Hansen, 2010). While MOW meals can comply with nutritional standards, meal ordering and consumption patterns can modify intake, and potentially the nutritional contribution.

4.2.3 Summary - MOW - The impact

To ensure an effective service delivery, and to develop targeted interventions that impact positively on nutritional outcomes, the MOW sector needs an understanding of meal service system parameters, client consumption patterns, and, ultimately nutritional intake. Thus, the overall aim of this study is to extend our understanding of the characteristics of MOW clients, the utilisation of services,

consumption patterns, and the nutritional contribution of the MOW meal to energy and protein requirements.

These findings may inform the ongoing monitoring and quality improvement measures of existing Meals on Wheels programs as well as potentially contributing to the knowledge and understanding needed to develop evidence-based nutrition guidelines for Meals on Wheels services.

4.3 Aims and objectives

The specific aims for Chapter 4 are to:

1. Determine the utilisation and consumption of meals by Meals on Wheels clients in North and West Metropolitan Region of Melbourne, and Macedon and Geelong regions of Victoria.
2. Assess the contribution of meals to energy and protein intakes and requirements for Meals on Wheels clients in North and West Metropolitan Region of Melbourne, and Macedon and Geelong regions of Victoria.

The research questions and objectives relevant to this chapter are outlined in Table 4.1.

Table 4.1 Research questions and objectives for Chapter 4

Chapter	Aim	Research question	Objectives of the research
4	1	How do MOW clients order and consume their meals?	Confirm the client's length of time using the service, referral source, frequency of ordering, consumption pattern, and perceptions of the social aspect of the service.
4	2	What is the contribution of meals to the nutritional intake and requirements of MOW clients?	Assess energy and protein requirements of patients and MOW clients. Determine the energy and protein intake of patients and MOW clients. Calculate the contribution of meals to energy and protein intake and nutritional requirements of patients and MOW clients.

4.4 Study design, participants, outcomes and methods

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4.4.1 Participants

A convenience sample of participants were obtained from a list of eligible clients provided by the Council services sourcing Meals on Wheels meals from Community Chef, a state-of-the-art food production facility for distribution by councils to meal recipients (Oppenheimer, 2014), including councils in the North and West Metropolitan Region of Melbourne, and Macedon and Geelong regions of Victoria. A list of potential participants was provided by the manager of the Meals on Wheels service from each council. Individual clients were contacted by the project officer and invited to participate in the study. The study was explained to the clients including the expectations of participants in the study. Clients interested in participating in the study were provided with the "Information to participants involved in research" document (Appendix 4.1), encouraged to read the information, speak with family/friends about the study, and recontact the investigator with any questions. During the initial phone call an appointment time was also made for a home visit to discuss in person any questions regarding the research and a signed informed consent obtained (Appendix 4.2).

Participants who were unable to speak English were excluded as were clients with cognitive issues that would make it difficult to respond to the questions, as well as provide informed consent.

4.4.2 Outcomes and data collection

Total daily energy intake (kJ) and protein intake (g)

The project officer, a trained dietitian, collected intake data from three 24-hour recalls. Data for the first day was collected face to face during a home visit. Intake data for days two and three were collected during a phone interview on subsequent days. The dietitian asked each respondent to recall all of the food and drink they consumed over the last 24 hours. Participants were prompted to describe the item and amount and refer to products and containers in their home to clarify product details and portion size. The nutritional content of all foods provided by the MOW services was provided by Community Chef. If information was not available, the nutritional information was calculated from the recipe details provided by Community Chef using FoodWorks©7Pro (Xyris Pty Ltd). Food and beverages other than MOW meals were analysed using FoodWorks©7Pro.

Energy and protein intake as a percentage of requirements

Protein requirements were calculated based on the Recommended Dietary Intakes (RDIs) for protein from the Nutrient Reference Values for Australia and New Zealand (NHMRC et al., 2006) for persons above 70 years, for men (1.07 g/kg) and for women (0.94 g/kg).

In contrast to other studies using the Schofield equation for older men and women to determine the estimated energy requirements, participants in this study were provided with a SenseWear^{TM} Armband (SWA) accelerometer to be worn 24-hours/day for seven days (with the exception of showering), to determine their energy expenditure or requirements. The SWA integrates, through proprietary non-linear algorithms, subject characteristics (age, gender, height, weight, handedness and smoking history), a bi-axial accelerometer, galvanic skin resistance, heat flux, skin and near body temperature, to estimate energy expenditure (EE) and step count (Dwyer et al., 2009). Energy expenditure is calculated based on the individual's weight, height, age, gender and activity levels. Data were recorded daily including the percentage of time the armband was worn (%), total EE (energy expenditure) including measured EE and EE estimated while the armband was not worn (kJ), duration of physical activity including intensity (moderate, vigorous, very vigorous), lying down, measured sleep, sedentary time (hours, minutes converted to a decimal), and steps (number). The project officer explained the use of the accelerometer to each participant during the initial interview in the participant's home (Appendix 4.3).

Energy and protein intakes from Meals on Wheels meals

Participants selected their meals in advance from the MOW service list of menu options, all produced by Community Chef, including soup, main protein, vegetables and desserts, salads and sandwiches.

Demographics and participant characteristics

Participant demographics including age, gender, weight (kg) using a Precision UC321PL scale, height (m), using a portable stadiometer, and Body Mass Index (BMI) (kg/m^2), were recorded during the interview.

Nutritional status

Nutritional status was assessed using the MNA®-SF, a tool validated for use with individuals living in the community (Kaiser et al., 2011), and frequently used as a screening tool in studies (Dent et al., 2012) (Appendix 4.4)

Social support and independence

As an individual's level of independence and access to social support have been identified as social determinants of health (WHO 2015, 17b), a semi structured interview was undertaken during each visit to determine participant's level of independence and level of social support. (Appendix 4.5)

Utilisation and consumption of MOW meals

A semi-structured interview was undertaken during each visit to confirm food eaten at home and outside the home including frequency of take-away meals, cooking at home, and visitor meals, how MOW meals were consumed, stored, wastage, and social contact associated with meal deliveries (Appendix 4.6)

Feedback from participants

A semi-structured interview was undertaken during each visit collected feedback from participants in response to the questions about the MOW service (Appendix 4.6, questions 16–18). Responses were assessed as either positive or negative, and results summarised.

4.4.3 Statistics

For numerical variables, such as age, the mean and standard deviation are provided. For categorical variables, the percentage at each level is reported. Quartile data was calculated for the number of days per week, various types of meals and meal components were consumed.

4.5 Results

A total of 83 clients, participated in the initial interview, less than 10% of the client base from all nine participating services (Table 4.2).

Table 4.2 Changes in client numbers relative to the client base, prior to the study commencing

Client group	Number	% client base
Client base, from all participating services	1140	
Clients referred to the project	290	25%
Clients agreed to participate	89	8%
Total clients in the study	83	7%

4.5.1 Demographics

For participants in this study, the mean age was 79.4 (± 10.8) years, and the majority of participants, 54.2%, were female (Table 4.3).

Table 4.3 Demographic characteristics of participants

Numerical variable	N	Mean	SD
Age at baseline	83	79.4	10.8
Categorical variable	Categories	Number of participants	Percent
Gender	Female	45	54.2%
	Male	38	45.8%

4.5.2 Participant characteristics

Participants in this study experienced 2.9 ± 1.6 medical conditions, and had a BMI of 29.1 ± 7.4 (Table 4.4). Depending upon the scale being used, the percentage of the participants assessed within the "healthy" weight range varied from 22% to 53% according to the WHO (WHO, 2000) or Winter (Winter et al, 2014) criteria accordingly. Using the MNA®-SF, a screening tool validated for use in older persons living in the community (Kaiser et al., 2011), 84.3% of participants were assessed as in the "normal", not malnourished or not in the "at risk" category (Table 4.4). It is worth noting that only one participant was in the malnourished category; therefore data for malnourished and "at risk" in this study were combined.

Table 4.4 Background characteristics of participants

Numerical variable	N	Mean	SD
Number of medical conditions	82	2.9	1.6
Weight in kg	83	77.7	20.0
Height in metres	83	1.63	0.1
BMI	83	29.1	7.4
Categorical variable	**Categories**	**Number of participants**	**Percent**
Healthy weight range – adjusted for older Australians (Winter et al., 2014)	Underweight < 23	10	12.1%
	Healthy 23–30	44	53.0%
	Overweight > 30	29	34.9%
Healthy weight range – adjusted for older Australians (WHO, 2000)	Underweight < 18.5	2	2.4%
	Normal 18.5–24.9	18	21.7%
	Overweight 25–29.9	34	41.0%
	Obese 30 +	29	34.9%
MNA®-SF screening category	Malnourished/at risk [1]	13	15.7%
	Normal	70	84.3%

[1] According to the MNA®-SF screening score, only one participant was in the malnourished category; hence data for malnourished and "at risk" were combined.

4.5.3 Energy expenditure / activity levels

In this study energy expenditure was assessed based on the data collected from the accelerometer worn by each participant. Data was recorded for 74 participants. Five of the 74 clients with data wore the armband for less than 90% of the time (equates to at least two hours, 24 minutes unaccounted for in a day). The mean daily energy expenditure was 8,761 ± 2,032 kJ (Table 4.5). Activity levels based on data from the participant's accelerometer confirmed a relatively sedentary activity level – less than 2,000 steps/day, an average MET (metabolic equivalent of task) of 1.16 ± 0.25, and only one hour/day on average of moderate or higher level of activity.

Table 4.5 Energy expenditure based on accelerometer data, steps and METS assessment

Nutrient requirement variable	N	Mean	SD
Total estimated expenditure (EE) (kJ) per day	74	8,761	2032
Total steps per day	74	1,761	1709
Average METs per day	74	1.16	0.25
Hours sedentary per day	74	22.67	1.13
Hours moderate activity per day [#]	74	1.00	1.08

[#] As there were very few "vigorous" hours per day, the hours of moderate and vigorous activity were combined into "moderate +".

4.5.4 Nutrient intake

As assessed from the three-day diet history, mean daily energy intake was, 7,009 ± 2,142 kJ, which equated to 82.6% ± 26.0% of energy expenditure as assessed from the accelerometer data (Table 4.6). Daily protein intake was 69.0 ± 20.4 g, or 98.3% ± 34.6% of the RDI. Based on MOW days only, MOW meals contributed 30.2% ± 14.0% of the energy intake, and 38.2% ± 16.9% of the total daily protein intake. Calculated over all recall days including those days when MOW were not consumed, the contribution of MOW meals to total intake was reduced 25.6% ± 14.6% of the energy intake, and 32.4% ± 17.6% of the total daily protein intake.

Table 4.6 Energy and protein intake including mean daily intake, contribution to requirements and contribution of MOW meals to intake

Nutrient intake variable	N	Mean	Standard deviation
Total energy (kJ)	83	7009	2142
Total protein (g)	83	69.0	20.4
Energy from MOW (MOW days)*	83	0.302	0.140
Protein from MOW (MOW days)*	83	0.382	0.169
Energy from MOW (average)*	83	0.256	0.146
Protein from MOW (average)*	83	0.324	0.176
Energy intake as% EE*	74	0.826	0.260
Protein intake as% RDI*	83	0.983	0.346

* Recorded as a proportion.

Assessing the contribution of MOW meals for participants in this study to the requirements for energy and protein as stated in the AMOWA *National Meal Guidelines* (AMOWA, 2016), neither the energy or protein intake for participants in this study are compliant (Table 4.7).

Table 4.7 Energy and protein requirements, MOW meal contribution to the daily requirement and compliance with AMOWA guidelines

	Nutrient requirement[1]		Contribution of MOW meal to intake		
Nutrient/gender	Total daily requirement[1]	MOW meal contribution[1]	Mean daily intake from MOW study[2]	% Contribution of MOW meals (study) to requirements[1]	Compliance with guidelines[1]
Energy[1]					
Male	7800 kJ	2600 kJ	2116 kJ	81%	No
Female	6900 kJ	2300 kJ	2116 kJ	92%	No
Protein[1]					
Male	81 g	40.5 g	26 g	65%	No
Female	57 g	28.5 g	26 g	92%	No

1 Based on nutrient targets for males above 70 years as the reference person to ensure adequate provision for all MOW clients, and the definition of a meal as "Any combination of course options that provides up to one-half of the daily requirements for protein, up to one-third of the daily requirements for energy, fibre and most other nutrients, with the exception of calcium" (AMOWA, 2016).

[2] Intake based on an average of all participants, male and female.

4.5.5 Social support and independence

The amount of social support was assessed by participants' responses to two questions posed during an interview, focusing on access to someone to talk to or go on outings with, and frequency of visitors (Appendix 4.5, questions 1 and 2). The responses from participants in this study indicated that 68.7% believed that they had "above average" or "high" degree of access to social support, and 78.3% had visits from friends or family at least weekly, with 27.7% having daily visits (Table 4.8).

Regarding their ability to manage independently, participants were asked three questions during interviews (Appendix 4.5, questions 3–5). Responses indicated that without help, 83.1% could prepare their own meals, 42.2% were able to go beyond walking distance, and 37.4% could shop for groceries (Table 4.8).

Table 4.8 Social support and independence for participants

Categorical variable	Categories	Number of participants	Percent
Social support			
Amount of social support	Below average	5	6.0
	Average	21	25.3
	Above average	31	37.4
	High degree	26	31.3
Frequency visits family/friend	Daily	23	27.7
	Several times per week	23	27.7
	Weekly	19	22.9
	Several times per month	5	6.0
	Monthly or less	13	15.7
Independence			
Can go beyond walking distance	Without help	35	42.2
	With some help	34	41.0
	Special arrangements required	14	16.9
Prepare own meals?	Without help	69	83.1
	With some help	10	12.1
	Unable to	4	4.8
Shopping for groceries?	Without help	31	37.4
	With some help	35	42.2
	Unable to	17	20.5

Providing additional evidence of independence and social support, participants were asked to estimate the frequency of them having meals other than MOW meals (Appendix 4.6, question 1). Table 4.9 summarises the number of days per week various types of meals are consumed. Home-cooked meals were most frequently identified as a non-MOW meal, an average of three days/week, followed in descending order of frequency by "other cooked meals", restaurant, and take-away meals, all less than one day/week.

Table 4.9 Frequency of consumption of meals other than MOW meals per week

Days per week	N	Mean	SD	First quartile	Median	Third quartile
Home cooked meal	82	3.29	2.62	1.00	3.00	6.25
Other cooked meal	83	0.63	1.06	0.00	0.25	1.00
Restaurant meal	83	0.34	0.53	0.01	0.25	0.50
Take-away	83	0.27	0.60	0.00	0.01	0.25

4.5.6 MOW client history

A number of questions were asked of participants to establish their history as a MOW client (Appendix 4.6, questions 2–5). The majority of participants were referred either by the hospital (27.7%), self-referred (19.3%), or referred by a relative (13.3%). Although the vast majority, 89.2%, were MOW clients for the first time, at the start of the study, 85.2% had been using MOW for more than 12 months (Table 4.10).

Table 4.10 Summary of the history of participants as a MOW client

Why did you start MOW?	Number of participants	Percent
Hospital	23	27.7
Self	16	19.3
Relative	11	13.3
Council staff	9	10.8
Doctor	6	7.2
Partner	5	6.0
Unknown	5	6.0
Specialist	4	4.8
Friend	3	3.6
Other	1	1.2
TOTAL	**83**	**100**
Duration of MOW	**Number of participants**	**Percent**
Three months or less	5	6.2
Four to 12 months	7	8.6
More than 12 months	69	85.2
Total responses	**81**	**100**
Number of times used MOW before	**Number of participants**	**Percent**
0	74	89.2
1	7	8.4
2	1	1.2
3	1	1.2

4.5.7 Service use – meals / week

Information was collected from the councils with respect to each participant's ordering patterns, specifically the number of meals per week, as well as deliveries and meal components (Appendix 4.6, questions 6 and 7). Each week participants received on average, 4.1 ± 1.56 meals/week in 3.0 ± 1.44 deliveries (Table 4.11), most frequently including the main meal (3.90 ± 1.51), dessert (3.86 ± 1.75),

followed by soup (2.98 ± 2.09). Sandwiches and salads were ordered less than weekly (Table 4.12).

Table 4.11 Number of meals ordered per week

Council report	Mean	SD
MOW meals/week	4.1	1.56
MOW deliveries/week	3.0	1.44

Table 4.12 Number of meal components ordered per week

Meal component	Number	Mean	SD	First quartile	Median	Third quartile
Soup/week	83	2.98	2.09	2	3	5
Main/week	83	3.90	1.51	3	4	5
Dessert/week	81	3.86	1.75	3	4	5
Salad/week	67	0.25	0.70	0	0	0
Sandwich/week	83	0.02	0.15	0	0	0

4.5.8 Consumption of MOW meal components – meal

Tables 4.13 and 4.14 show when various items from MOW were consumed (Appendix 4.6, question 8). When participants reported eating the main, for example, at both lunch and dinner, this was reported as a combined category "lunch and dinner", as the number in combined categories was relatively small. The number eating the main at lunch, for example, can be derived from the total of the categories involving lunch: 38.6 + 10.8 = 49.4%. The consumption of juice is tabulated separately as it was consumed at many times.

While meal components were consumed throughout the day, participants in this study tended to consume soup at the lunch or midday meal, 38.6% (Table 4.13). The main meal, dessert and salad were consumed at the evening meal, 63.9%, 57.8% and 21.7% respectively. Breakfast only accounted for dessert for one participant. Juice was consumed most frequently at breakfast, 48%, but also at lunch, 42.2%, dinner, 41.0% and supper (45.8%) (Table 4.14).

Table 4.13 Consumption of MOW meal component by meal

Meal component	Soup		Main		Dessert		Salad	
When consumed	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
None	25	30.1			7	8.4	54	65.1
Lunch	32	38.6	16	19.3	14	16.9	8	9.6
Dinner	16	19.3	53	63.9	48	57.8	18	21.7
Tea/supper					1	1.2		
Breakfast & dinner					1	1.2		
Lunch & dinner	9	10.8	14	16.9	8	9.6	3	3.6
Lunch & tea/supper					1	1.2		
Lunch & dinner & tea/supper					3	3.6		
Total	**83**	**100**	**83**	**100**	**83**	**100**	**83**	**100**

Table 4.14 Consumption of MOW juice – meal

Meal	Percentage times juice consumed for all participants
Breakfast	48.2
Lunch	42.2
Dinner	41.0
Tea/supper	45.8

4.5.9 MOW meals – plating time and reheating method

In response to questions about reheating the meal (Appendix 4.6, questions 9 and 10), typically, participants decanted meal components from their tray and plated after reheating, 49.4%. (Table 4.15). Some participants 21.7%, consumed the meal in their original container. The vast majority of meals were reheated in microwave oven (95.2%).

Table 4.15 MOW meals – plating time and reheating method

Categorical variable	Categories	Number of participants	Percent
When plated	After heating	41	49.4
	Before heating	24	28.9
	Not plated	18	21.7
Cooking method	Microwave	79	95.2
	Other	4	4.8

4.5.10 Throwing out MOW meals – frequency and reason

Participants were also asked if they ever threw out MOW meals (Appendix 4.6, question 11) and for an explanation. Over half of the participants, 56.6%, confirmed they had thrown out a meal, most frequently, the meat/main protein component of the meal, 18.1%, followed by the vegetables, 12.1%. Desserts were rarely thrown out, 3.6%. (Table 4.16).

Table 4.16 The number of MOW meal components thrown out

Thrown out	Number of participants	Percentage of all participants
Meal component(s)[#]	47	56.6
Soup	7	8.4
Meat/main protein	15	18.1
Starch	6	7.2
Veg	10	12.1
Salad	4	4.8
Dessert	3	3.6

[#] A meal could include any hot or cold component of the MOW menu.

With respect to the reasons for throwing out the meal, quality and personal preference/appetite were similarly represented by those who discarded meals (60% and 62% respectively; n = 47). Interestingly 15% of participants stated they gave their meal to the pet (Table 4.17).

Table 4.17 Reasons for discarding MOW meals

One or more reasons for discarding meal relating to:	Percent of those who discarded (N = 47)
MOW quality – texture was poor, taste was poor, portion too large, cannot eat whole meal, overall quality was poor, past use by date	59.6
Participant preference/appetite – dislikes meal, do not feel like it, dislikes specific meal item, does not eat item	61.7
Other – gives to pet	14.9

4.5.11 Delivery of MOW meals

Participants were asked about their interaction with the MOW delivery person (Appendix 4.6, questions 12–15). In the majority of cases, the delivery person brought the meals inside (83.1%) and chatted with the participant (89.2%), and participants considered the delivery a social interaction (81.9%). (Table 4.18). None of the participants experienced a delivery person reheating or replating the meals. The study did not confirm the procedures for drivers prior to the introduction of the study. This information would be useful in assessing the impact of the study on the level of interaction between drivers and clients.

Table 4.18 Aspects of the meal delivery service

Aspect of meal delivery	Number of participants	Percentage of all participants
Chat with delivery person	74	89.2
Meals brought inside	69	83.1
Meal delivery is social	68	81.9
Same delivery person	9	10.8
Delivery person replates	0	0
Delivery person heats meal	0	0

4.5.12 Positive and negative comments

Feedback received from participants in response to the questions about the MOW service (Appendix 4.6, questions 16–18) were assessed as either positive or negative, and are summarised in Table 4.19.

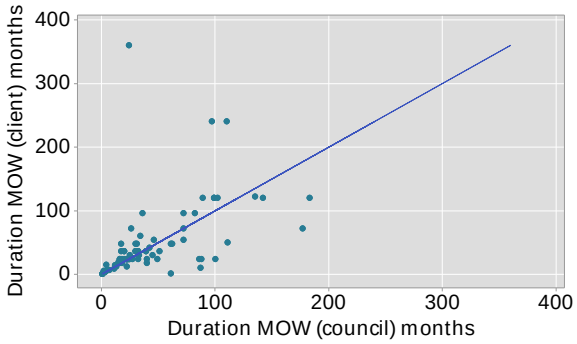
Table 4.19 Feedback from participants about the meal delivery service

Number of comments about MOW	Participants providing comments					
	Positive comments		Negative comments		Separate comments	
	Number	Percentage	Number	Percentage	Number	Percentage
0	19	22.9	24	28.9	24	28.92
1	28	33.7	24	28.9	25	30.1
2	22	26.5	20	24.1	19	22.9
3 or more	14	16.8	15	18.11	15	18.1

4.5.13 Client and council reports

Both participants and the councils providing the MOW services were asked to provide participants' length of time receiving MOW meals and ordering frequencies. The following figures use plots of the raw data to provide a visual assessment of the agreement between these reports. Figure 4.1 refers to the

duration of MOW. Figure 4.2 illustrates the responses to questions related to ordering frequency, illustrating the responses form the council and client related to ordering frequency for each meal component. The solid lines show where points lie if there is perfect agreement.



Blue line shows agreement between both estimates

Figure 4.1 Data on the duration with MOW from the council (x-axis) and the client (y-axis)

The next graph shows the difference between the two duration estimates: client minus council. There are some quite substantial differences. The results on Figure 4.2 indicated 38% of the differences are within three months; for 25% the council estimate is 8 or more months longer than the client; for 37% the client estimate is 4 or more months longer than the council. Given council was able to provide documented support for the data, council data was used in this study.

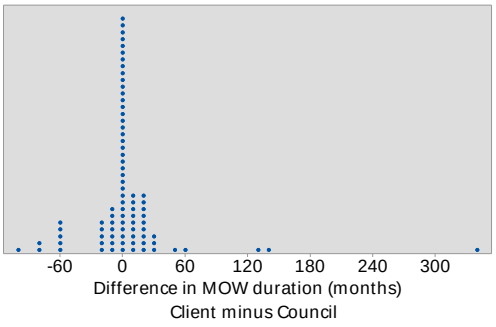


Figure 4.2 Difference in the MOW duration in months – client minus council data

4.6 Discussion

As the fastest growing age group in the population, with a risk of malnutrition and associated outcomes, the demand for services, including nutrition support services such as MOW, for persons aged over 65, and particularly over 85, is expected to increase (Oppenheimer, 2014). This study contributes to our understanding of a relatively nutritionally healthy group of MOW clients with respect to their characteristics, nutritional intake relative to requirements, MOW meal ordering and consumption patterns, feedback on the service, levels of independence and social engagement.

With respect to demographics and characteristics, consistent with other studies (Chareh et al., 2020; Dewar et al., 2020; Locher et al., 2008; Ponza et al., 1996; Wellman et al., 2007), the MOW clients in this study, participants were older adults, (79.4 ± 10.8 years), and predominately female (54.2%). Participants represent a relatively healthy population with average of 2.9 ± 1.6 self-reported medical conditions, and a mean BMI of 29.10 ± 7.4 kg/m^2, higher than similar studies in Australia (Luscombe-Marsh et al., 2014; Walton et al., 2015), Japan (Htun et al., 2016), Ireland (O'Dwyer et al., 2009), and the US (Kretser et al., 2003). In addition, the prevalence of the risk of malnutrition in this study, based on the MNA®-SF, is relatively low (15.7%).

A review of 54 studies shows a prevalence of malnutrition from 0% to 83%, where a variety of screening tools and heterogeneity of study samples were considered factors influencing the broad result (Hamirudin et al., 2016). A more recent review of 32 European studies set in the community using only MNA®-SF to assess the risk of malnutrition, highlights the significance of a standardised approach, reporting prevalence rates from 8.5% for a high risk of malnutrition, increasing to 32.7% when a high and moderate risk of malnutrition were combined (Leij-Halfwerk et al., 2019). Several individual studies of older persons in the community using the MNA® screening tool, reports similar results ranging from 24.2% for men (32.8% for women) in a Spanish study (Cuervo et al., 2008), to 28% in a Turkish study (Ülger et al., 2010), and 35% in a Japanese study (Htun et al., 2016) and an Australian study (Underhill et al., 2015). Given the similarities of

demographics, screening tools and exclusion criteria across the studies, the low incidence of malnutrition in this study is consistent with the concept of a relatively healthy population nutritionally.

An extension of client characteristics, their history with MOW services, including the referral source, length of time and frequency of use, is an opportunity to gain further insight into individual expectations, circumstances and the role of the services within the community (Frongillo et al., 2010). In this study, the majority of participants, although new to MOW (89.2%), had been using the service for more than 12 months (85.2%), suggesting some level of understanding of the options offered by the MOW service and the potential to have established some stability with respect to ordering and consumption patterns. Consistent with a recent Australian survey (Coenen et al., 2021), referrals in this study were primarily from hospital (27.7%), followed by self-referrals (19.3%), relatives (13.3%) and council staff (10.8%), suggesting the MOW service is known throughout the community. Highlighting the benefit of monitoring referral sources, an Australian study reporting data over a four-year period identifies a shift in referrals from hospitals to friends, families and self-referrals, combined with a low referral rate from general practitioners, suggesting the need for strategies to review the communication and referral processes between health care sectors (Charlton et al., 2019).

4.6.1 Intakes – energy and protein

Nutritional intake is a key deliverable for MOW services. Although the participants in this study were relatively healthy, the mean intake for energy and protein did not meet requirements for participants in this study (82.6% ± 26.0% or 98.3% ± 34.6%); however, protein intake was close to requirements. Although this is the only study identified where energy requirements were assessed on the basis of individual activity levels using an SMA, results were similar to other studies. Energy intake for participants in two early North American studies using the Canadian Recommended Nutrient Intakes (RDI) (Maclellan, 1997), and the Recommended Dietary Allowance (RDA) (Ponza et al., 1996), did not meet requirements. In two Australian studies assessing energy intake against the Schofield equation (Schofield, 1985) with a physical activity factor of 1.4, energy

requirements were either not met (Charlton, Walton et al., 2013), or "not different" than requirements (Walton et al., 2015). Protein requirements for participants in this study were close to being met (98%), an outcome that may have been impacted by a higher mean body weight, the basis for calculating protein requirements. Previous studies consistently report protein requirements were met, using reference standards which ranged from 1 g protein per kg body weight for a population of malnourished or at-risk clients (Charlton, Walton et al., 2013), to the age-specific standard used in this study, 1.07 and 0.94 g/kg for males and females respectively (Walton et al., 2015), and national nutrient standards, RNI (Maclellan, 1997) and RDA (Ponza et al., 1996).

Nutritional outcomes are also measured against industry standards. Consistent with individual requirements, intake of energy and protein did not comply with the AMOWA guidelines (AMOWA, 2016), although understandably, guidelines were closer to being met for females, 92% for energy and protein. The use of different standards/guidelines and assessment criteria complicated the comparison with other studies. An Irish study reports MOW meals met the guidelines based on providing one-third of energy and one-half of daily protein requirements (O'Dwyer et al., 2009). In this study, however, the assessment was based on a full meal, rather than the amount ordered and consumed by the clients (O'Dwyer et al., 2009). Some services do offer clients the choice of meal components they would like to order, soup, main meal and/or dessert, creating flexibility for the client. However, this does increase the likelihood that clients will not order a full three-course meal (Fogler-Levitt et al., 1995b; Galea et al., 2013), reducing the potential nutritional contribution from MOW meals.

4.6.2 Ordering and consumption

Nutritional intake is impacted by the foods ordered and consumed. Although meal ordering across all meal components was high, with all participants in this study ordering the main meal, and only 7 % not ordering dessert, as 30% did not order soup (Table 4.13), the likelihood of the meals meeting the AMOWA guidelines for energy and protein was reduced. This ordering pattern was observed in another Australian study, where the main and dessert combination would meet the MOW NSW guidelines for energy for women, but when soup was added both energy and

protein guidelines were met, but for women only (Charlton et al., 2019). While clients have expressed preferences for choice and flexibility, this option can reduce the nutritional contribution of MOW meals. Developing a comprehensive understanding of MOW client behaviour can inform the development of policies and programs, and increase the potential for a positive impact on nutritional intake.

Understanding how and when meals are consumed can assist in targeting strategies to improve dietary intake. Variations in meal timing observed in the current study are similar to other studies (Galea et al., 2013), including those just delivering chilled meals (Parsons & Roll, 2004), with participants in this study splitting meal components over two or three meals, and some swapping between lunch and dinner (9.6% to 16.9%). While other studies report the majority of meals were consumed at the time of delivery (O'Dwyer et al., 2009), or at one sitting (Ponza et al., 1996), the type of meal – hot, chilled or frozen – which may have affected consumption patterns, was not specified. Meal reheating and plating practices also varied in this study, with 21.7% of participants consuming the meal directly from the original package after heating; whereas other studies report clients plating the meal after reheating (Galea et al., 2013). In addition to individual preference, these practices can be affected by the meal packaging (Fogler-Levitt et al., 1995a), such as soup delivered in an individual sealed pouch rather than a bowl. These observations highlight the importance of considering meal consumption and utilisation patterns, when designing service models, to ensure a model that is flexible enough to meet client needs and expectations.

Further impacting dietary intake, in addition to not ordering all meal components, there is evidence that the MOW meals are not fully consumed (Fogler-Levitt et al., 1995a; Ponza et al., 1996; Owen 1992), with reasons for non-utilisation of meals ranging from dislike of food, poor appetite, oral problems, delivery time and difficulty opening packages (Fogler-Levitt et al., 1995a), to creating more than one meal from a single meal (Locher et al., 1998), and sharing meals with others (Fogler-Levitt et al., 1995a). While consumption patterns have been documented, evidence related to meals being thrown out has been lacking. A surprising result from this study indicates that 56.6% of participants threw out meals, with the main meal (protein) component the most frequently discarded (18.1%), along with

vegetables (12.1%), impacting on the potential to meet total protein, fibre and micronutrients intake. Fortunately, soup, starch and dessert, all of which present opportunities for fortification, were less frequently discarded. Feedback from participants regarding the non-utilisation of MOW meals identified outcomes that, if addressed, could reduce the frequency that meals are thrown out. Meal quality issues, the responsibility of the meal producer accounted for 60% of comments, while feedback associated with individual client preferences (62%) was focused on by the service provider.

Surprisingly, 14.9% of those who discarded meals gave their meal to a pet, a practice previously reported only anecdotally (Locher et al., 1998), and potentially reflecting social issues associated with meals. The potential impact of throwing out meals on nutritional outcomes, costs and the environment provides multiple reasons to explore the non-consumption of MOW meals to ensure meals and services reflect individual preferences. To inform strategies for improving the service and nutritional outcomes, future studies investigating MOW need to report the incidence of clients throwing away meals, the percentage of meals discarded, and the reasons for why that portion/meal is being discarded. Also, the results for non-utilisation and throwing out of MOW meals presents as similar opportunity to the plate waste observed in hospitals reported in Chapter 3 where, while 100% consumption of MOW meals is not considered reasonable, the plate waste data provides a basis from which to monitor outcomes, including intake, and refine service models (Williams & Walton, 2011), a potential synergy with respect to system management across sectors.

4.6.3 Comments from participants

While the utilisation of meals provides a level of feedback regarding the level of satisfaction, the comments from participants contributes further insight into client expectations. In the current study, the unexpected percentage of clients throwing out meals appears inconsistent with the similarity in the number of positive and negative comments from MOW clients. However, this inconsistency in feedback was observed in another study where, during interviews, MOW clients mentioned a number of issues of concern, while scoring the service highly on surveys (Timonen & O'Dwyer, 2010). In this case, the authors noted the reluctance of clients to

complain, an observation made in previous studies of aged care clients (Leventhal, 2008), individuals receiving home help (Westerberg et al., 2017) and hospital patients (Andrew et al., 2011; Haste et al., 2020). In a study where a large number of MOW clients did not provide a reason for not consuming the full meal, the authors report some clients did not want to be seen as a complainer or they feared a loss of service (Fogler-Levitt et al., 1995). One of the few studies reporting on client feedback from New Zealand, identifies choice and repetition as negative aspects of the service, particularly for ethnic and cultural groups, along with a lack of knowledge, feelings of embarrassment and loss of independence as barriers to using the service (Wilson & Dennison, 2011). The potential for clients to have low expectations has also been suggested as a motivation to prevent clients from commenting on the food or the services (Timonen & O'Dwyer, 2010).

There is some synergy between these reports and a study where MOW clients participating in a snack program reduced their risk of malnutrition risk and increased their body weight, but were unwilling to continue citing perceived health status, a lack of need, and an ability to manage as barriers to continuing the service (Charlton, Batterham et al., 2013). This theme is addressed in a follow-up study reporting on the implementation of the AMOWA *National Meal Guidelines*, recommending further research on the uptake of and satisfaction with MOW, and the importance of understanding client feedback with respect to service delivery, to ensure systems are responsive to individual client needs (Clancy et al., 2019). Given the need for an understanding of the client perspective in the design of the service, the service model needs to incorporate an approach that supports the client in providing feedback that reflects their perception, without fear of retribution (Leventhal, 2008; Royal Commission into Aged Care Quality and Safety, 2021b; Westerberg et al., 2017).

4.6.4 Independence and social support

The ability of the MOW client to manage tasks, including meal preparation, independently varies and, if not supported, will impact the client's ability to remain living in the community and achieving positive health outcomes (Royal Commission into Aged Care Quality and Safety, 2021b). Compared with a study where 69% of male participants never prepared their own meals (Payette et al.,

1995), and a US study where 41% “were unable” or had “much difficulty” preparing meals (Ponza et al., 1996), the majority of participants in this study were able to prepare their own meals without support (83%). However, in contrast, only 37% of participants in this study were able to shop without assistance, an observation consistent with overseas studies (Coenen et al., 2021; Evans et al., 2014; Frongillo et al., 2010; Gollub & Weddle, 2004; Payette et al., 1995; Ponza et al., 1996; Smith et al., 2004). This apparent contradiction could reflect an early observation in this study, where 58% of participants are unable to go beyond walking distance without assistance. Perhaps the provision of a form of transport could extend the current level of independence across a number of tasks including shopping for groceries and potentially prevent or delay, further deterioration, extending the ability of individuals to remain independent (Royal Commission into Aged Care Quality and Safety, 2021a, 2021b; WHO, 2015; WHO & Noncommunicable Diseases and Mental Health Cluster, 2002).

As discussed in Chapter 1, in addition to formal support programs such as MOW, the informal support provided by friends and family can assist the individual in remaining independent, including managing meal preparation (Royal Commission into Aged Care Quality and Safety, 2021b; WHO, 2017b; WHO & Noncommunicable Diseases and Mental Health Cluster, 2002). In contrast to two US studies where up to 40% of participants saw family or friends less than once per month or never (Frongillo et al., 2010; Ponza et al., 1996), the majority of participants in this study (> 75%) had contact with friends or family at least weekly, similar to a US study where the minority of clients (10–20%) have contact once or twice a month or less (Thomas et al., 2016). Regular contact with these informal support people can contribute directly to the ability to support older individuals living in the community to maintain nutritional health and independence, helping with shopping, transport and meal provision (Chareh et al., 2020).

Although the person delivering the MOW meal provides a form of formal support, as the only face-to-face contact between MOW service and the client, they represent an opportunity to enhance the service to the MOW client that is appreciated by the client. Given the majority of participants in this study were able

to prepare their own meals, it is not a surprise that the delivery person only brought the meal inside, and none of the participants required assistance with re-plating or re-heating the MOW meal. However, over 80% of the participants still chatted with the delivery person and considered the meal delivery a "social experience". The importance of contact with the MOW delivery person was reflected in a study where, although 75% of MOW clients reported that the delivery person left immediately, the 25% of clients where the delivery person spent some time to talk with or check on them, was valued highly (Ponza et al., 1996).

The potential role for drivers in identifying individual clients who needed support was highlighted in an early study (Locher et al., 2008), and demonstrated again in a recent study where, following a training program, drivers submitted 429 alerts for 189 clients resulting in 132 referrals for self-care (33%) health (17%), and care management services (17%). This level of interaction, while limited in duration, has been described as providing MOW clients with a point of engagement with the community based on mutual reciprocity, as the delivery person receives respect and appreciation for their service, and the MOW client benefits from a friendly face-to-face visit, albeit short and simple, filling a void in their day and providing a check on problems that might need to be addressed (Locher et al., 1998).

4.6.5 Strengths and limitations

This Australian study was undertaken in a specific area of North and West Metropolitan Region of Melbourne, and Macedon and Geelong regions of Victoria, limiting the application of the results to other geographic and cultural areas. While the sample size was larger than a number of other studies, the variability within the MOW population reinforces the need for multiple studies to be repeated with larger sample sizes if results are able to be generalised. The sample was further limited because participants were relatively healthy nutritionally, not intentionally, but as a result of the requirement for participants to undertaken interviews and use an armband, which may have excluded those who were less nutritionally well and independent. Although participation by individuals who are at greater risk is challenging, it is important to recognise the limitations of these studies and ensure that the conclusions do not exclude the assessment of individuals within the community.

A strength of the study involved data collection, where, rather than relying on food diaries or estimates, intake was recorded during three 24-hour recalls records by a trained dietitian during interviews on the first day, and phone interviews on the following two days. Single day recalls have the potential to contribute incomplete recalls and data outliers to the study (Gollob et al, 2004). Recent reports that consumption patterns for MOW clients do not consistently include a complete MOW each day, presents a further complication in the collection of a comprehensive set of data for analysis that reflects actual consumption patterns (Galea et al, 2013). The 3-day recall, considered a reliable method of data collection for this population (Payette et al, 1995), supported by a phone interview (Dubois, 1990), administered by a single dietitian, was chosen as an achievable strategy that would optimise the integrity of the data set. Discrepancies between data collected from the councils and clients highlighted the risk of reliance on self-reported details. Creating a unique point of comparison, energy intake was compared with an individual activity assessment rather than pre-determined population standard. The accelerometer recorded several measures of activity that were used in the determination of energy requirements, providing evidence of the actual activity level of this group of older Australians. While the participants are relatively independent and healthy, the results for the group indicated a sedentary lifestyle with less than 2,000 steps/day, an average MET of 1.16 ± 0.25, and only 1 hour/day on average of moderate + activity. While this approach provides the opportunity to collect data on an individual level, in this study the accelerometer presented practical challenges.

Recording the activity level participants were required to wear an accelerometer in the form of an arm band resulting in some participants reporting issues with skin sensitivity, bulkiness of the unit, having to remove it in the shower, becoming itchy when it is hot, and having to remember to wear it. In spite of these challenges, only five of the 74 clients with data wore the armband for less than 90% of the time. Given the focus on nutrition and social support within Meals on Wheels services, future research would benefit from the development of standardised approach to assessing outcomes, including validated tools to assess levels of social support, independence, client feedback, and MOW meals utilisation and consumption specific to the MOW community, as has been developed for malnutrition risk for

various health care sectors. These tools would provide a common base for comparison of research outcomes as well as community service delivery models.

4.7 Conclusion

For this group of relatively independent and well-nourished participants, MOW meals contributed 30% of energy and 38% of participants' protein intake, with the total daily intake for participants met 82% of energy and 98% of protein requirements. In addition to providing insight into meal ordering and consumption patterns, data necessary to developing targeted interventions, the results revealed over half the participants throw out meals (56.6%), with 14.9% of these giving MOW meals to a pet. In contrast, positive and negative feedback from participants was similar suggesting the need for further investigation to clarify the participant expectations regarding meal quality and service levels. As was seen in Chapter 3 with hospital food service studies, the heterogeneity of the study design and the lack of detail regarding meal components and service delivery models presents a barrier to collating the results effectiveness of MOW programs (Walton et al., 2020).

However, results from this study reinforces the need for the meal service to be responsive to individual variation in meal ordering and consumption patterns, levels of independence, and social contact if nutritional outcomes are to be optimised and waste minimised (Charlton et al., 2019; Walton et al., 2017). Service indicators such as meal utilisation, throwing out of meals and feedback from clients can provide valuable insight into existing issues, expectations, and possible system modifications. Regardless of the circumstances and issues, future strategies need to provide for a flexible system with processes capable of responding to changing needs of individual clients (Timonen & O'Dwyer, 2010). MOW services can be encouraged by the successful implementation of client-focused systems in other health care sectors including hospital food services, specifically room service.

Chapter 5 MOW client characteristics – associations with outcomes

5.1 Abstract

The impact of malnutrition on health status and quality of life , has prompted calls for early detection and treatment of malnutrition to prevent deterioration and loss of independence . This study explores the associations between the participant characteristics documented in Chapter 4, and the outcome variables including total energy and protein intake, the contribution of MOW meals to intake, the contribution of intake to requirements and participants' perception of MOW as a social time. The results demonstrate a greater total intake of energy and protein for males, a decline in the contribution of energy intake to requirements as the number of medical conditions increased ($p < 0.05$) and a non-significant trend for a lower energy intake for participants who were at risk or malnourished ($p = 0.071$). As the length of time with MOW increased, the contribution of total energy intake to requirements increased ($p = 0.033$), while the contribution of MOW meals to protein intake declined ($p < 0.05$), along with a negative non-significant trend for energy ($p = 0.091$).

The most consistent result was the positive association between the number of MOW meals ordered and the contribution of MOW meals to nutritional intake, with the most surprising result being the decline in total energy and protein intake and the contribution of energy to requirements as the number of positive comments increased ($p < 0.05$). While the vast majority of participants chatted with the delivery person (89%) and considered MOW meal delivery social (82%), the only association was a non-significant trend for females more likely to find MOW delivery social compared with males ($p = 0.091$). Exploring factors impacting on intake across multiple client groups, including those less well-nourished, may assist in identifying opportunities for early interventions to maintain or improve nutritional health.

5.2 Introduction

The need for services to support older persons to continue to live independently in the community for as long as possible is a focus for governments (Australian Government Department of Health, 2012) and international health agencies to optimise resource allocation and health outcomes (WHO, 2017b). Malnutrition has a negative impact on health status, with those that are not well-nourished more likely to be admitted to hospital and have a longer length of stay (Visvanathan et al., 2003), potentially limiting the ability of individuals to remain in their own home (Payette et al., 2000). Prevalence rates for malnutrition for older persons living in the community have been reported from 8.5% in a systematic review across European countries (Leij-Halfwerk et al., 2019). However, just over 40% of the participants in a study of 235 clients aged 65 years and over from a community nursing service providing home nursing care were assessed as either at risk of malnutrition or malnourished, highlighting the vulnerability of this group of older people and the importance of screening and intervention programs that are targeted to those at greatest nutritional risk (Rist et al., 2012).

Chapter 2 reviews studies that identified associations with malnutrition risk for older persons (Chang, 2016; Leij-Halfwerk et al., 2019; Rist et al., 2012; Schilp et al., 2012) and determinants of malnutrition (O'Keeffe et al., 2019). In addition, studies have reported the potential for MOW services to increase nutrient intake; however, results have been mixed, with small sample size, heterogeneity of study design and population groups identified as factors inhibiting the ability to consolidate study outcomes (IJmker-Hemink et al., 2020; Keller, 2006; O'Keeffe et al., 2019; Walton et al., 2020; Zhu & An, 2013). Studies that explore population characteristics, meal behaviour and nutrient-related outcomes are rare, highlighting a gap in the understanding of the food-related behaviours that may inform the development of targeted strategies (Locher et al., 2008; Sharkey, 2003).

Acknowledging the need to understand client utilisation of MOW programs, an early study in the USA investigating determinants of client retention, identifies, race, client dissatisfaction with the service and poor appetite as key factors which, if addressed, could improve acceptability of the program and client retention (Choi,

1999). The absence of information related to the MOW population characteristics, and the utilisation and consumption of MOW meals has been identified in previous studies investigating factors of importance to nutritional health (Charlton, Walton et al., 2013; Fogler-Levitt et al., 1995b; Galea et al., 2013; Payette et al., 1995; Tilston et al., 1993), along with the lack of evidence assessing the impact of these variables on outcomes (IJmker-Hemink et al., 2020). Although evidence has demonstrated interventions such as the provision of protein-enriched bread or snacks in addition to meals, or meals and snacks for whole days, can improve energy and protein intake and satisfaction, the investigation of client behaviours and characteristics on intake remains absent.

Chapter 4 describes MOW clients who, similar to other studies, were older, primarily female, had mainly been with MOW for 12 months, and were consuming three to four MOW meals per week. Although participants were relatively well nourished, socially connected and independent, their intake did not meet requirements for energy or protein, or the AMOWA standard (AMOWA, 2016), a result that may have been affected by the number of meals that were thrown out, an unexpected result because the feedback from clients was not remarkably negative. One of the more consistent results of this study was the positive feedback of meal delivery as a social time, an aspect of the service that is reflected in the aim of MOW to provide a wellbeing check and contribution to social cohesiveness, as well as a meal (Oppenheimer et al., 2014).

Although participants in this study were relatively independent and socially connected, the vast majority chatted with the delivery person (89%) and considered meal delivery as social (82%), even though only 11% experienced the same delivery person. Continuing the investigation of client characteristics, behaviour and nutritional intake, the aims of this current study are to explore the associations between the participant characteristics documented in Chapter 4, and the outcome variables including total energy and protein intake, the contribution of MOW meals to intake, the contribution of intake to requirements, and the participant's perception of MOW as a social time.

5.3 Aims and objectives

The overall aim for Chapter 5 is to:

> Identify factors associated with nutritional intake for MOW meals clients.

The research questions and objectives relevant to this chapter are outlined in Table 5.1.

Table 5.1 Research questions and objectives for Chapter 5

Chapter	Aim	Research question	Objectives of the research
5	3	What client characteristics and MOW service parameters are associated with an increase in nutritional intake?	Examine the association between client characteristics and MOW service variables and: • total energy and protein intakes. • contribution of MOW meals to intake • energy and protein requirements.
5	3	Are any client characteristics or MOW service variables associated with MOW as a social time?	Examine the association between the client perception of MOW as a social experience and: • total energy and protein intake • contribution of MOW meals to intake • energy and protein requirements.
5	3	Is there an association between MOW client's risk of malnutrition and their level of social support and independence?	Examine the association between client's risk of malnutrition and: • amount of social support and frequency of visitors • preparation of meals and shopping for groceries.

5.4 Study design

This study utilises the data presented in Chapter 4 to undertake an analysis of associations between client demographics, characteristics and food-related behaviours with outcome variables reflecting the focus of MOW services, providing a nutritious meal and a social contact. The eight participant demographics, characteristics and behaviours included in this study are:

1. age
2. gender
3. number of medical conditions.
4. MNA® (Mini Nutritional Assessment) score
5. social support – amount, and frequency of visitors, the same MOW delivery person, and chat with the MOW delivery person
6. independence – meal preparation and shopping
7. utilisation of MOW – length of time with MOW and number of meals/week
8. satisfaction with MOW – positive and negative comments.

Each of these variables was assessed for an association with nine outcome variables, reflecting MOW goals. Eight of the outcome variables focus on energy and protein intake reflecting the provision of a nutritious meal. The final outcome, the participant's perception of MOW delivery as a social time, reflects the MOW aim to provide a social connection for those living in the community. As reported in Chapter 4, the vast majority of participants responded positively when asked if they considered MOW delivery as a social time (82%) and confirmed they interacted with delivery person (89%). The nine outcome variables include:

- total energy (kJ)
- total protein (grams)
- % energy from MOW (MOW days only)
- % protein from MOW (MOW days only)
- % energy from MOW (average over all recall days)
- % protein from MOW (average over all recall days)
- total protein intake as% RDI
- total energy intake as% energy expenditure
- Meals on Wheels delivery as a social time (yes/no).

Finally, to explore the potential impact of the level of social support (amount and frequency of visits) and independence (prepare meals and shopping) reported in

Chapter 4, this study examines the association between these variables and nutritional status as measured by MNA®-SF.

Regarding the contribution of MOW to intake, the study includes two approaches reflecting the flexible ordering system available to MOW clients in this study, where the order did not require a full meal (soup, main meal, and dessert) each day. Rather, participants were able to order any combination of meal components, as frequently as they desired. The analysis included in this study reports the contribution of MOW to intake based on two perspectives:

- only the days over which MOW meals were consumed.
- all three recall days regardless of the inclusion of MOW meal components in the daily intake.

5.4.1 Statistics

For each of the outcome variables, the method of analysis of the association between two variables reflected the type of variable involved. Typically, if both variables were numeric, a correlation coefficient was used. Because different approaches were possible for some variables, the type of measure is described for each of the results below.

Due to the small numbers in some of the social support variable categories (Table 5.2), some re-coding of the levels was undertaken, reducing the responses to three categories.

Table 5.2 Social support variables by category

Variable	Category	N	Percentage
Amount of social support	Below average	5	6.0
	Average	21	25.3
	Above average	31	37.4
	High degree	26	31.3
Frequency visits family/friends	Daily	23	27.7
	Several times per week	23	27.7
	Weekly	19	22.9
	Several times per month	5	6.0
	Monthly or less	13	15.7

Data for social support variables were re-coded (grouped) as follows. Amount of social support:

- below average and average
- above average
- high degree.

Frequency of visits:

- daily
- weekly/several times/week
- monthly/several times/month.

5.5 Results

With respect to the outcome variables, as detailed in Chapter 4 the participants in this study consumed 7,009 ± 2,142 kJ, or 82.6% ± 26.0% of the estimated energy expenditure and they consumed 69.0 ± 20.4 g protein which was 98.3% ± 34.6% of their RDI for protein. Based on MOW days only, MOW meals contributed 30.2% ± 14.0% of the energy intake, and 38.2% ± 16.9% of the total daily protein intake. Calculated over all recall days including those days when MOW meals were not consumed, the contribution of MOW meals to total intake was reduced 25.6% ± 14.6% of the energy intake, and 32.4% ± 17.6% of the total daily protein intake.

5.5.1 Age

For the participants recruited in this study, with a mean age of 79.4 ± 10.8 years there was a negative association between age and the contribution of MOW meals to energy and protein intake, averaged only over the days that MOW meals were consumed ($p < 0.05$) (Table 5.3). There were no significant associations between age and other outcome variables or participant perception of MOW as a social experience.

Table 5.3 Age and nutrient-related outcome variables

	Age at Baseline #		
Outcome variables	Correlation	95% CI	*p*-value [#]
Total energy	0.082	−0.136, 0.293	0.461
Total protein	0.020	−0.197, 0.235	0.856
% energy from MOW (MOW days)	−0.345	−0.522, −0.139	0.001*
% protein from MOW (MOW days)	−0.275	−0.463, −0.063	0.012*
% energy from MOW (average)	−0.160	−0.363, −0.058	0.149
% protein from MOW (average)	−0.135	−0.341, −0.083	0.224
Protein intake as% RDI	0.063	−0.275, 0.155	0.568
% expenditure	0.204	−0.026, 0.413	0.081

Associations based on Pearson's correlation coefficient, difference of means with a 95% confidence interval and a *p*-value for a test of the null hypothesis of no association between two variables of interest. [#] indicates Pearson's correlation coefficient. *$p < 0.05$.

The mean age for each group is presented in Table 5.4. There is no difference in age between the participant's perception of MOW delivery as a social time.

Table 5.4 Age related to participant perception of MOW delivery as a social time

Meal delivery is a social time	Age at baseline			Estimate Difference of mean age (yes-no)	95% confidence interval	*p*-value [#]
	N	Mean	SD			
Yes	68	79.5	11.6	0.39	−4.20, 4.98	0.864
No	15	79.1	6.9			

Data are reported as N = number of participants, mean, SD = standard deviation, estimate of the difference of means with a 95% confidence interval, and *p*-value for a two-sample *t*-test that the true means are the same. [#] indicates a two-sample *t*-test.

5.5.2 Gender

The gender mix presented in Chapter 4 indicates a majority of participants were female (54%). Table 5.5 outlines each outcome variable and the means by gender, along with the comparison of means: male-female, and the estimate of the difference of means with a 95% confidence interval, and *p*-value. There is a gender difference, with male participants consuming more total energy and protein than females. However, there was no impact on meeting requirements or contribution from MOW meals. There is no association between gender and participant perception of MOW as a social experience.

Table 5.5 Gender related to nutrient-related outcome variables and participant perception of MOW delivery as a social time

Outcome variable	N	Mean	SD	Difference of means (M-F)	95% CI	*p*-value[#]
Total energy						
Male	38	7999	2106	1826	959, 2693	< 0.001*
Female	45	6172	1806			
Total protein						
Male	38	78.3	22.2	17.19	8.75, 25.63	< 0.001*
Female	45	61.1	14.8			
% energy from MOW (MOW days)						
Male	38	0.293	0.135	−0.02	−0.08, 0.05	0.606
Female	45	0.309	0.145			
% protein from MOW (MOW days)						
Male	38	0.381	0.151	−0.00	−0.07, 0.07	0.970
Female	45	0.382	0.184			
% energy from MOW (average)						
Male	38	0.269	0.142	0.02	−0.04, 0.09	0.452
Female	45	0.245	0.151			
% protein from MOW (average)						
Male	38	0.347	0.160	0.04	−0.03, 0.12	0.264
Female	45	0.304	0.187			
Protein intake as % RDI						
Male	38	0.920	0.275	−0.115	−0.261, 0.031	0.121
Female	45	1.035	0.391			
% expenditure						
Male	34	0.838	0.232	0.024	−0.096, 0.143	0.697
Female	40	0.815	0.283			
Meal delivery is social (yes)	**N**	**%**	**SD**	**Estimate of difference of% (M-F)**	**95% CI**	***p*-value^**
Male	38	73.7		−15.2	−31.9, 1.5	0.091
Female	45	88.9				

Data for outcome variables are reported as N = number of participants, mean, SD = standard deviation, an estimate of the means with a 95% confidence interval, and a *p*-value for a two-sample *t*-test that the true means are the same. For meal delivery as a social time, an estimate of the difference in percentages is provided with a 95% confidence interval. The *p*-value is from Fisher's exact test for the association between two categorical variables. [#] indicates a two-sample *t*-test. ^ indicates Fisher's exact test. * $p < 0.05$.

5.5.3 Number of medical conditions

Chapter 4 describes participants in this study as presenting with a mean of 2.9 ± 1.6 medical conditions. There is a negative association between the number of medical conditions and energy intake as a percentage of expenditure only, not with any other outcome variables or participant perception of MOW as a social

experience (Table 5.6). There was no association between the number of medical conditions and participant perception of MOW as a social experience (Table 5.6).

Table 5.6 Number of medical conditions related to nutrient-related outcome variables and participant perception of MOW as a social time

	Number of medical conditions		
Outcome variables	Correlation	95% CI	*p*−value [#]
Total energy	−0.164	−0.367, 0.054	0.140
Total protein	−0.086	−0.296, 0.132	0.445
% energy from MOW (MOW days)	0.036	−0.183, 0.251	0.750
% protein from MOW (MOW days)	−0.072	−0.285, 0.147	0.520
% energy from MOW (average)	−0.048	−0.262, 0.171	0.669
% protein from MOW (average)	−0.103	−0.313, 0.117	0.358
Protein intake as% RDI	−0.055	−0.268, 0.163	0.627
% expenditure	−0.272	−0.471, −0.046	0.013*
Meal delivery is social time	N	Mean	SD
Yes	67	3.00	1.68
No	15	2.47	1.46
Difference of mean number of medical conditions	Estimate (yes – no)	95% confidence interval	*p*-value ^
	0.533	-0.353, 1.420	0.226

Associations with nutrient outcomes based on Pearson's correlation coefficient with a 95% confidence interval and a *p*-value for a test of the null hypothesis of no association between two variables of interest. For meal delivery as a social time, an estimate of the difference of means is provided with a 95% confidence interval, and *p*-value for a two-sample *t*-test that the true means are the same. [#] Pearson's correlation coefficient. ^ indicates a two-sample *t*-test. * $p < 0.05$.

5.5.4 MNA®

The majority of participants described in Chapter 4 (84%), were well-nourished based on the MNA®-SF. The MNA® short-form (MNA®-SF) is a valid nutritional screening tool with high sensitivity, specificity and correlation to the full MNA®, that reduces the number of questions and the time required to administer (Kaiser et al., 2009). For each outcome variable, the means by MNA® screening category are given in Table 5.7 along with the comparison of means: at risk/worse – normal. There is no association between MNA® score and outcome variables or participant perception of MOW as a social experience.

Table 5.7 MNA®-SF score related to nutrient-related outcome variables and participant perception of MOW as a social time

Outcome variables – MOW as a social time	N	Mean	SD	Difference of means (at risk/worse or normal)	95% CI	*p*-value #
Total energy						
At risk or worse	13	6125	1735	−1048	−2193, 97	0.071
normal	70	7173	2181			
Total protein						
At risk or worse	13	62.6	17.9	−7.61	−19.26, 4.04	0.187
normal	70	70.2	20.7			
% energy from MOW (MOW days)						
At risk or worse	13	0.340	0.191	0.05	−0.07, 0.16	0.430
normal	70	0.295	0.129			
% protein from MOW (MOW days)						
At risk or worse	13	0.416	0.194	0.04	−0.08, 0.16	0.491
normal	70	0.375	0.164			
% energy from MOW (average)						
At risk or worse	13	0.288	0.212	0.04	−0.09, 0.17	0.548
normal	70	0.250	0.132			
% protein from MOW (average)						
At risk or worse	13	0.343	0.219	0.02	−0.11, 0.16	0.724
normal	70	0.320	0.168			
Protein intake as % of RDI						
At risk or worse	13	0.933	0.401	−0.060	−0.311, 0.192	0.621
normal	70	0.992	0.337			
% expenditure						
At risk or worse	13	0.745	0.233	−0.098	−0.251, 0.055	0.195
normal	61	0.843	0.263			
Meal delivery is social (yes)	**N**	**%**		**Difference of means (At risk/worse or normal)**	**95% CI**	***p*-value^**
At risk or worse	13	84.6		3.2	−18.4, 24.8	> 0.95
normal	70	81.4				

MNA®-SF score related to nutrient-related outcome variables and participant perception of MOW as a social time. Data for outcome variables are reported as N = number of participants, mean, SD = standard deviation, an estimate of the means with a 95% confidence interval, and a *p*-value for a two-sample *t*-test that the true means are the same. For meal delivery as a social time, an estimate of the difference in percentages is provided with a 95% confidence interval. The *p*-value is from Fisher's exact test for the association between two categorical variables. # indicates a two-sample *t*-test. ^ indicates Fisher's exact test.

5.5.5 Social support

The level of social support assessed in Chapter 4 on the basis of the participant's perception of their level of social support and the frequency of visits from family

and friends. The results suggest a socially connected cohort, with only 6% of participants nominating their level of support below average, and 78% having visitors at least weekly.

5.5.6 Amount of social support

The results for the outcome variables according to the re-coded categories of social support and the results from general linear models are presented in Table 5.8, and pairwise comparisons in Table 5.9. No association was identified between the amount of social support and nutrient-related outcome variables using either approach.

Table 5.8 Level of social support related to nutrient-related outcome variables – general linear model

Outcome variables – social support	N	Mean	SD	F	Df	*p*-value [#]
Total energy						
Average or below	26	6737	2106	1.74	2, 80	0.183
Above average	31	6697	1716			
High degree	26	7651	2540			
Total protein						
Average or below	26	69.20	20.92	1.01	2, 80	0.367
Above average	31	65.41	14.57			
High degree	26	73.11	25.16			
% energy from MOW (MOW days)						
Average or below	26	0.3229	0.1556	0.72	2, 80	0.489
Above average	31	0.3053	0.1361			
High degree	26	0.2767	0.1285			
% protein from MOW (MOW days)						
Average or below	26	0.3812	0.1843	0.09	2, 80	0.916
Above average	31	0.3907	0.1507			
High degree	26	0.3718	0.1790			
% energy from MOW (average)						
Average or below	26	0.2579	0.1583	0.20	2, 80	0.822
Above average	31	0.2663	0.1453			
High degree	26	0.2419	0.1398			
% protein from MOW (average)						
Average or below	26	0.3071	0.1851	0.28	2, 80	0.757
Above average	31	0.3417	0.1662			
High degree	26	0.3200	0.1818			
Protein intake as % RDI						
Average or below	26	0.9888	0.3265	0.70	2, 80	0.502
Above average	31	0.9306	0.3222			
High degree	26	1.0390	0.3930			
% expenditure						
Average or below	21	0.7655	0.2338	1.32	2, 71	0.273
Above average	29	0.8164	0.2156			
High degree	24	0.8896	0.3191			

Statistical analysis completed via general linear model. Data are reported as N = number of participants, mean, SD = standard deviation, and *p*-value for a test that the true means are the same. [#] indicates general linear models.

Table 5.9 Level of social support related to nutrient-related outcome variables – pairwise comparison

Outcome variables	Difference of means#	95% CI	*p*-value#
Total energy			
Above average – average or below	-40	-1389, 1310	0.997
High degree – average or below	914	-493, 2321	0.272
High degree – above average	954	-396, 2303	0.216
Total protein			
Above average – average or below	-3.79	-16.72, 9.15	0.764
High degree – average or below	3.92	-9.57, 17.41	0.768
High degree – above average	7.70	-5.23, 20.64	0.334
% energy from MOW (MOW days)			
Above average – average or below	-0.0176	-0.1068, 0.0715	0.884
High degree – average or below	-0.0462	-0.1392, 0.0467	0.464
High degree – above average	-0.0286	-0.1177, 0.0605	0.724
% protein from MOW (MOW days)			
Above average – average or below	0.0095	-0.0990, 0.1180	0.976
High degree – average or below	-0.0095	-0.1227, 0.1037	0.978
High degree – above average	-0.0190	-0.1275, 0.0895	0.908
% energy from MOW (average)			
Above average – average or below	0.0084	-0.0856, 0.1024	0.975
High degree – average or below	-0.0161	-0.1141, 0.0819	0.919
High degree – above average	-0.0245	-0.1184, 0.0695	0.808
% protein from MOW (average)			
Above average – average or below	0.0346	-0.0780, 0.1472	0.744
High degree – average or below	0.0130	-0.1045, 0.1304	0.962
High degree – above average	-0.0216	-0.1342, 0.0910	0.890
Protein intake as % RDI			
Above average – average or below	-0.0583	-0.2789, 0.1624	0.803
High degree – average or below	0.0502	-0.1799, 0.2803	0.861
High degree – above average	0.1084	-0.1122, 0.3291	0.472
% expenditure			
Above average – average or below	0.0508	-0.1266, 0.2283	0.772
High degree – average or below	0.1241	-0.0609, 0.3091	0.249
High degree – above average	0.0733	-0.0976, 0.2441	0.562

The estimate of the difference of means with a 95% confidence interval, and a *p*-value for a pairwise comparison of means that the true means are the same. # indicates pairwise comparisons for each outcome variable.

The percentage of participants who assessed meal delivery as social was compared with their level of social support (Table 5.10). The *p*-value for this test of

association is 0.332; there is no association between level of social support and participant assessment of MOW delivery as social.

Table 5.10 Level of social support related to perception of MOW delivery as a social time

Delivery is social	Amount of social support					
	Average or below^	Above average^	High degree^	Chi-square	DF	*p*-value*
Yes	23	26	19	2.204	2	0.332
No	3	5	7			
Percent social	88%	84%	73%			

Data are reported as cell contents count = number participants, and a *p*-value for a test of association based on a Pearson chi-square test. ^ cell contents count. * Pearson chi-square test.

5.5.7 Frequency of visits

In this study, a second measure of social support focuses on the frequency of visitors. Again, participants reflected a reasonable level of social connection, as detailed in Chapter 4, where only 16% of participants had visitors monthly or less. The results from general linear models and pairwise comparison are presented on Table 5.11 and Table 5.12. No association was identified between the frequency of visits and nutrient-related outcome variables.

Table 5.11 Frequency of visits related to nutrient-related outcome variables – general linear model

Outcome variables	Frequency family visits	N	Mean	SD	F	df	*p*-value [#]
Total energy							
	Daily	23	7713	2287	1.76	2, 80	0.179
	Several times/weekly	42	6761	1945			
	Less than weekly	18	6687	2304			
Total protein							
	Daily	23	71.41	21.52	0.22	2, 80	0.805
	Several times/weekly	42	68.18	19.91			
	Less than weekly	18	67.89	20.79			
% energy from MOW (MOW days)							
	Daily	23	0.2745	0.1308	0.91	2, 80	0.408
	Several times/weekly	42	0.3215	0.1420			
	Less than weekly	18	0.2911	0.1461			
% protein from MOW (MOW days)							
	Daily	23	0.3545	0.1446	0.79	2, 80	0.459
	Several times/weekly	42	0.4046	0.1783			
	Less than weekly	18	0.3635	0.1763			
% energy from MOW (average)							
	Daily	23	0.2405	0.1477	1.03	2, 80	0.361
	Several times/weekly	42	0.2782	0.1461			
	Less than weekly	18	0.2243	0.1452			
% protein from MOW (average)							
	Daily	23	0.3032	0.1598	1.57	2, 80	0.215
	Several times/weekly	42	0.3562	0.1890			
	Less than weekly	18	0.2758	0.1546			
Protein intake as % RDI							
	Daily	23	0.9833	0.2814	0.48	2, 80	0.622
	Several times/weekly	42	1.0114	0.3965			
	Less than weekly	18	0.9155	0.2973			
% expenditure							
	Daily	20	0.8992	0.2509	1.18	2, 71	0.313
	Several times/weekly	36	0.8082	0.2544			
	Less than weekly	18	0.7790	0.2760			

Statistical analysis completed via general linear model. Data are reported as N = number of participants, Mean, SD = standard deviation, and *p*-value for a test that the true means are the same. [#] indicates general linear models.

Table 5.12 Frequency of visits related to nutrient-related outcome variables – pairwise comparison

Outcome variables	Difference of means	95% CI	*p*-value [#]
Total energy			
Several times/weekly – daily	−952	−2268, 364	0.201
< weekly – daily	−1026	−2622, 570	0.280
< weekly – several times/weekly	−74	−1503, 1355	0.992
Total protein			
Several times/weekly – daily	−3.23	−15.97, 9.51	0.817
< weekly – daily	−3.51	−18.97, 11.94	0.850
< weekly – several times/weekly	−0.28	−14.12, 13.56	0.999
% energy from MOW (MOW days)			
Several times/weekly – daily	0.047	−0.0397, 0.1338	0.402
< weekly – daily	0.0167	−0.0886, 0.1219	0.924
< weekly – several times/weekly	−0.0304	−0.1246, 0.0638	0.722
% protein from MOW (MOW days)			
Several times/weekly – daily	0.0501	−0.0548, 0.1550	0.492
< weekly – daily	0.0090	−0.1183, 0.1363	0.984
< weekly – several times/weekly	−0.0411	−0.1551, 0.0728	0.665
% energy from MOW (average)			
Several times/weekly – daily	0.0377	−0.0530, 0.1284	0.583
< weekly – daily	−0.0161	−0.1262, 0.0939	0.935
< weekly – several times/weekly	−0.0538	−0.1524, 0.0447	0.396
% protein from MOW (average)			
Several times/weekly – daily	0.053	−0.0551, 0.1611	0.474
< weekly – daily	−0.0274	−0.1586, 0.1037	0.872
< weekly – Several times/weekly	−0.0804	−0.1979, 0.0370	0.236
Protein intake as % RDI			
Several times/weekly – daily	0.0281	−0.1877, 0.2439	0.948
< weekly – daily	−0.068	−0.330, 0.194	0.811
< weekly – several times/weekly	−0.0958	−0.3302, 0.1385	0.593
% expenditure			
Several times/weekly – daily	−0.0910	−0.2641, 0.0820	0.422
< weekly – daily	−0.1202	−0.3217, 0.0814	0.332
< weekly – several times/weekly	−0.0291	−0.2082, 0.1500	0.920

The estimate of the difference of means with a 95% confidence interval, and a *p*-value for a pairwise comparison of means that the true means are the same. [#] indicates pairwise comparisons for each outcome variable.

The results of the examination of the association between two categorical variables – the percentage of participants who thought meal delivery was social, according to the frequency of family/friends visitors – are presented in Table 5.13. No association between level of social support and participant assessment of MOW delivery as social was determined. *p*-value = 0.388.

Table 5.13 Frequency of visits related to perception of MOW delivery as a social time

Delivery is social	Frequency of visits					
	Daily^	Several times/ weekly^	Less than weekly^	Chi-square	DF	*p*-value*
Yes	21	33	14	1.895	2	0.388
No	2	9	4			
Percent social	91%	79%	78%			

Data are reported as cell contents count = number participants, and a *p*-value for a test of association based on a Pearson chi-square test. ^ cell contents count. * Pearson chi-square test.

5.5.8 Meal delivery – chat with delivery person / same delivery person

In this study, even though only 11% of participants saw the same delivery person, the overwhelming majority, 89%, chatted with the driver. While this result indicates a social component to the delivery, the outcome resulted in a small group of nine participants who did not chat. The same issue arose with the variable "Same MOW delivery person". Most clients did not have the same delivery person (89%), limiting the potential to detect associations between "Chatting with MOW delivery person" or "Same MOW delivery person" and any of the outcome variables. As such, further analysis was not conducted for these variables.

5.5.9 Independent – prepare own meals

While 83% of participants in this study were able to prepare their own meals, only 37% were able to shop for groceries without help, suggesting independence varied with the activity. The distributions of these two measures of independence are shown in Table 5.14. Given the small number of people in the "Unable to" category for "Prepare own meals?" this category was combined with "With some help" and the combined category was called "Requires help".

Table 5.14 Level of independence related to ability to prepare own meals – distribution

Independence variable	Level of independence	Number	Percentage
Prepare own meals?	Without help	69	83.1
	With some help	10	12.1
	Unable to	4	4.8
Shopping for groceries?	Without help	31	37.4
	With some help	35	42.2
	Unable to	17	20.5

For each outcome, the means by "Prepare own meals" are given in Table 5.15, along with the comparison of means, the estimate of the difference of means with a 95% confidence interval. There is no association between needing help to prepare meals and the nutrition-related outcome variables. The p-value for those agreeing meal delivery is social, is consistent with no association between the two categorical variables.

Table 5.15 Level of independence related to ability to prepare own meals

Outcome variable	**N**	**Mean**	**SD**	**Estimate [1]**	**95% CI**	***p*-value[#]**
Total energy						
Without help	69	7105	2241	575	−439, 1588	0.254
Requires help	14	6531	1540			
Total protein						
Without help	69	70.1	21.5	6.52	−2.16, 15.19	0.136
Requires help	14	63.6	12.6			
% energy from MOW (MOW days)						
Without help	69	0.309	0.147	0.041	−0.023, 0.104	0.201
Requires help	14	0.268	0.095			
% protein from MOW (MOW days)						
Without help	69	0.384	0.176	0.014	−0.071, 0.099	0.736
Requires help	14	0.370	0.131			
% energy from MOW (average)						
Without help	69	0.264	0.151	0.048	−0.029, 0.124	0.209
Requires help	14	0.216	0.120			
% protein from MOW (average)						
Without help	69	0.330	0.181	0.034	−0.060, 0.128	0.461
Requires help	14	0.296	0.149			
Protein intake as % RDI				0.118	−0.072, 0.308	0.211
Without help	69	1.003	0.353			
Requires help	14	0.885	0.302			
% expenditure						
Without help	63	0.820	0.262	-0.038	−0.218, 0.143	0.660
Requires help	11	0.858	0.255			
Meal delivery social (yes)	**N**	**Percentage**		**Estimate [1]**	**95% CI**	***p*-value^**
Without help	69	82.6		4.0	−19.2, 27.3	0.711
Requires help	14	78.6				

Data for outcome variables are reported as N = number of participants, mean, SD = standard deviation, an estimate of the means with a 95% confidence interval, and a *p*-value for a two-sample *t*-test that the true means are the same. For meal delivery as a social time, an estimate of the difference in percentages is provided with a 95% confidence interval. The *p*-value is from Fisher's exact test for the association between two categorical variables. [#] indicates a two-sample *t*-test. ^ Fisher's exact test. [1] Without – requires help.

5.5.10 Independent – shopping for groceries

The variable "Shopping for groceries" has three levels – or three groups, creating an additional layer of complexity for the analysis. Tables 5.16 and 5.17 present the results for the outcome variables according to the categories for ability to shop for groceries and the results from general linear models and pairwise comparison, respectively. No association was identified between the level of assistance required for shopping for groceries and nutrient-related outcome variable using either method.

Table 5.16 Level of independence related to shopping – general linear model

Outcome variables	Shopping for groceries?	N	Mean	SD	F	df	*p*-value[#]
Total energy							
	Without help	31	7,281	2,368	0.42	2, 80	0.659
	With some help	35	6,800	2,048			
	Unable to	17	6,942	1,959			
Total protein							
	Without help	31	72.19	21.99	0.74	2, 80	0.481
	With some help	35	66.07	20.89			
	Unable to	17	69.27	15.84			
% energy from MOW (MOW days)							
	Without help	31	0.2786	0.1322	0.79	2, 80	0.460
	With some help	35	0.3219	0.1596			
	Unable to	17	0.3031	0.1064			
% protein from MOW (MOW days)							
	Without help	31	0.3501	0.1728	0.87	2, 80	0.422
	With some help	35	0.4001	0.1805			
	Unable to	17	0.4020	0.1330			
% energy from MOW (average)							
	Without help	31	0.2394	0.1410	0.76	2, 80	0.470
	With some help	35	0.2794	0.1695			
	Unable to	17	0.2384	0.0972			
% protein from MOW (average)							
	Without help	31	0.3044	0.1813	0.49	2, 80	0.613

	With some help	35	0.3462	0.1950			
	Unable to	17	0.3143	0.1171			
Protein intake as % RDI							
	Without help	31	1.0209	0.3101	1.50	2, 80	0.229
	With some help	35	0.9086	0.3162			
	Unable to	17	1.066	0.445			
% expenditure							
	Without help	29	0.8346	0.2272	1.45	2, 71	0.240
	With some help	31	0.7763	0.2305			
	Unable to	14	0.9165	0.3595			

Statistical analysis completed via general linear model. Data are reported as N = number of participants, mean, SD = standard deviation, and *p*-value for a test that the true means are the same. [#] indicates general linear model.

Table 5.17 Level of independence related to shopping – pairwise comparison

Outcome variables	Difference of means	95% CI	*p*-value [#]
Total energy			
With some help – without help	−481	−1753, 791	0.639
Unable to – without help	−339	−1895, 1217	0.861
Unable to – with some help	142	−1382, 1666	0.973
Total protein			
With some help – without help	−6.11	−18.15, 5.92	0.449
Unable to – without help	−2.91	−17.64, 11.82	0.884
Unable to – with some help	3.20	−11.23, 17.63	0.857
% energy from MOW (MOW days)			
With some help – without help	0.0433	−0.0393, 0.1259	0.426
Unable to – without help	0.0246	−0.0765, 0.1256	0.831
Unable to – with some help	−0.0187	−0.1177, 0.0803	0.894
% protein from MOW (MOW days)			
With some help – without help	0.0500	−0.0497, 0.1496	0.458
Unable to – without help	0.0519	−0.0700, 0.1739	0.568
Unable to – with some help	0.0019	−0.1175, 0.1214	0.999
% energy from MOW (average)			
With some help – without help	0.04	−0.0466, 0.1265	0.514
Unable to – without help	−0.0009	−0.1068, 0.1050	> 0.995
Unable to – with some help	−0.0409	−0.1446, 0.0628	0.615
% protein from MOW (average)			
With some help – without help	0.0418	−0.0624, 0.1460	0.605
Unable to – without help	0.0099	−0.1175, 0.1374	0.981
Unable to – with some help	−0.0319	−0.1567, 0.0930	0.815
Protein intake as % RDI			
With some help – without help	−0.1122	−0.3148, 0.0904	0.386
Unable to – without help	0.0450	−0.203, 0.293	0.901
Unable to – with some help	0.1570	−0.085, 0.400	0.274
% expenditure			
With some help – without help	−0.0583	−0.2180, 0.1014	0.658
Unable to – without help	0.0819	−0.1192, 0.2831	0.594
Unable to – with some help	0.1402	−0.0588, 0.3392	0.217

Associations are based on the pairwise comparison of means. For each of the outcome measures, and each level of independence related to shopping, the difference of meals is reported with a 95% confidence interval, and *p*-value for a test that the true means are the same. [#] indicates pairwise comparison.

To examine the association between two categorical variables of interest, the percentage of participants who thought meal delivery was social, according to the level of shopping for groceries has been assessed (Table 5.18). A significant

association between these two variables was determined via a Pearson chi-square test. *p*-value = 0.040.

Table 5.18 Level of independence related to shopping and MOW delivery as a social time

Delivery is social	Shopping for groceries					
	Without help^	**With some help^**	**Unable to^**	**Chi-square**	**DF**	***p*-value***
Yes	26	25	17	6.435	2	0.040 **
No	5	10	0			
Percent social	84%	71%	100%			

Statistical analysis completed via a Pearson chi-square test. Data are reported as cell contents count = number participants, and a *p*-value for a test of association. ^ cell contents count. * Pearson chi-square test. ** $p < 0.05$

5.5.11 MOW meals/week

In Chapter 4, although participants reported ordering an average of 4.1 ±1.56 meals per week, total energy and protein intake did not meet requirements. The strength of association between the number MOW meals/week and the numerical outcome variables, indicates a positive association between the contribution of MOW to intake of energy and protein for both methods of assessment – MOW days only, and an average across all three recall days (Table 5.19). There is no association between the number of MOW meals per week and participant perception of MOW as a social experience.

Table 5.19 Number of MOW meals per week related to nutrient outcome variables

Outcome variables	Number of MOW/week Correlation	95% CI	*p*-value #
Total energy	−0.011	−0.226, 0.205	0.919
Total protein	−0.120	−0.327, 0.098	0.279
% energy from MOW (MOW days)	0.326	(0.119, 0.506)	0.003*
% protein from MOW (MOW days)	0.360	(0.156, 0.534)	0.001*
% energy from MOW (average)	0.371	(0.168, 0.543)	0.001*
% protein from MOW (average)	0.395	(0.196, 0.563)	<0.001*
Protein intake as % RDI	−0.161	−0.364, 0.057	0.145
% expenditure	−0.171	−0.384, 0.060	0.146

Meal delivery is social time	Number of MOW/week N	Mean	SD	Estimate difference of mean number of MOW/week (yes-no)	95% confidence interval	*p*-value ^
Yes	68	4.12	1.59	−0.02	−0.92, 0.89	0.971
No	15	4.13	1.51			

A 95% confidence interval is provided for the correlation with a *p*-value from the Pearson's correlation coefficient for a test of the null hypothesis of no association between two variables of interest. For meal delivery as a social time, data are reported as N = number of participants, mean, SD = standard deviation, with an estimate of the difference of means is provided with a 95% confidence interval, and *p*-value for a two-sample *t*-test that the true means are the same. # indicates Pearson's correlation coefficient. ^ indicates a two-sample *t*-test. * $p < 0.05$.

5.5.12 MOW history – length of time with MOW

In Chapter 4, the majority of participants are described as being with MOW for more than 12 months (85%). Using Pearson's correlation coefficient to measure the strength of association between the duration of MOW and the numerical outcome variables, a negative association is identified between the length of time with MOW and the contribution of MOW meals to protein intake, on MOW days, and a positive association with the contribution of energy intake to expenditure (Table 5.20). There is no association between the length of time with MOW and participant perception of MOW as a social experience.

Table 5.20 The length of time with MOW related to nutrient outcome variables

Outcome variables	Duration of MOW (months)		
	Correlation	95% CI	*p*−value [#]
Total energy	0.196	−0.021, 0.395	0.080
Total protein	0.154	−0.064, 0.358	0.169
% energy from MOW (MOW days)	−0.189	−0.391, 0.030	0.091
% protein from MOW (MOW days)	−0.253	−0.447, −0.037	0.023*
% energy from MOW (average)	−0.146	−0.353, 0.075	0.195
% protein from MOW (average)	−0.164	−0.369, 0.056	0.143
Protein intake as % RDI	0.176	−0.041, 0.377	0.115
% expenditure	0.250	0.029, 0.448	0.033*

Meal delivery is social time	Duration of MOW			Estimate difference of mean duration of MOW (Yes – no)	95% confidence interval	*p*-value^
	N	Mean	SD			
Yes	67	42.7	40.5	−3.2	−27.7, 21.4	0.791
No	14	45.9	39.9			

A 95% confidence interval is provided for the correlation with a *p*-value from the Pearson's correlation coefficient for a test of the null hypothesis of no association between two variables of interest. For meal delivery as a social time, data are reported as N = number of participants, mean, SD = standard deviation, with an estimate of the difference of means is provided with a 95% confidence interval, and *p*-value for a two-sample *t*-test that the true means are the same. [#] Pearson's correlation coefficient. ^ indicates a two-sample *t*-test. * $p < 0.05$.

5.5.13 Satisfaction – positive comments

Feedback from participants regarding MOW indicates a similar number of positive and negative comments. Analysis using Pearson's correlation coefficient identifies a negative correlation between positive comments and total energy and total protein intake as well as the contribution of energy intake to expenditure (Table 5.21). The *p*-value is for a two-sample *t*-test indicated no association between the number of positive comments and outcome variables or participant perceptions of MOW as a social experience.

Table 5.21 The number of positive comments related to nutrient outcome variables

	Number of positive comments		
Outcome variables	**Correlation**	**95% CI**	***p*-value** [#]
Total energy	−0.473	−0.625, −0.287	< 0.001*
Total protein	−0.347	−0.524, −0.142	0.001*
% energy from MOW (MOW days)	0.117	(−0.102, 0.324)	0.294
*% protein from MOW (MOW days)	0.084	(−0.134, 0.294)	0.450
% energy from MOW (average)	−0.017	(−0.232, 0.199)	0.878
% protein from MOW (average)	−0.040	(−0.253, 0.177)	0.720
Protein intake as % RDI	−0.199	−0.398, 0.017	0.072
% expenditure	−0.411	−0.580, −0.207	< 0.001*

Meal delivery is social time	**Number of positive comments**			**Estimate difference of mean number of positive comments (yes – no)**	**95% confidence interval**	***p*-value ^**
	N	**Mean**	**SD**			
Yes	68	1.49	1.22b	0.085	−0.651, 0.822	0.812
No	15	1.40	1.24			

A 95% confidence interval is provided for the correlation with a *p*-value from the Pearson's correlation coefficient for a test of the null hypothesis of no association between two variables of interest. For meal delivery as a social time, data are reported as N = number of participants, mean, SD = standard deviation, with an estimate of the difference of means is provided with a 95% confidence interval, and *p*-value for a two-sample *t*-test that the true means are the same. [#] Pearson's correlation coefficient. ^ indicates a two-sample *t*-test. * $p < 0.05$.

5.5.14 Satisfaction – negative comments

As reported for positive feedback from participants, Pearson's correlation coefficient was used to give a measure of the strength of association between the number of negative comments and the numerical outcome variables (Table 5.22). However, there was no association between the two variables of interest and no association between negative comments and outcome variables or participant perception of MOW as a social experience.

Table 5.22 The number of negative comments related to nutrient outcome variables.

	Number of negative comments		
Outcome variables	**Correlation**	**95% CI**	***p*-value [#]**
Total energy	−0.125	−0.332, 0.093	0.259
Total protein	−0.110	−0.318, 0.108	0.324
% energy from MOW (MOW days)	0.117	(−0.102, 0.324)	0.294
% protein from MOW (MOW days)	0.084	(−0.134, 0.294)	0.450
% energy from MOW (average)	−0.017	(−0.232, 0.199)	0.878
% protein from MOW (average)	−0.040	(−0.253, 0.177)	0.720
Protein intake as % RDI	0.010	−0.206, 0.225	0.925
% expenditure	−0.094	−0.310, 0.131	0.426

Meal delivery is social time	**Number of negative comments**			**Estimate difference of mean number of negative comments (yes – no)**	**95% confidence interval**	***p*-value ^**
	N	**Mean**	**SD**			
Yes	68	1.62	1.80	−0.249	−1.612, 1.114	0.705
No	15	1.87	2.36			

A 95% confidence interval is provided for the correlation with a *p*-value from the Pearson's correlation coefficient for a test of the null hypothesis of no association between two variables of interest. For meal delivery as a social time, data are reported as N = number of participants, mean, SD = standard deviation, with an estimate of the difference of means is provided with a 95% confidence interval, and *p*-value for a two-sample *t*-test that the true means are the same. [#] indicates Pearson's correlation coefficient. ^ indicates a two-sample *t*-test. * $p < 0.05$.

5.5.15 Association of outcome variables and meal delivery as a social time

To explore the social aspect of the MOW service, this section investigates the associations between the participants' perception of MOW delivery as a social time and each of the nutrition-related outcome variables. For each outcome (total daily energy and protein, the percentage contribution to energy and protein for MOW days only and as an average across all days, protein intake as a percentage of RDI, and energy intake as a percentage of expenditure). The means with regards to MOW as a social time (yes or no) are given in Table 5.23, along with the comparison of means, the estimate of the difference of means with a 95% confidence interval, and *p*-value for a the two-sample independent *t*-tests. Overall, in this analysis, there is no association between outcome variables and participants' perception of meal delivery as a social time.

Table 5.23 Outcome variables and participant perception of MOW as a social time

Outcome variable	N	Mean	SD	Estimate difference of means – (social–not)	95% CI	*p*−value [#]
Total energy						
MOW is social	68	6833	1971	−969	−2539, 601	0.210
MOW is not social	15	7803	2730			
Total protein						
MOW is social	68	68.3	19.6	−3.75	−17.72, 10.21	0.579
MOW is not social	15	72.1	24.0			
% energy from MOW (MOW days)						
MOW is social	68	0.309	0.143	0.040	−0.035, 0.114	0.280
MOW is not social	15	0.269	0.121			
% protein from MOW (MOW days)						
MOW is social	68	0.383	0.170	0.008	−0.092, 0.107	0.875
MOW is not social	15	0.376	0.167			
% energy from MOW (average)						
MOW is social	68	0.259	0.153	0.017	−0.056, 0.090	0.636
MOW is not social	15	0.242	0.117			
% protein from MOW (average)						
MOW is social	68	0.322	0.182	−0.012	−0.103, 0.078	0.779
MOW is not social	15	0.334	0.146			
Protein intake as % RDI						
MOW is social	68	0.984	0.362	0.0064	−0.1642, 0.1770	0.939
MOW is not social	15	0.978	0.273			
% expenditure						
MOW is social	60	0.817	0.251	−0.0442	−0.2261, 0.1377	0.615
MOW is not social	14	0.862	0.299			

Data are reported as N = number of participants, mean, SD = standard deviation, and *p*-value for a two-sample *t*-test that that the true means are the same. The estimate of the difference of means with a 95% confidence interval, and *p*-value for a two-sample *t*-test that the true means are the same. [#] indicates a two-sample *t*-test.

5.5.16 Association with nutritional status

This study examines the association between malnutrition risk and the variables related to social contact and independence, specifically the amount of social support, frequency of visitors, preparing meals, and shopping for groceries.

Amount of social support

A chi-square test was used to test the association between two categorical variables, participant assessment of their level of social support and nutritional risk (Table 5.24). The *p*-value for this test of association is 0.806.

Table 5.24 MNA®-SF screening category related to the amount of social support

MNA® screen category	Amount of social support					
	Average or below^	Above average^	High degree^	Chi-square	DF	*p*-value*
Malnourished/at risk	4	4	5	0.431	2	0.806
Normal	22	27	21			
Percent malnourished/at risk	15%	13%	19%			

Statistical analysis completed via a Pearson chi-square test. Data are reported as cell contents count = number participants, and a *p*-value for a test of association. ^ cell contents count. * Pearson chi-square test.

Frequency of visits

A chi-square test was used to test the association between two categorical variables, "Frequency of visits" and nutritional risk (Table 5.25). The *p*-value for this test of association is 0.212.

Table 5.25 MNA®-SF screening category and the frequency of visits

MNA® screen category	Frequency of visits					
	Daily^	Several times/ weekly^	Less than weekly^	Chi-square	DF	*p*-value*
Malnourished/at risk	6	4	3	3.104	2	0.212
Normal	17	38	15			
Percent Malnourished/at risk	26%	10%	17%			

Statistical analysis completed via a Pearson chi-square test. Data are reported as cell contents count = number participants, and a *p*-value for a test of association. ^ cell contents count. * Pearson chi-square test.

Prepare own meals

A comparison of the percentage of those who di and did not require help with meal preparation, with participants who are at risk or malnourished, is provided in Table 5.26. The *p*-value for this test of association is > 0.995

Table 5.26 MNA®-SF screening category and ability to prepare meals

MNA®-SF screen category	Ability to prepare meals				
	N	Percent	Estimate difference of percentages (without – requires help)	95% confidence interval	*p*-value[#]
Malnourished/at risk					
Without help	69	15.9	1.7	−18.6, 21.9	> 0.995
Requires help	14	14.3			

Data are reported as N = number of participants, Percent, the estimate of the difference in percentages is provided with a 95% confidence interval. The *p*-value is from Fisher's exact test for the association between two categorical variables. [#] indicates Fisher's exact.

5.5.17 Shopping for groceries

A chi-square test was used to test the association between two categorical variables, "Shopping for groceries?" and malnutrition risk (Table 5.27). The *p*-value for this test of association is 0.301.

Table 5.27 MNA®-SF screening category and ability to shop for groceries

MNA® Screen Category	Shopping for groceries					
	Without help^	With some help^	Unable to^	Chi-square	DF	*p*-value*
Malnourished/at risk	7	5	1	2.404	2	0.301
Normal	24	30	16			
Percent malnourished/at risk	23%	14%	6%			

Statistical analysis completed via a Pearson chi-square test. Data are reported as cell contents count = number participants, and a *p*-value for a test of association. ^ cell contents count. * Pearson chi-square test.

5.6 Discussion

With a focus on identifying factors that impact on nutritional intake, this study explores potential associations between MOW client characteristics and behaviours, with nutritional intake for the relatively healthy, independent and socially connected MOW client group detailed in Chapter 4, highlighting associations with the number of MOW meals ordered per week, length of time with MOW, and number of positive comments about MOW.

5.6.1 Daily intake and meeting requirements

Although the associations for intake and meeting requirements were mixed, results provide a focus for future investigations. In this study, as the length of time

participants were with MOW increased, the energy intake as a percentage of requirements increased ($p = 0.033$), with a trend for total intake to increase ($p = 0.080$), reinforcing the potential for MOW to impact nutritional intake over time. Unfortunately, results from this study indicated the contribution of energy to requirements declined as the number of medical conditions increased ($p = 0.013$), with a trend for total energy intake to decline for those at risk of malnutrition ($p = 0.071$). Although not significant, this latter result represents a potentially clinically relevant decline in the contribution of energy intake to requirements for participants at risk represented a potential significant reduction of 1,048 kJ per day, or 12% of the daily requirement, suggesting further research to clarify the outcome with a larger sample size that includes less well-nourished participants. While previous studies have reported associations with frailty (Choi, 1999) and nutritional risk (Johansson et al., 2009; Keller, 2006; Payette et al., 2000), studies investigating MOW populations for associations with nutritional intake are limited.

Data from a national survey in the US report results from two non-consecutive 24-hour dietary recalls among 145 MOW clients demonstrated an increased intake of protein, but not for energy on days when MOW meal components were consumed (An, 2015). The limited number of quality studies and the challenges presented by inconsistencies in study design and data analysis when comparing studies were highlighted in a recent systematic review (IJmker-Hemink et al., 2020). The mixed results in this study reinforce the need for larger, ideally longitudinal studies, to report nutritional intake along with associations with individual characteristics and system-related variables that can impact intake.

5.6.2 Contribution of MOW meals to intake

As discussed in Chapter 4, MOW services vary with respect to the ordering requirements, with some services requiring clients to order the full meal (soup, main and dessert); while other services (Galea et al., 2013), including the ones in this study, offer clients the option of selecting individual meal components, on their preferred days. In this study, the contribution of MOW meals to intake was only impacted when intake data was assessed on MOW days only, with the contribution of MOW to intake decreasing with age (for energy and protein), and as the length of time with MOW increased for protein. For energy, only a trend for

a decrease in the contribution of MOW meals to intake was reported ($p = 0.091$). When assessed over all three recall days, there was no association with age or length of time with MOW. These results are an example of the need for clarity with respect to the service levels provided and the study design to enable comparison across studies and develop evidence-based strategies for improving outcomes.

While offering MOW clients a flexible approach to ordering responds to client requests for choice (Oppenheimer, 2014), the outcome is an inability for the MOW service provider to confidently predict the potential contribution of a MOW "meal" to nutritional intake and industry standards (Charlton, Batterham et al., 2013), as highlighted by the impact of allocating the MOW meal components consumed over all recall days, rather than just the days the MOW components were consumed. The impact of ordering protocols was highlighted in another Australian study where MOW meals only met energy and protein guidelines if all three components of the meal were ordered; however, meal components ordered provided a lower contribution to intake (Galea et al., 2013). A creative approach to the delivery of MOW services will be required if nutritional outcomes are to be optimised while the expectations of the clients are accommodated (Oppenheimer et al., 2014).

In contrast to the length of time with MOW, and not surprisingly, a positive association was reported in this study between the number of MOW meals consumed per week and the contribution of MOW meals to energy and protein intake, an association that was consistent both MOW days ($p = 0.003$ energy; ($p = 0.001$; protein), and an average over the three recall days ($p = 0.001$ energy; ($p < 0.001$ protein). This outcome is similar to an early study in the UK where the contribution of the MOW meal to intake was considered "insignificant" when fewer than four meals per week, although the authors acknowledged the service was still able to provide some social contact value (Tilston et al., 1994). A recent systematic review introduced another variable, reporting a similar association where a high frequency of meals over a shorter intervention period (10–14 days) improved energy and protein intakes, suggesting the number of meals per week can be important, particularly when time frames are short (IJmker-Hemink et al., 2020). While there are some variations among study design, these studies provide evidence of an association between the number of MOW meals ordered and

contribution to intake, even in this relatively healthy, independent client population.

The length of time with MOW, however, produced mixed results with the contribution of total energy intake to requirements increasing over time (p = 0.033), while the contribution of MOW meals to intake declined with respect to protein (p = 0.023), and showed a negative trend for the contribution of MOW meals to energy intake (p = 0.091). While there is no obvious explanation, the observation of these outcomes in a relatively healthy population suggest research to investigate these outcomes with a less nutritionally health group of clients and the potential for these variables to be indicators of a need for a service modification or interventions to improve the impact of the MOW service.

5.6.3 Satisfaction with MOW

Perhaps the most surprising result in this study was the negative association between the number of positive comments from participants and total intake of energy ($p < 0.001$) and protein (p = 0.001), and the percentage contribution of energy to expenditure (requirements) ($p < 0.001$), and a trend for the contribution of protein to requirements (p = 0.072). This apparent contradiction in this study where total intake declines as satisfaction increases, suggests a level of unreported dissatisfaction and a need for further investigation of client satisfaction, particularly given the percentage of participants in this study who throw out meals (56.6%). This outcome could suggest participants have experienced a loss of appetite without adjusting the level of ordering, highlighting a potential opportunity for follow-up with the clients to check for circumstances that could be affecting the outcomes, and potentially their nutritional health. While other studies have not measured the same variables, a recent study of home help service users illustrated a similar contradiction, with all participants expressing satisfaction with the services, while all but one also mentioned problems (Westerberg et al., 2017). Other studies have reported overall satisfaction with various aspects of the meals (IJmker-Hemink et al., 2020; Lirette et al., 2007) with reference been made to improving texture (Lirette et al., 2007) and variety (Lirette et al., 2007; Tilston et al., 1994).

Investigating these seemingly contradictory results, a number of studies focused on the client's sensitivity to impact the provision of honest feedback, including factors such as a lack of self-confidence (Leventhal, 2008), an unwillingness to admit dependency and inability to prepare one's own food, a concern of being greedy (Tilston et al., 1994), a fear of unfavourable treatment while dependent (Andrew et al., 2011; Leventhal, 2008), and a belief that positive responses will be more acceptable to the researcher (Andrew et al., 2011). Once again, the complex nature of the MOW client population is highlighted, and has demonstrated to potentially confuse the design of an effective service model. The association between positive comments and the negative association between the contribution of MOW to intake and the length of time with MOW, deserves further investigation that incorporates a mixed method approach in order to obtain a more meaningful understanding of client satisfaction, and factors impacting on intake and meal utilisation, to ensure the client's perspective is clarified, and targeted strategies developed (Andrew et al., 2011).

5.6.4 MOW delivery as a social time

Although this study reports a non-significant trend for females to be more likely to consider MOW meal delivery a social time ($p = 0.091$), there was an absence of any association between participant characteristics, behaviour or outcome variables. The results could reflect the relatively healthy cohort, as well as the independence and social connection of participants, as they regularly (weekly) either cook their own meals, are provided with meals from families or friends, or source take-away or restaurant meals. In addition, as the number in the category tends to be low when comparing groups within the sample, such as for preparing meals and shopping for groceries, thus the study potentially lacked statistical power to investigate these variables.

While there are a number of studies investigating loneliness and social isolation and their association with malnutrition (Johansson et al., 2009), there is a paucity of studies investigating the social aspects of MOW services and their impact on intake and nutritional status. Although this cohort is relatively healthy, socially connected, as documented in Chapter 4, 89% of participants chatted with the delivery person, and 82% consider the delivery "social, reinforcing the role for

MOW to provide a social connection, particularly for those who are less independent" (Oppenheimer et al., 2014).

5.6.5 Strengths and limitations of this study

In addition to the impact of variations in study design on the ability to compare study results (O'Keeffe et al., 2019), the heterogeneity of food utilisation and consumption patterns and food preferences among MOW clients has been a recurring theme throughout this study, providing support for an approach to the provision of MOW services that addresses the changes in client preferences and expectations and focuses on the needs and expectations of the client (Oppenheimer et al., 2014). The decline in appetite associated with ageing (Moran, 2004) (Morley & Silver, 1988) provides the context for the emphasis on ensuring individual needs and preferences are addressed to stimulate participant appetites (Moran, 2004). Poor appetites have been associated with a lower protein consumption and smaller portion size, reinforcing the need for a better understanding of individual dietary patterns to underpin strategies to improve intake (van der Meij et al., 2017). The potential impact of underestimating this factor was demonstrated in a study in the US where up to 15% of participants identified dissatisfaction with food, food preferences or poor appetite as reasons for leaving the program (Choi, 1999). While the results were not significant, comments from participants reflected similar issues in the current study – appetite, preference and quality.

The results from this, and all studies, needs to be read in the context of the client circumstance and the possibility they have organised alternate support systems or, they may no longer require support, they may be indifferent. For example, participants in this study regularly consumed meals they prepared at home, was provided from a friend/relative, or consumed in a restaurant (Chapter 4, Table 4.9). In any case, these results reinforce the importance of understanding the client's perception of the service to ensure the service delivery model is meeting the needs and expectations of the client. As a first step, screening and assessment have been identified as tools to assist in directing services to meeting individual client needs (Krondl et al., 2008). By addressing nutritional risk, strategies can be targeted to the individual's needs, including the social and political significance of food and

eating-related activities (Locher et al., 1998), and programs revised accordingly to improve nutritional outcomes and independence (Hamirudin et al., 2016; A. Kretser et al., 2003; Timonen & O'Dwyer, 2010). The variables outlined in this study provide a logical starting point for monitoring clients' utilisation and behaviour patterns, including a client's nutritional status, medical conditions, meal component ordering patterns, number of meals/week, client satisfaction, and the practice of throwing out or sharing meals.

The hospital and hotel/restaurant sectors represent a similar process of ordering, production, assembly and delivery, albeit with a geographically simpler delivery process. In these sectors, the patient/customer, has their order taken by a person who is responsible for clarifying menu options, recording the order, in some cases matching likes/dislikes with menu options (McCray, Maunder, Norris et al., 2018; Maunder et al., 2015). In this study the interaction between the client and the service was not reported, highlighting a gap in the current understanding of the ordering process.

As is reported in Chapter 3, attention to this step in the process can be an opportunity to increase the dialogue between the patient/MOW client and the service, more than an order-taker, but a channel for communicating individual preferences and, in the long term, improve intake (Maunder et al., 2015; McCray, Maunder, Norris et al., 2018). This focus on the "front of house", or the staff who are in direct contact with the patient/MOW client, has been a pivotal point for improving hospital food services, and an essential component in the room service model (Doorduijn et al., 2016; Kuperberg et al., 2008; McCray, Maunder, Barsha et al., 2018; McCray, Maunder, Krikowa et al., 2018; Sathiaraj et al., 2019; Williams, 1998), highlighting the opportunity to share knowledge across sectors.

The strength of the present study is in the assessment of the MOW service as an end-to-end process from the client's perspective, from ordering to delivery, including the social aspects of MOW with respect to intake, as well as associations between nutritional outcomes and the characteristics and the client's utilisation and consumption of the meals. The study is unique because energy requirements are individualised based on expenditure measured by an accelerometer worn by the

clients. While this approach has reduced the comparability of results incorporating energy requirements, this study demonstrates the potential for this type of technology, to be incorporated into research studies, contributing to a more targeted individualised assessment. Finally, this study illustrates the complexity of MOW system with the demonstration of an understanding of the process steps, the impact of different approaches to assessment of the contribution of MOW to intake, and the potential impact on system comparisons, reinforcing the importance of the inclusion of a detailed representation of the MOW service systems to facilitate study comparisons (Walton et al., 2020).

The ability to generalise the results is limited by the single geographic area and the specific menu and systems employed to deliver the service. The sample size limited the analysis of variables where skewed responses reduced the ability to detect associations. Ideally, larger studies would be conducted across a variety of geographic locations, cultural groups and delivery models, facilitating a more sensitive analysis if variables such as age were assessed in groups. Although the number of medications was not included in this study, given polypharmacy, and the effect of drugs on appetite are a common cause of anorexia (Morley, 2012), the inclusion of medication usage in future studies is recommended. The absence of a validated questionnaire for social support, independence and satisfaction further limits comparison across the sector, and presents an opportunity for the development of standardised tools specific to MOW services that supports the collection of meaningful responses from clients.

Although the collection of quantitative data was the main focus of this study, the results reinforce the need for future research to incorporate a qualitative component to provide insight into client motivation and expectations to assist in tailoring more effective interventions. An unintended characteristic of the study sample, participants that were relatively healthy nutritionally, independent and had regular social contacts, created a risk of bias. It is worth remembering MOW services aim to provide more than a meal, acknowledging their role in providing a social connection (AMOWA, 2019). Whether a brief social contact through meal deliveries or referrals to other agencies and activities, MOW services offer social inclusion for both the participants and the volunteers themselves, creating

connections throughout the local community (AMOWA, 2019). Ideally, future studies would have the opportunity to investigate MOW services with clients from a broad range of locations, nutritional status, independence and social connection.

5.7 Conclusion

In this study, total intake was greater for male participants, while the contribution of energy intake to requirements declined with the number of medical conditions. Disappointingly, the contribution of MOW to energy and protein intake declined with age. As time with MOW increased, the contribution of total energy intake to requirements increased, while the contribution of MOW meals to protein intake declined, with a similar trend for energy ($p = 0.091$). While the vast majority of participants chatted with the delivery person (89%) and considered MOW social (82%), reflecting the social connection and wellbeing check aspects of AMOWA. However, the results for this study did not demonstrate any association with the perceptions of MOW as a social time. The most consistent result was the positive association between the number of MOW meals ordered and the contribution of MOW meals to intake, with the most surprising result, the decline in total energy and protein intake and the contribution of energy to requirements, as the number of positive comments declined.

The study highlights the heterogeneity of the delivery models and client characteristics within the MOW sector, the impact on nutritional outcomes, and the need for services that can be adapted to suit individual needs (Keller, 2006; Oppenheimer et al., 2014). Further study is needed to understand client perceptions across a range of MOW groups, including those that are less healthy, independent and socially connected.

Chapter 6 MOW – a social intervention

6.1 Abstract

Although studies have demonstrated MOW has a positive impact on nutritional intake, and interventions involving food fortification and oral nutrition supplements (ONS) can enhance nutritional outcomes, there is a paucity of research investigating the impact of social interventions on nutritional intake. This study assesses the impact of a three-month program of social visits on energy and protein intakes for the participants of the studies presented in Chapters 4 and 5. In this study, participants were assigned to either a control group, a group that received six social visits every two weeks, or a third group that received three visits once per month, over three months In addition, in response to the association between the number of MOW meals per week and the contribution of MOW to intake reported in Chapter 5, this study investigates whether the type of day (Meals on Wheels or not) had an effect on the outcomes, and if that effect was dependent on the type of treatment received.

An increase in energy intake (kJ) was observed on MOW days compared with non-MOW days ($p = 0.003$), with no impact detected for the total intake of energy or protein for either the fortnightly or monthly intervention groups. The characteristics of this sample reflect a relatively well-nourished, independent and socially connected group of older MOW clients. These characteristics in combination with the small sample size may have impacted the results of this study. As discussed in Chapters 4 and 5, eating is influenced by appetite as well as physiological, emotional, cultural and social factors. Given the prevalence of malnutrition and the impact on health and wellbeing for older persons living in the community, further research investigating the potential for social interventions to make a positive impact on intake and quality of life are warranted.

6.2 Introduction

Having explored the characteristics and food-related behaviour of MOW clients in Chapter 4, and the potential associations with nutritional intake in Chapter 5, this chapter picks up the final stage of this study, investigating the impact of a short social intervention on the nutritional intakes of MOW clients. To provide the context for this study, it is appropriate to reflect on the MOW mantra "More than a meal", referring to the provision of a meal combined with a safety and wellbeing check, and social connection for clients (AMOWA., 2021).

Previous studies have reported the potential for variations of MOW services to make a positive impact on nutritional intake (Walton et al., 2020; Zhu & An, 2013). A randomised, controlled cross-over trial in the Netherlands was able to demonstrate that simply increasing meal variety can be an effective strategy for improving energy intake in older adults (Wijnhoven et al., 2015), an important message given the frequency with which a lack of variety is mentioned by MOW (Choi, 1999; Lee & Raiz, 2015; Lirette et al., 2007; Locher et al., 2008; Oppenheimer et al., 2014). Compared with providing a standard five hot meals/week, increasing meal provision to three meals and two snacks, seven days/week, participants experienced a significant increase in body weight (Kretser et al., 2003), consistent with the association between the number of MOW meals and intake reported in Chapter 5.

A successful strategy for hospital patients discussed in Chapter 2, providing oral nutrition supplements, has been studied with MOW clients demonstrating the potential to increase body weight (Milne et al., 2009) and energy and protein intake (Lipschitz et al., 1985). In contrast, studies investigating the fortification of MOW meals, another strategy utilised in the hospital sector, have produced mixed results. A positive outcome was demonstrated in the Netherlands when, compared with standard portion sizes and protein content, increasing portion size and protein content of beef and chicken meals maintained taste acceptability, and led to a significantly higher energy and protein intake (Ziylan et al., 2016). While a 12-week, double-blinded, parallel group study in Australia, participants receiving a high energy, high protein meal at least three days/week increased their energy and

protein intake, suggesting the need for further trials with larger samples, and across a variety of contexts including services that offer flexible meal ordering (Arjuna, Miller, Ueno et al., 2018).

In contrast to these positive outcomes, a potentially negative result was reported in a single-blind randomised trial of 98 community-dwelling older adults in the Netherlands where, switching clients from standard MOW meals to protein-rich, ready-made MOW meals and dairy products for 28 days resulted in a risk of a decreasing protein intake, if meals are not selected for high protein content (Borkent et al., 2019). Finally, in spite of a successful outcome with participants realising an increase in body weight following the introduction of a snack program, half the MOW clients were not interested in continuing with the program as they did not consider the snacks to be of benefit to them (Charlton, Walton et al., 2013). These mixed results reinforce the importance of understanding and addressing the motivations and expectations of the client in order to optimise the impact of interventions.

Although there is evidence to support MOW has a positive impact on nutritional intake, and interventions involving food fortification and ONS can enhance nutritional outcomes, there is a paucity of research investigating the impact of social interventions on nutritional intake (Charlton et al., 2019; Galea et al., 2013). The role of a social connection in supporting wellness and the maintenance of independence for older adults is acknowledged globally (Royal Commission into Aged Care Quality and Safety, 2019). The awareness of loneliness and social isolation as public health and wellbeing issues is demonstrated in Australia with the recommendation to extend the nationally funded Community Visitors Scheme supporting local organisations to recruit volunteers who provide regular visits to Australians in receipt of subsidised aged care services (Royal Commission into Aged Care Quality and Safety, 2021a). The potential for loneliness and social isolation has been nominated as a potential cause of malnutrition in the ESPEN Guidelines for nutrition in geriatrics, and eating with others is nominated as a potential intervention (Volkert et al., 2019).

While feelings of loneliness were reduced when meals were delivered daily rather than weekly or compared with those on a waiting list, the impact on nutritional intake was not assessed (Thomas et al., 2016). The few studies investigating interventions related to the social component of MOW services on nutritional intake are recent, and results are mixed. Interestingly, a German cross-sectional, multi-site study reports no difference in the nutritional status of older persons living at home and receiving informal nutritional support in the form of hot meals mainly from relatives, or those receiving MOW (Chareh et al., 2020). Unfortunately, the frequency, service delivery models and nutrient intake, were not reported (Chareh et al., 2020), limiting the comparison of results. In contrast, a positive result was reported in a randomised controlled multicentre trial over 12 months across 10 centres in Spain (Fernández-Barrés et al., 2017). This explores the impact of a structured nutrition education intervention for Nutrition Home Care Program caregivers trained to provide advice to clients related to menu selections and how to design a healthy diet (Fernández-Barrés et al., 2017). In this study of older persons at risk of malnutrition, protein intake improved along with the risk of malnutrition (Fernández-Barrés et al., 2017). Social contact has been identified as a priority area for inclusion in the National Meal Guidelines, following a recent national Australian survey reports the social contact provide by the service was reported as highly valued, with people living in small country towns more likely to value the social contact provided by MOW than those in major cities ($p = 0.001$) (Coenen et al., 2021).

Previous reviews of MOW services have identified that focus on the broad aims: nutritious meals and a social connection; a flexible approach that is responsive to the changing needs of the client are necessary; and to ensuring a sustainable future for MOW in Australia (Oppenheimer et al., 2015). Further exploration of the social context of MOW can open a new avenue for addressing malnutrition as well as contribute to the development of a more sustainable service delivery model. In addition, focusing on the social component presents an opportunity to gain further understanding of the population characteristics and individual client needs and expectations, which are essential information in developing a targeted service model. The next stage of this study followed participants from the studies presented in Chapters 4 and 5 for three months, exploring the impact of a social

intervention on nutritional intake, including the influence of the type of day – MOW or non-MOW day, on nutritional outcomes.

6.3 Aims and objectives

Following on from the analysis of the baseline data for this study presented in Chapters 4 and 5, Chapter 6 focus on the three-month data, specifically:

> To assess the impact of a social intervention on energy and protein intakes and requirements of MOW clients (Table 6.1).

Table 6.1 Research questions, objectives and chapter

Research question			Objectives of the research
6	4	Does an intervention increase nutritional intake for MOW clients?	Assess the impact of a three-month program of social visits on energy and protein intake of MOW clients.

6.4 Study design

6.4.1 Participants

Following consent, the 83 participants included in the initial stage of this study in Chapter 4, were randomly assigned to one of the following three groups to be reviewed after the three-month intervention (Table 6.2).

Table 6.2 Allocation of participants to intervention groups

Study group	Intervention	Intervention frequency	Count	Percent
Control	Nil	Nil	30	36.1%
Fortnightly	Six short, 30-minute, visits from an research assistant (RA)	Every two weeks	27	32.5%
Monthly	Three short, 30-minute, visits from an RA	Every four weeks	26	31.3%

6.4.2 The intervention

Given there is a paucity of literature on the impact of social intervention, this study establishes a baseline for investigating the impact of social intervention on nutritional intake for MOW clients. The baseline, a simple social intervention within the context of existing MOW services, provides a starting point from which

future studies can either replicate the study in different settings and/or scaffold the investigation by introducing additional variables.

The social intervention provided to each group was the same for fortnightly and monthly groups. The control group did not receive any social visits. The participants in both of the intervention groups received a 30-minute home visit from a research assistant (RA), who was a university student studying psychology. The same RA visited with the client for the duration of the project. The RAs were not intended to represent nutrition or food specialists, rather individuals with strong communication skills who can be informed about the MOW process such that they are able to support the participants in the study. The focus for the RA were to engage in conversation, establish a relationship with the participant, provide support for ordering of MOW meals, follow up on food intake, changes to their appetite, food preferences, changes in food consumed outside of the service and activity level, as well as providing an additional social interaction for the participant, and a link to the community. If participants had questions about meal ordering or any of the services available, the RA would pass on the request to the MOW service or seek information to respond to the client's issue. At the end of three months, each participant was visited in their home by the project officer to collect the same data collected at baseline – diet history, MNA®-SF screen (Appendix 4.4), and MOW survey (Appendices 4.5 and 4.6), as reported in Chapter 4.

6.4.3 Outcomes

The analysis of the three-month data is considered in two parts:

> Part 1: The nutrition-related outcomes at three months.
>
> Part 2: Further analysis to determine the impact of the groups and days – MOW days and non-MOW days – on the outcomes at three-months.

Part 1 considers the following outcomes at three months. Continuous outcomes:

- total energy (kJ)

- total protein (grams)
- % energy from MOW (MOW days only)
- % protein from MOW (MOW days only)
- % energy from MOW (average over recall days)
- % protein from MOW (average over recall days).

Binary (yes/no) outcomes:

- total energy as a percentage of expenditure over 100%
- total protein as a percentage of RDI over 100%
- total energy as a percentage of expenditure over 75%
- total protein as a percentage of RDI over 75%.

Part 2 focuses on the impact of the days – MOW days and non-MOW days – on outcomes, specifically total energy (kJ) and total protein (grams) intake at three-months, as measured on three days at baseline and at three months.

6.4.4 Statistics

Part 1 – energy and protein – total intake and contribution of MOW

In each case, the variable of interest at three months is the outcome, with the baseline score and treatment group as the explanatory variables. The baseline score, a "covariate", provides estimates of the effect of the treatment group, adjusted for the baseline. For continuous variables, the primary focus of the analysis, the comparison of the groups and pairwise comparisons of the mean differences are provided for each outcome using a linear model. For the binary outcomes, the comparison of groups and pairwise comparison of odds from logistic regression modelling of binary outcomes. The odds ratio is provided with a 95% confidence interval and a *p*-value for a test of the null hypothesis of no difference between the odds.

Part 2 – total energy and protein – the impact of the type of day

Part 2 provides an analysis of the nutritional outcomes – total energy (kJ) and total protein (g) – at three-months, as measured on three different days, at baseline and

three months. While the intention was to measure intake for each client over three days, for some clients; however, fewer days were measured. Further complicating the analysis, some of the days were MOW days, some were not. Because this aspect was not designed into the original plan of the study, it was possible that for some clients all three days corresponded to one particular type. This analysis also assessed whether the type of day (MOW or not) had an effect on the outcomes, and if that effect was dependent on the type of treatment received.

A general linear mixed model was used to allow for fixed or explanatory variables of interest – treatment group and type of day. This analysis also accounted for the multiple observations made on individuals as part of the structure of the data by considering individuals who might potentially participate as a random effect in the model. The model included a covariate, the outcome as measured at baseline.

For each outcome, two models were considered. The first included an interaction of group and type of day (MOW or not). As the interaction was not detected for either outcome, possibly due to limitations in sample size, a second model, a main effects model, is presented for each outcome, comparing type of day and group, separately.

6.5 Results

The results in this study provide an analysis of the data collected for the MOW clients reported in Chapters 4 and 5, specifically, the impact of a social intervention for which data was collected at three months, and assessed against the baseline data reported in Chapter 4.

6.5.1 Participants

A total of 83 clients participated in the initial interview and baseline data collection reported in Chapter 4, (Appendices 4.4. to 4.6), is less than 10% of the client base from all nine participating services (Table 6.3). During the three months of the project 10 participants (12%) withdrew for a variety of reasons including health reasons, death and transfer to aged care facilities. The remaining 73 participants varied with the number of MOW and non-MOW day observations:

- 36 had observations on MOW days only
- 32 had observations on both MOW and non-MOW days
- only five had observations on non-MOW days only.

Because a number of participants found the armbands uncomfortable and did not wear the armbands for data collection at three months, energy expenditure data at three months was only available for 55 participants.

6.5.2 Results Part 1: energy and protein – total intake and contribution of MOW

The results for continuous variables – total energy and protein intake, and the contribution of MOW meals to energy and protein requirements, are reported by group in Tables 6.4 to 6.9.

Total energy and protein intake

The mean and standard deviation for each of the continuous outcomes – total energy and protein, and the percentage energy and protein from MOW meals, for both MOW days only, and an average over all days, at three months, according to the intervention received in Table 6.4.

Table 6.3 Summary of the client base, clients referred, agreed to participate, and participants included in each of the two interviews over the three months of the study

Client group	Number	% client base
Client base, from all participating services	1,140	
Clients referred to the project	290	25%
Clients agreed to participate	89	8%
Total clients – baseline	83	7%
Total clients – three months	73	6%

Table 6.4 Summary statistics for continuous outcomes at three months by intervention group

Outcome at three months	Intervention[1]	N	N missing	Mean	SD
Total energy (kJ)	Control	25	5	6917	2008
	Fortnightly	25	2	7032	2160
	Monthly	23	3	6802	1625
Total protein (g)	Control	25	5	69.4	20.1
	Fortnightly	25	2	68.3	19.6
	Monthly	23	3	64.9	14.4
% energy from MOW (MOW days)^	Control	25	5	0.312	0.138
	Fortnightly	25	2	0.288	0.158
	Monthly	23	3	0.258	0.131
% protein from MOW (MOW days)^	Control	25	5	0.390	0.166
	Fortnightly	25	2	0.376	0.174
	Monthly	23	3	0.335	0.176
% energy from MOW, average^	Control	25	5	0.240	0.113
	Fortnightly	25	2	0.231	0.141
	Monthly	23	3	0.214	0.119
% protein from MOW, average^	Control	25	5	0.299	0.134
	Fortnightly	25	2	0.301	0.171
	Monthly	23	3	0.274	0.156

^ Percentages are represented as proportions.

[1] Control – no social visit; fortnightly – six short social visits, every two weeks; monthly – three short social visits, monthly.

The overall tests for each explanatory variable in each of the linear models fitted is provided in Table 6.5. For each outcome, there are two results, one for each of the explanatory variables – baseline (Baseline Measure) and intervention group (Intervention Group) representing the relationship between the data at baseline to the data at three months. The *p*-value is provided for the test of the effect of the explanatory variable on the outcome recorded at three months. An association was observed between data for total energy and total protein intake at baseline and three months (Baseline Measure) ($p < 0.001$). No other associations were observed in the linear modelling.

Table 6.5 Results from linear modelling of continuous outcomes

Outcome **Explanatory variable**	**F-value**	**df**	***p*-value** [#]
Total energy (kJ)			
Baseline measure	156.76	1, 69	< 0.001*
Intervention group	0.86	2, 69	0.428
Total protein (g)			
Baseline measure	88.06	1, 69	< 0.001*
Intervention group	1.71	2, 69	0.188
% energy from MOW (MOW days only)			
Baseline measure	0.75	1, 69	0.388
Intervention group	1.03	2, 69	0.362
% protein from MOW (MOW days only)			
Baseline measure	0.28	1, 69	0.595
Intervention	0.73	2, 69	0.483
% energy from MOW (average over recall days)			
Baseline measure	3.59	1, 69	0.062
Intervention group	0.57	2, 69	0.571
% protein from MOW (average over recall days)			
Baseline measure	2.39	1, 69	0.127
Intervention group	0.46	2, 69	0.635

[#] indicates linear model. *$p < 0.05$.

An estimate of the pairwise difference of meals using Tukey's method of pairwise comparisons shows no significant difference for any outcome, with a 95% confidence interval and a *p*-value for a test of the null hypothesis of no difference between means (Table 6.6). As expected from the overall test of the intervention (Table 6.5), none of the *p*-values are small. As an example, the mean difference in total energy comparing monthly with the fortnightly interventions is only 7 kJ, the best estimate of the true difference of means, based on this study. The precision of the estimate is described by the confidence interval which indicates a large range for the plausible values for the true mean difference are between −748 kJ and 761 kJ, an outcome repeated for the other variables.

Table 6.6 Pairwise comparison of means from linear modelling of continuous outcomes

Continuous outcomes		Mean difference	
Explanatory variable[1]	**Estimate**	**95% CI**	***p*-value [#]**
Total energy (kJ)			
Fortnightly – control group	−357	−1099, 386	0.486
Monthly – control group	−350	−1104, 404	0.510
Monthly – fortnightly group	7	−748, 761	> 0.995
Total protein (grams)			
Fortnightly – control group	−5.65	−14.02, 2.72	0.245
Monthly – control group	−5.57	−14.04, 2.90	0.263
Monthly – fortnightly group	0.08	−8.43, 8.59	> 0.995
% energy from MOW (MOW days only)^			
Fortnightly – control group	−0.026	−0.123, 0.072	0.800
Monthly – control group	−0.060	−0.161, 0.041	0.329
Monthly – fortnightly group	−0.035	−0.135, 0.066	0.688
% protein from MOW (MOW days only)^			
Fortnightly – control group	−0.016	−0.133, 0.102	0.945
Monthly – control group	−0.060	−0.181, 0.062	0.472
Monthly – fortnightly group	−0.044	−0.164, 0.077	0.658
% energy from MOW (average over recall days)^			
Fortnightly – control group	−0.009	−0.092, 0.074	0.963
Monthly – control group	−0.037	−0.123, 0.049	0.561
Monthly – fortnightly group	−0.028	−0.114, 0.058	0.719
% protein from MOW (average over recall days)^			
Fortnightly – control group	0.004	−0.100, 0.108	0.996
Monthly – control group	−0.035	−0.143, 0.072	0.709
Monthly – fortnightly group	−0.039	−0.147, 0.068	0.657

^ Percentages are represented as proportions.

[#] indicates Tukey's method of pairwise comparisons, with a 95% confidence interval, and a *p*-value for a test of the null hypothesis of no difference between the means.

[1] Control – no social visit; fortnightly – six short social visits, every two weeks; monthly – three short social visits, monthly.

Contribution of MOW meals to intake

The modelling for the binary outcomes (Table 6.7) is based on the odds, the proportion of participants who achieve the outcome and the odds of achieving the outcome. The results indicate that, not unexpectedly, the odds of achieving > 75% of the requirement for energy or protein is greater than for > 100% of requirements. With respect to the RDI for protein, for the control and fortnightly

groups the probability of achieving > 75% of the RDI is four times the probability of not achieving the outcome.

Table 6.7 Summary statistics for binary outcomes at three months by intervention based on an odds ratio

Outcome at three months	Intervention[1]	N	N missing	Proportion	Odds
Total energy as % of expenditure (> 1)					
	Control group	18	12	0.333	0.499
	Fortnightly group	19	8	0.368	0.582
	Monthly group	18	8	0.333	0.499
Total protein as % RDI (> 1)					
	Control group	25	5	0.520	1.083
	Fortnightly group	25	2	0.320	0.471
	Monthly group	23	3	0.261	0.353
Total energy as % of expenditure (> 0.75)					
	Control group	18	12	0.722	2.597
	Fortnightly group	19	8	0.579	1.375
	Monthly group	18	8	0.556	1.252
Total protein as % RDI (> 0.75)					
	Control group	25	5	0.800	4.000
	Fortnightly group	25	2	0.800	4.000
	Monthly group	23	3	0.696	2.289

[1] Control – no social visit; fortnightly – six short social visits, every two weeks; monthly – three short social visits, monthly.

The overall tests for each explanatory variable in each of the logistic regression models fitted is provided in Table 6.8. The interpretation of the *p*-values is the same as for the continuous outcome models where for each outcome there are two results, one for each outcome variable. The *p*-value is provided for the test of the effect of the explanatory variable on the outcome; where the *p*-value is small the observed result is not consistent with the null hypothesis of no effect of the explanatory variable on outcome. As for Table 6.4, there was an association between the data at Baseline and three months; however, all of the *p*-values were large for the test of the intervention for each outcome.

Table 6.8 Results from logistic regression modelling of binary outcomes

Outcome at three months			
Explanatory variable	**Wald test**	**df**	***p*-value[#]**
Total energy as % of expenditure (> 1)			
Baseline measure	7.85	1	0.005*
Intervention	0.23	2	0.891
Total protein as % RDI (> 1)			
Baseline measure	20.38	1	< 0.001*
Intervention	2.49	2	0.287
Total energy as % of expenditure (> 0.75)			
Baseline measure	14.23	1	< 0.001*
Intervention	3.23	2	0.199
Total protein as % RDI (> 0.75)			
Baseline measure	20.33	1	< 0.001*
Intervention	2.57	2	0.277

[#] indicates logistic regression model. *$p < 0.05$.

A comparison between groups based on an odds ratio that has been adjusted for the baseline is presented in Table 6.9. As expected from the overall test of the intervention in Table 6.8, none of the *p*-values in Table 6.9 are significant.

Table 6.9 Pairwise comparison of odds from logistic regression modelling of binary outcomes

Binary outcome variable		Odds ratio	
Explanatory variable[1]	**Estimate**	**95% CI**	***p*-value [#]**
Total energy as % of expenditure (> 1)			
Fortnightly/control	0.867	0.194, 3.869	0.852
Monthly/control	0.683	0.143, 3.278	0.634
Monthly/fortnightly	0.788	0.170, 3.658	0.761
Total protein as % RDI (> 1)			
Fortnightly/control	0.370	0.090, 1.576	0.179
Monthly/control	0.352	0.078, 1.593	0.175
Monthly/fortnightly	0.952	0.205, 4.424	0.950
Total energy as % of expenditure (> 0.75)			
Fortnightly/control	0.518	0.088, 3.051	0.467
Monthly/control	0.183	0.028, 1.198	0.076
Monthly/fortnightly	0.354	0.063, 1.995	0.239
Total protein as % RDI (> 0.75)			
Fortnightly/control	2.028	0.258, 15.967	0.502
Monthly/control	0.359	0.050, 2.577	0.308
Monthly/fortnightly	0.177	0.021, 1.514	0.114

[#] indicates an odds ratio with a 95% confidence interval and a *p*-value for a test of the null hypothesis of no difference between the odds.

[1] Control – no social visit; fortnightly – six short social visits, every two weeks; monthly – three short social visits, monthly.

6.5.3 Results Part 2: total energy and protein – the impact of the type of day

Total energy

A test of the interaction in the linear model for energy did not detect an interaction of type of day (MOW or not) and group was not detected for energy ($F_{2,167} = 0.97$, $p = 0.381$), possibly due to limitations in sample size.

The results for the main effect model, a linear model where comparisons for type of day and group are considered separately, are shown on Table 6.10. The mean energy at baseline indicates an association between the data at baseline and at three-months ($p = 0.001$). An effect of the type of day is detected ($p = 0.003$), but not of group.

Table 6.10 Tests of the overall effects from the main effect model

Explanatory variable	F	df	*p*-value[#]
Mean energy at baseline	147.17	1, 70	< 0.001*
Group	0.91	2, 60	0.406
Type of day (MOW or not)	9.04	1, 167	0.003*

[#] indicates main effect model. *$p < 0.05$.

The effect of the type of day is detected ($p = 0.003$), but not of group, as expected as the baseline covariate is statistically significant (Table 6.11). The estimated mean difference in total energy (kJ) comparing MOW days with non-MOW days is 938 kJ, with higher average total energy on the MOW days. Mean differences between pairs of treatments are smaller. No interaction of type of group or MOW days are detected.

Table 6.11 The estimated mean difference in total energy by type of day and pairs of treatments

Explanatory variable	Difference of means	Estimate energy (kJ)	95% CI	*p*-value[#]
Type of day	MOW – non-MOW	938	322, 1553	0.003*
Group[1]	Fortnightly – control	–191	–956, 573	0.820
	Monthly – control	–434	–1209, 340	0.375
	Monthly – fortnightly	–243	–1004, 518	0.724

[#] indicates Tukey's method of pairwise comparisons. *$p < 0.05$.

[1] Control – no social visit; fortnightly – six short social visits, every two weeks; monthly – three short social visits, monthly.

Total protein

As for energy, the interaction of type of day (MOW or not) and group was not detected for the general linear mixed model for total protein intake ($F_{2,160} = 2.03$, $p = 0.134$).

The tests of the overall effects from the main effect model for protein intake are shown on Table 6.12. As for energy, the mean protein at baseline indicates an association between the data at baseline and at three-months ($p < 0.001$). No interaction of type of group or MOW days detected.

Table 6.12 Tests for the main effect model for protein for baseline, group and MOW days

Explanatory variable	F	df	*p*-value[#]
Mean protein baseline	74.53	1, 87	< 0.001*
Group	1.35	2, 64	0.266
MOW day	1.17	1, 159	0.281

[#] indicates main effect model. * $p < 0.05$.

The estimated mean difference in total protein (g) comparing Meals on Wheels days with non-Meals on Wheels days is 4.28 g (Table 6.13), with higher average total protein on the Meals on Wheels days, a relatively small difference.

Table 6.13 Difference of means for day type and for group for protein, based on Tukey's method of pairwise comparisons

Explanatory variable	Difference of means	Estimated Protein (g)	95% CI	*p*-value[#]
Type of day	MOW – non-MOW	4.28	–3.53, 12.09	0.281
Group[1]	Fortnightly – control	–5.33	–14.53, 3.87	0.352
	Monthly – control	–5.66	–14.94, 3.62	0.315
	Monthly – fortnightly	–0.33	–9.49, 8.83	0.996

[#] indicates Tukey's method of pairwise comparisons.

[1] Control – no social visit; fortnightly – six short social visits, every two weeks; monthly – three short social visits, monthly.

6.6 Discussion

Malnutrition remains an issue for older persons living in the community, including those receiving MOW, impacting on their health status and quality of life. While studies have investigated the impact of MOW meal modifications on nutritional intake, research into the social aspect of MOW services has primarily focused on the degree of social contact and the value placed by MOW clients on the social contact aspect of the service (Oppenheimer, 2014). While the benefits of eating with others has been reported (Locher, Ritchie et al., 2005), the potential for the social experience to impact on nutritional intake remains largely unexplored. The aim of this study was to evaluate the effectiveness of a short social visit on energy and protein intake. Although no difference was observed between intervention groups with respect to nutritional intake, the results did demonstrate an increased intake of energy on MOW days compared to days when MOW was not consumed irrespective of group.

An effect of the intervention on the outcome variables was not detected for the three groups: control, fortnightly visits, and monthly visits, although the small sample size in the follow up group of participants (n = 73) may have made it difficult to detect effects of the intervention.

The outcome in this study also needs to be considered in the context of the relatively well nourished (15.66% malnourished or at risk), independent group of participants as demonstrated by the daily energy and protein intakes, 7,009 kJ or 83% of requirements, and 69 g or 98% of requirements respectively, reported in Chapter 4, which are relatively high compared with other studies (Charlton, Walton et al., 2013; Arjuna, Miller, Ueno et al., 2018; Wright et al., 2015). Similarly, as reported in Chapter 4, participants at baseline were, in part at least, meeting requirements, particularly for protein (98%), creating a further challenge to demonstrating a positive outcome, a factor reported in a previous study (Arjuna, Miller, Ueno et al., 2018), suggesting there may be a greater impact with a higher risk group of less well-nourished and independent MOW participants.

Nevertheless, this study did detect an effect of the type of day, but not of group, on the total energy intake, with higher average total energy intake on MOW days. Although the mean difference in energy intake between types of days (938 kJ) is lower than that reported in a previous study, pre- and post-MOW (1,489 ± 17 kJ), where only 8% of clients were well-nourished (Wright et al., 2015), and for the introduction of fortified meals (1,958 ± 621 kJ) (Arjuna, Miller, Ueno et al., 2018), the higher average between MOW and non-MOW days, the equivalent of a banana and 200 mL full-cream milk, if able to be maintained, can offer a clinical benefit, especially for older MOW clients at risk of malnutrition. This outcome is consistent with the positive association reported in Chapter 5, between the number of meals per week and the contribution of MOW to energy intake, whether assessing the contribution over MOW days or all three recall days.

Similar positive results associated with MOW days, were reported in a study of Canadian women, where lower intakes of energy and protein were observed on non-MOW days, compared with MOW days (Sharkey, 2003), and in a study where, using national US data, a positive impact on protein was reported when

participants consumed any MOW food or beverage (An, 2015). Simply introducing MOW meals, at least three times per week, to a population of older adults in the US, where 92% were considered malnourished or at-risk, with a relatively low intake (5290 kJ and 54 g protein), produced positive results with respect to both their sense of social isolation and loneliness, and their daily intake of energy and protein (Wright et al., 2015).

Although this study is the first to investigate the impact of a series of short social contacts on intake, social isolation in older adults has been associated with higher rates of adverse health outcomes (Beridze et al., 2020)(Nagarajan et al., 2020; Dickens et al., 2011), and a decreased interest in food that may eventually lead to reduced independence (Krondl et al., 2008). Reinforcing the impact of social contact, a US study of home-bound older adults receiving home health services reports participants who were at higher risk of undereating included those receiving either infrequent or very frequent care by a caregiver (Locher et al., 2008). The potential impact of social contact on nutritional intake was reported in another study in the US where, in contrast to the presence of others "in the house", the average intake increased by 477 kJ when the others were present during the meal (Locher, Robinson et al., 2005), suggesting the potential role for a more targeted social intervention on nutritional intake. An approach that focuses on the individual's circumstance and needs is consistent with the hospital interventions reported in Chapter 3, specifically BMOS and room service, where nutritional intake has either remained unchanged or increased, while plate waste decreased. The results are a reminder that eating is a complex mixture of social, environmental and individual factors which are important to optimising nutritional intake and quality of life (Locher et al., 2009).

Rather than the absence of an impact of a short social intervention on nutritional intake deterring further research, the outcomes do not suggest there is no need to continue to explore the role of social contact on the intake for MOW clients. This study has investigated an uncomplicated social intervention on a relatively socially connected, nutritionally healthy group of MOW clients. As our understanding of the interaction between MOW service delivery systems, client ordering and consumption patterns on intake evolves, we will have an enhanced perspective

from which to design further studies investigating the impact of social connection on intake, ideally with participants at greater nutritional risk.

6.6.1 Strengths and limitations

A major strength of this study is the random allocation of participants to two separate intervention groups and a control group. To reduce the risk of reporting bias, a single project officer completed all interviews and 24-hour recalls at baseline and at three-months. Similarly, interventions in the form of a short social visit were completed by two research assistants who were allocated randomly to individual participants for the duration of the project. To minimise the risk of confounding variables, the intervention was limited to a single variable, a short social visit. The comprehensive set of baseline data reported in Chapter 4 provided an enhanced context from which to assess the study outcomes.

This relatively small sample (n = 73) resulted in an underpowered study, particularly when participants were allocated across three sub-groups such as for the analysis of the interaction of group and type of day (MOW or not). Because the vast majority of participants in this study were relatively well-nourished (84%), independent (83% prepare meals without help), and socially connected (78% had visitors at least weekly), the impact of the intervention was not able to be assessed on MOW clients who are more dependent, isolated socially, and at greater nutritional risk. Furthermore, participants who dropped out of the study (12%) may have reduced the nutritional risk of the study sample. Accommodating individual meal consumption patterns including days and meal times, while acknowledging the reality of the participant lifestyle, created a further variable to be incorporated into the study design. The complication is a further reminder of the importance of understanding participant consumption patterns prior to confirming the study design and analysis to minimise this complication. Although a six or 12-month project can be difficult to maintain for older persons, even those living independently at home, studies over a longer period are ideal to be able to demonstrate a sustainable outcome.

Ideally, this study will be repeated with a larger, less nutritionally well and independent group of MOW clients. While studies have reported success with

programs involving trained advisors (Fernández-Barrés et al., 2017), and having someone to be with the client during the meal time (Locher, Robinson et al., 2005), given current government budget controls, social interventions that are the least resource-intensive are appropriate interventions to explore. For example, a daily phone call from older volunteers to provide a safety and socialisation check, was considered to provide clients with a frequent, and less resource-intense social intervention (Kretser et al., 2003).

Whether establishing new positions or extending the roles of existing staff and volunteers who currently interact with clients, such as the office staff or drivers to contribute to social interaction with the client, there are opportunities to be explored to improve social interaction and nutritional outcomes for MOW clients (Choi, 1999).

In the case of MOW, typically delivery volunteers or paid staff are front-line workers with the most regular contact with the client, creating a regular, albeit short, interaction with the client. However, delivery persons are not necessarily the same each day as was observed in this study, where only 11% of participants had the same delivery person. Nevertheless, in this study, almost 89% of clients chatted with the delivery person on arrival, for 83% of clients the meal was brought into the home, and 82% considered the meal delivery a social experience, suggesting that even when the delivery person varies, the opportunity for a social experience is not lost. This is important given some service delivery models do not have the resources to support an extended time with the client (O'Dwyer et al., 2009). Regardless of the format of the interaction, there are options to provide a social connection that may enhance intake, monitor the client's health and wellbeing, assist the client with selecting the most appropriate meals, as well as gain further feedback on meals the can inform service improvements, while enhancing the sense of self-worth for both the client and the volunteer (O'Dwyer et al., 2009).

6.7 Conclusion

This study is an important first step in the investigation of social intervention strategies on nutritional intake for older adults receiving MOW services. An

increase in energy intake (kJ) was observed on MOW days compared with non-MOW days ($p = 0.003$), with no impact detected for the total intake of energy or protein for either the fortnightly or monthly intervention groups. The characteristics of this sample reflect a relatively well-nourished, independent and socially connected group of older MOW clients when, combined with the small sample size may have impacted the results of this study. Consistent with the current MOW priorities, shifting the focus of MOW services to reflect the increasing influence of social isolation has been identified as a key factor to be addressed by MOW when considering the sustainable approaches to service delivery (Oppenheimer et al., 2014; Winterton et al., 2013). Ideally larger scale studies will be undertaken to explore the opportunity to improve quality of life and the potential impact on intake.

Chapter 7 - An overall thesis summary, discussion, and the next step

7.1 This thesis - a summary

The impact of an ageing population and growing levels of chronic disease in the community are increasing demands across all sectors of the health care industry globally (AIHW, 2018). A trend that is expected to continue, impacting all health care sectors including hospitals and for older persons living in the community (ABS, 2018; Productivity Commission, 2015). Malnutrition impacts health outcomes and quality life for individuals across health care sectors, as well as the ability of individuals to retain their independence (Elia & Southampton, 2015). In hospital, malnutrition has been associated with an increased length of stay and rates of readmission, impacting health care costs (Abizanda et al., 2016; Australian and New Zealand Society for Geriatric Medicine, 2009; Elia et al., 2016; Meijers et al., 2012; Wilson, 2013). Malnutrition is multifactorial involving a complex set of internal and external influences, which are further complicated by the heterogeneity of the population (Nieuwenhuizen et al., 2010).

The overall aim of this thesis is:

> To evaluate the impact of interventions targeting the energy and protein intake of hospital patients and Meals on Wheels clients in the Australian context.

The specific aims of the research program are to:

1. Determine the utilisation and consumption of meals in an acute care private hospital in Brisbane and Meals on Wheels services in North and West Metropolitan Region of Melbourne, and Macedon and Geelong in Victoria.
2. Assess the contribution of meals to energy and protein intakes and requirements for patients in an acute care private hospital in Brisbane and Meals on Wheels clients in North and West Metropolitan Region of Melbourne, and Macedon and Geelong regions of Victoria.
3. Identify factors associated with nutritional intake for MOW meals clients.

4. Assess the impact of an intervention on energy and protein intakes and requirements of hospital patients and MOW clients.

The following summarises the results from each of the studies in this thesis that were undertaken to address these aims.

7.1.1 Chapter 3 – Room service Intervention

Chapter 3 investigates the impact of a room service food service system, where patients received their meal within 45 minutes of ordering their meal, compared with a traditional hot plating system where patients order their meals one day in advance. An analysis of patient meals consumed over a 24-hour period, demonstrated an overall reduction in plate waste of 7% ($p < 0.05$), including a reduction in plate waste post-room service at lunch, and dinner meals and, with respect to food categories, soup, hot starch, and vegetables ($p < 0.05$). In spite of these operational efficiencies, whether assessed as an absolute value or against a threshold of estimated energy and protein requirements, energy and protein intake was unchanged following the implementation of room service.

7.1.2 Chapter 4 MOW – Participant characteristics

This study profiled a group of 83 Meals on Wheels (MOW) clients, primarily female (54.2%) with a mean age of 79.4 ± 10.8 years. Overall, only 15.7% of participants were malnourished or at risk of malnutrition, and the majority had visitors at least weekly (78%), and were able to make their own meals without help (83%). However, over half of the participants (63%) were unable to, or required assistance to, shop for groceries. With respect to the utilisation and consumption of MOW meals, all participants in the study ordered the main MOW meal, 93% ordered dessert, and 70% ordered soup, with meals frequently consumed over two or three meals. Over half of the participants reported throwing out meals (56.6%), with 14.9% of these giving MOW meals to a pet. In contrast to the level of discarding meals, the positive and negative feedback from participants was similar suggesting the need for further investigation to clarify the participant expectations regarding meal quality and service levels. Nevertheless, in this study, MOW meals contributed 30% of energy and 38% of participants' protein intake, and the total daily intake for participants met 83% of energy and 98% of protein requirements.

7.1.3 Chapter 5 MOW associations with outcome variables'

This study assessed a MOW service as an end-to-end process from the client's perspective, exploring associations between the participant characteristics and the outcome variables. While male participants consumed a greater total intake of energy and protein than females, the contribution of energy intake to requirements declined as the number of medical conditions increased, with a trend to a lower energy intake for participants at-risk of malnutrition ($p = 0.071$). As the length of time with MOW increased, the contribution to total energy intake to requirements increased ($p = 0.033$), while the contribution of MOW meals to protein intake declined ($p < 0.05$), along with a negative trend for energy intake ($p = 0.091$). The contribution of MOW meals to energy and protein intake increased as the number of MOW meals increased. Interestingly, total energy and protein intake, and the contribution of energy to requirements, declined as the number of positive comments from participants increased. While the vast majority of participants chatted with the delivery person (89%), and considered MOW meal delivery social (82%), the only association with the perception of MOW delivery as a social time, was a trend for females more likely to find MOW delivery social compared with males ($p = 0.091$).

7.1.4 Chapter 6 – MOW Intervention

This study assessed the impact of a three-month program of social visits on energy and protein intake. The 83 participants included in the initial stage of this study (Chapter 4), were randomly assigned to either the control group or one of two intervention groups, where participants received either six social visits every two weeks, or three social visits once each month. This study reports an increase in energy intake (kJ) on MOW days compared with non-MOW days ($p = 0.003$), with no impact detected for the total intake of energy or protein for either the fortnightly or monthly intervention groups. The relatively well-nourished, independent and socially connected profile of this group of participants, in combination with small group sizes, may have impacted the results of this study.

7.2 Discussion - limitations of the methodology

The studies presented in Chapters 3 to 6 were limited by a number of common factors.

- The results of these studies are specific to the geographic locations associated with each of the studies, an acute care, private hospital in metropolitan Brisbane (Chapter 3), and the North and West Metropolitan Region of Melbourne, and Macedon and Geelong regions of Victoria (Chapters 4 to 6), restricting the generalisability of the results.
- The sample size limited the power of both studies, particularly in the MOW study where results for the participants remaining at the end of the intervention (Chapter 6) were analysed by sub-groups.
- Overall, participants were relatively well nourished, excluding individuals with the greatest potential to benefit from the interventions. Unfortunately, as those at greatest nutritional risk tend to be unwell or otherwise indisposed, the likelihood of attracting these participants is reduced.
- Access to qualitative and costing data would have provided further context to the results and potentially informing the refinement of subsequent interventions.

Room service (Chapter 3)

- Logistical complications precluded the design of a randomised control trial for the room service study (Chapter 3). However, a level of rigour was provided by conducting the study, pre- and post-room service, at the same hospital within a short time period (five months), using a consistent methodology and investigator, and cohorts with a similar demographic.
- The heterogeneity of previous study designs combined with the lack of definition of system variables limited the comparison of results across studies. In addition, differences in design variables including the requirement to consume three main meals within a 24-hour period may have contributed to a group of participants with a lower level of nutritional risk relative to previous studies.

- The logistics of following up on each patient's meal delivery and collection, particularly for midday meals pre-room service, and all deliveries post-room service, was difficult to complete in a timely manner across numerous ward areas.
- The allocation of post-room service orders to arbitrary meal times for comparison with pre-room service outcomes, may have biased the results.
- The results may have been affected by the collection of post-room service data during the early stage (14 weeks) of implementation, when the staff and patients were still adjusting to new systems and routines.

Meals on Wheels (Chapters 4, 5 and 6)

- The absence of validated tools specific to MOW clients, to assess levels of independence and social connection, reduced the ability to compare results across studies.
- Participants indicated the interviews were lengthy (an hour or more) and wearing the accelerometer was uncomfortable. Discomfort from wearing the accelerometer resulted in a number of participants not wearing the accelerometer for the three-month data collection, affecting the quantity of data. To minimise discomfort and drop-out rates, ideally the methodology would reduce the length of interview and utilise less bulky, more comfortable wearable technology to monitor energy expenditure.
- The intervention in this study was limited to three months. Ideally, studies would be undertaken over an extended period to assess the impact of time on outcomes.

7.3 Discussion - future directions –research and policy

The optimisation of nutritional intake is complicated by the number of factors influencing eating patterns and the availability of food. The following outlines research opportunities that, build on four of the influences on dietary intake identified from the studies in this thesis, and explore strategies to increase nutritional intake in hospital and MOW settings.

Food service systems are complex. Each food service process step, from menu design, to production decisions related to fortification, meal ordering including the timing relative to delivery, and the level of interaction with staff and volunteers can influence nutritional intake. The studies presented in this thesis highlight the importance of documenting these food service process steps from meal ordering to the delivery of the meal, in order to identify barriers and opportunities to improve nutritional intake. To reinforce potential synergies across service delivery models, an assessment of reports and Master dissertations from MOW services across Australia is recommended for future publications.

Research opportunity – hospital patients

Conduct room service studies in multiple settings using consistent study designs to clarify the potential for a room service system to consistently reduce the amount of food ordered and plate waste, while increasing nutritional intake, and reducing the length of stay. Where possible, include patients at risk of malnutrition. To assist in identifying variables that may impact outcomes, in addition to detailing the system intervention, document system components pre- and post- the intervention:

Menu:

- Type of menu – such as a la cart/restaurant-style, or cycle menu. Include the length the menu cycle.
- Degree of choice for each menu component; for example, soup, main, salad/sandwich, dessert.

Meal ordering:

- Prescribed or flexible meals.
- Timing for meal orders relative to the meal delivery.
- Options for patients to change their meal selection prior to the meal delivery.
- Degree of interaction with staff, in person or by phone, or limited to a paper menu.

Patient type:

The potential for outcomes to vary by patient type has been reported in previous studies, suggesting an opportunity to target implementation strategies to specific patient groups (McCray, Maunder, Krikowa et al., 2018). Because studies are typically undertaken at a single facility and, in some cases, single wards, with small sample sizes, there is value in repeating the study to explore and compare the impact across various patient groups such as medical, surgical, oncology, maternity, and paediatrics.

Plate waste:

Ideally, plate waste data would be collected and analysed by meal time and food category to inform the targeting of system interventions to optimise dietary intake. Ensuring a consistent approach to data analysis would support the comparison of results between studies.

Research opportunity – Meals on Wheels

Because there are few studies detailing the MOW process, there is an opportunity to incorporate system details into future studies to facilitate the identification of variables that may impact nutritional outcomes, including:

- The menu format, including the number of meal items available within each menu category, and length of the cycle.
- The meal ordering process, including the timing of the order prior to the delivery of the meals, opportunities for the MOW client to change their order prior to delivery, the method of ordering (hard copy, phone, email and so on), and access to support from staff/volunteers regarding process details, such as variations to delivery frequency and times, and other available support services.

Social aspect of eating. For both the older person living in the community and patients in hospital, there is an opportunity to investigate the impact of social interaction on dietary intake. In the hospital setting a previous study determined an

improvement in patient energy and protein intake was considered the result of modified work processes that enabled staff time with patient (Maunder et al., 2015), consistent with the individualised and timely ordering process incorporated into a room service model. Although MOW meals are typically ordered days, or in some cases weeks, in advance, there remains an opportunity to integrate a component of social interaction through the meal ordering process.

Research opportunity – hospital patients

In the hospital context, the opportunity for the patient to connect with food service staff are the points at which the patient places their meal order and receives the meal. Providing a timely order process; support for meal selection; a friendly face that listens to the patient/understands and responds to their needs and expectations can create a social connection, and potentially improve nutritional intake.

Studies that document and compare the impact of menu ordering system options that incorporate direct staff–patient contact, whether contact is in person, by phone, or with electronic meal ordering options can extend the understanding of the impact of a social connection on nutritional intake for hospital patients. Ideally, these studies would be documented across patient group – medical, surgical and so on – to assist in targeting future strategies.

Research opportunity – Meals on Wheels

While the short, social visits undertaken in this current study were not associated with an increased nutritional intake, this study provides a baseline, an initial step in the exploration of the potential for social interventions to impact on intake. Ideally, future studies should investigate the impact of a targeted social intervention that incorporates individualised support for MOW clients.

Allocating a volunteer or staff member to support individual MOW clients with respect to their meal selection and ordering could reflect the role undertaken by the hospital menu monitor/nutrition assistant who supports the patient in their meal selection and provides a point of contact with the food service. This appointment of a "client liaison" position could focus the social visits and extend the development

of a relationship with individual clients, collecting data to guide the development of future interventions by:

- providing assistance with ordering and/or reviewing individual meal choices to clarify ingredients and inclusions, identify quality issues
- liaising with the service provider to identify meal and ordering options to address client-specific issues.
- providing MOW clients with information related to additional meal related services that may be either new services, or current services not known to the client
- collecting formal or informal feedback from the client regarding the product and services
- undertaking a wellness check, a task typically undertaken by the delivery person
- completing a malnutrition screen, given appropriate training
- encouraging the client to actively participate in and manage their meals.

Qualitative studies. Individual eating patterns are impacted by physiological, medical, psychological, emotional, cultural and social factors, highlighting the importance of exploring multiple strategies, rather than a single system option, to optimise individual nutritional intake.

Undertaking qualitative research can assist in understanding the opinions, attitudes, experiences and expectations of hospital patients and MOW clients with respect to food services, and inform the development of new and/or enhanced strategies to improve nutritional intake

Research opportunity – hospital patients

Qualitative studies based on open-ended questions and unstructured interviews with patients can explore patient experiences and expectations regarding meal services. Targeting feedback on systems features including enhanced menu selection, flexible meals, and meal ordering close to the meal delivery (for example, 45 minutes), as well as individual factors, such as appetite, medical

circumstances, mobility and cultural factors, the potential barriers to, and impact of room service systems on dietary intake can be identified.

Where interviews are conducted in locations where room service has not been implemented, visual aids such as sample menus could be used to prompt discussion. Collection of feedback from these patients can include the impact of room service on mid meal and beverage services.

Collecting and analysing feedback across different patient groups, such as medical, surgical, oncology, maternity and paediatrics, will assist in targeting interventions to meet patient needs and expectations.

Research opportunity – Meals on Wheels

The "client liaison" position introduced above could explore feedback on the current services in a relaxed environment where the MOW client is encouraged to voice their opinions and contribute to the development of an enhanced service.

The analysis of the data from these interventions can provide a context to the observations and results from previous interventions, such as the potential discrepancy between positive/negative comments and throwing out of meals reported in Chapter 4, as well as suggesting future strategies. Given the MOW clients can be with the service for extended periods, ongoing feedback from individuals through the "client liaison" position also can provide continuity of feedback over time while empowering the client to assume a participative role in the organisation.

Interrelationships between health care sectors. The studies in this thesis highlight the similar process steps involved in the provision of food services between hospitals and MOW services, and the potential for innovations to be shared across health care sectors. Specifically, a variation to the enhanced meal ordering process employed in a room service model, if incorporated into a "client liaison" role identified above in the "social aspect of eating" can impact the outcome of MOW services provided to older adults living in the community. In addition to sharing strategies, this intersectoral approach to food services can be

extended to develop working relationships between sectors, consistent with the model of "social prescribing" that supports the individual as they move between sectors (Alliance for Healthier Communities, 2020; Drinkwater et al., 2019; Husk et al., 2020; Mulligan et al., 2020b, 2020a; The RACGP and Consumers Health Forum of Australia, 2019; Wilkinson et al., 2020). Consistent with the coordinated approach to the delivery of aged care services recommended by the Royal Commission into Aged Care, Quality and Safety (Royal Commission into Aged Care Quality and Safety, 2021a), this level of research can elevate the awareness within the health community of the services provided by MOW, and ensure they become stakeholders in the provision of support to individuals as they move from home, hospital and other health services.

Research opportunity – an intersector approach

Undertake studies that focus on the provision of food services across all sectors, including hospitals, residential aged care and services provided to older persons living in the community, including MOW services. The ultimate goal of these studies is to minimise disruptions for the individual and create an environment that contributes to the provision of food service that supports the nutritional health of the individual. These studies would document the current situation with respect to inter-sector communication, collecting data from the referral source and recipient agency to provide an understanding of the baseline from which systems can be developed for providing a seamless transition for the individual between sectors. Data to be collected include:

- A process flow detailing the steps from the point where the referral is raised to the final transfer to the recipient agency. Details to include the method of communication, timing, and persons responsible, both prior to and during studies, to support the analysis of the impact of the study on the outcomes.

- Data to be collected includes information provided by referring agent to the recipient service regarding the individual's diet requirements, preferences, and circumstances - medical, physical, social, environmental - that may impact dietary intake.

- For each referral source, clarify their understanding of the range of food services provided by recipient sector agency.

This information will provide the understanding of the individuals and service providers necessary for targeted strategies across the sectors, including steps in the process where delays, miscommunication, lack of information or other factors interrupt the transition. Ideally the study design would include interviews and/or focus groups with key stakeholders such as hospitals/community health centres/general practice surgeries to explore issues, opportunities and barriers to the provision of food support services for individuals

7.4 Conclusion – the time is now

The time is right to expand the focus of malnutrition across the health care sectors and develop interventions that acknowledge, identify and address the needs of the individual, and provides a system of coordination that maintains a continuum of nutritional care for the individual across the sectors. This approach can provide the individual with the level of "attention" recommended by Florence Nightingale over 150 years ago (Nightingale, 1860). Forty years ago, Butterworth described malnutrition as "a common accompaniment to the stress of illness" which could be corrected by the application of a "little common sense" to the undesirable practices affecting the nutritional health of patients, ranging from "failure to observe, lack of communication, withholding of meals to accommodate procedures and other unnecessary delays" (Butterworth, 1974). Sadly, in 2021, malnutrition remains an issue across all health care sectors. The cost impact of our lack of action is real. In the UK alone the proportion of health activity in the UK due to malnutrition for 2011–12 was estimated at 15% of the total UK expenditure on health care, with older persons accounting for the majority of the cost (Elia & Southampton, 2015). For the past 150 years, our lack of attention to a basic need – nutrition – has prevented our older adults in the community to "develop and maintain the functional ability that enables well-being" (WHO, 2017b), and lead a full, independent life. Our knowledge base is growing, enhanced by working collaboratively across sectors. The time to pay attention is now.

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Appendices

Appendix 3.1: Information to participants involved in research

INFORMATION TO PARTICIPANTS INVOLVED IN RESEARCH

You are invited to participate

You are invited to participate in a research project entitled: Determining the impact of a hospital food service system on plate waste (food uneaten), dietary intake, patient satisfaction and costs

This project is being conducted by a researcher Jacquie Krassie (Accredited Practising Dietitian) from the College of Health and Biomedicine at Victoria University.

Project explanation

The study aims to determine the impact of a room service food service system on plate waste (food uneaten), bulk food waste, dietary intake, patient satisfaction and costs of the service.

What will you be asked to do?

Participants will be asked to take part in a one-on-one interview with a staff member from Victoria University. The interview will take place in your hospital room and is expected to take approximately 5-10 minutes to complete.

A Nurse Unit Manager will contact you prior to the interview to answer any questions you have about the study and arrange an interview time.

At any time prior to or during the project, you can withdraw from the project.

All of the data collected in the study will be coded and remain anonymous. De-identified data will be stored in a locked cabinet at the University. Any data used in reports, publications or presentations would be de-identified. Individuals will remain anonymous.

Prior to the start of the interview you will be asked to sign a consent form. Once again, you are still able to withdraw from the project at any time with no effect on the services you are receiving from the Hospital.

During the interview, you will be asked about your appetite during the preceding few days including any recent changes you've noticed in your appetite and other factors that may have affected your

intake and to estimate your body weight. You will also be given the opportunity to comment on any aspects of the current meal service including those you like and those you would like to see changed.

What will you gain from participating?

Participating in this study will give you the opportunity to provide anonymous feedback regarding the food service that you receive. Your input will help to shape further improvements in the meals and service received by patients from the Hospital.

How will the information you give be used?

Information from the study will be used in reports, publications, presentations at conferences that will contribute to developing strategies to improve the service provided to and the nutritional well-being of hospital patients.

As all of the data collected in the study will be coded and remain anonymous, there is no risk of any impact on the level of services you receive from the Hospital. Individuals participating in this project will remain anonymous.

What are the potential risks of participating in this project?

Participating in this study will not affect your relationship with the Hospital. Although the Hospital will be aware that you are participating in this research, all information given in the interview is strictly confidential and will remain anonymous.

Who is conducting the study?

Mater Private Hospital

Victoria University

Jacquie Krassie

Principal Investigator

Email: Jacqui.Krassie@vu.edu.au

Any queries about your participation in this project may be directed to the Principal Investigator listed above.

If you have any queries or complaints about the way you have been treated, you may contact the Mater Health Services, Human Research Ethics Committee, Level 3 Quarters Building, Annerley Road, Woolloongabba 4128 Queensland. Ph 07 3163 2392

Appendix 3.2: Consent form for participants involved in research

CONSENT FORM FOR PARTICIPANTS INVOLVED IN RESEARCH

INFORMATION TO PARTICIPANTS:

We would like to invite you to be a part of a study titled: Determining the impact of a hospital food service system on plate waste, dietary intake, patient satisfaction and costs

CERTIFICATION BY SUBJECT

I,..... (name)

of..... (suburb)

certify that I am at least 18 years old* and that I am voluntarily giving my consent to participate in the study being conducted at Victoria University by Jacquie Krassie, *Determining the impact of a hospital food service system on plate waste, dietary intake, patient satisfaction and costs.*

I certify that the objectives of the study, together with any risks and safeguards associated with the procedures listed hereunder to be carried out in the research, have been fully explained to me by:

Researcher :.....

and that I freely consent to participation involving the procedures written below:

To be interviewed in my room by the research staff from Victoria University. The staff member will ask a series of questions about my appetite including any recent changes I have noticed in my appetite and other factors that may have affected my meal intake as well as to estimate my current body weight. I will also be given the opportunity to comment on any aspects of the current meal service including those I like and those I would like to see changed. I understand

that my food intake will be estimated based upon the food left on my meal tray when it is returned to the kitchen. I understand that the results of the study will be published.

I certify that I have had the opportunity to have any questions answered and that I understand that I can withdraw from this study at any time.

I have been informed that the information I provide will be kept confidential.

Signed:……

Date: ……/……/……

Any queries about your participation in this project may be directed to the researcher

Jacquie Krassie

M 0414 861 803

If you have any queries or complaints about the way you have been treated, you may contact the

Mater Health Services, Human Research Ethics Committee, Level 3 Quarters Building, Annerley Road, Woolloongabba 4128 Queensland. Ph 07 3163 2392

Appendix 4.1: Information to participants involved in research

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

INFORMATION TO PARTICIPANTS INVOLVED IN RESEARCH

Invitation to participate

You are invited to participate in a research project entitled: *The role of monitoring Meals on Wheels recipients to improve health.*

This project is being conducted by, A/Prof Andrew McAinch; Ms Jacquie Krassie; Prof Lily Stojanovska Prof Remco Polman; Dr Jannique van Uffelen and A/Prof Craig Fry from Victoria University.

Project explanation

The study aims to investigate meal consumption patterns and physical activity levels of Meals on Wheels clients and the impact on their health to improve service provision and monitoring of clients to assist them to maintain independence.

What will you be asked to do?

Participants will be interviewed by a dietitian in their home at the start of the project and again at 3 months, 6 months and 12 months following the initial interview.

Each interview is expected to take approximately 1 to 1.5 hours. Prior to the interview you will be contacted by one of the researchers to arrange a convenient time for the interview as well as ask some basic questions regarding your health. Following each interview you will also receive 2 follow-up phone calls to ask questions about your food intake. Each of these phone calls will take less than 30 mins.

During the interview, you will:

- Be asked about your food intake, meal ordering patterns, body weight and appetite.
- Be asked to complete a health survey that includes questions related to your mental and physical health.
- Have your activity levels measure in the led up to the interview via wearing an accelerometer for 1 week. An accelerometer is a small device (the size of a small mp3 player) worn on an arm band for 7 days and only taken off when in the shower.
- Be given the opportunity to comment on any aspects of the current Meals on Wheels service including those you like and those you would like to see changed.

During the project, details on your meal ordering patterns will also be obtained from the provider of the Meals on Wheels meals.

Participants will be assigned to one of 3 groups. Depending upon the group you are allocated to, you may be visited by another member of the research team on 6 occasions every fortnight for 3 months or monthly for 6 months to participate in a further interview. The researcher will visit you in your home for approximately 30 minutes during each of these visits to provide support for your ordering of meals on wheels services, follow up on your food intake, changes to your appetite, food preferences, changes in food consumed outside of the service and to monitor your activity levels.

All of the data collected in the study will be coded and remain anonymous. Any data used in reports, publications or presentations would be de-identified. Individuals will remain anonymous. De-identified data will be stored in a locked cabinet at the University.

Prior to the start of the interview you will be asked to sign a consent form. You are, however, able to withdraw from the project at any time. Participation in this project is voluntary. If you decide not to participate in this project it will not affect the services you receive from Meals on Wheels.

Project: *The role of monitoring Meals on Wheels recipients to improve health* *Version: 23-6-14*

Appendix 4.1: Information to participants involved in research (continued)

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

What will you gain from participating?

Participating in this study will give you the opportunity to provide anonymous feedback regarding the Meals on Wheels service to contribute to improvements in the meals, service and ultimately the nutritional status and independence for Meals on Wheels clients.

All participants will be visited by a trained dietitian to talk about their food intake and activity levels and will be monitored for a one year period. Participants randomised to the intervention group will also receive additional support for meal ordering from researchers during the project.

How will the information you give be used?

Information from the study will be used in reports, publications and presentations at conferences, contributing to strategies to improve the service and the well-being of Meals on Wheels clients.

What are the potential risks of participating in this project?

The Meals on Wheels service may be aware that you are participating in this research due to the collection of the details of food ordered through the service, which they already have on their data base as part of their services to you. However all the data collected from you will be strictly confidential, and all of the data collected in the study will be coded and remain anonymous. There is no risk of any impact on the level of services you receive from Meals on Wheels.

How will this project be conducted?

Information for the project will be gathered during a one-on-one interview with you in your home. You will also be called on the telephone to organise appoints for the one-on-one visits, to collect some basic information from you which will be followed-up during the visits or to collect additional information following the one-on-one visit.

Who is conducting the study?

Victoria University, A/Prof Andrew McAinch, Principal Investigator

Email: andrew.mcainch @vu.edu.au Phone: 9919 2019

Victoria University, Ms Jacquie Krassie, Co-Investigator

Email: Jacqui.krassie@vu.edu.au Phone: 0414861803

Other Co-Investigators: Prof Lily Stojanovska Prof Remco Polman; Dr Jannique van Uffelen and A/Prof Craig Fry

The project is funded by a grant from Macedon Ranges and North Western Melbourne Medicare Local.

Any queries about your participation in this project may be directed to the Chief Investigator listed above.

If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

Project: *The role of monitoring Meals on Wheels recipients to improve health* *Version: 23-6-14*

Appendix 4.2: Consent form for participants involved in research

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

CONSENT FORM FOR PARTICIPANTS INVOLVED IN RESEARCH

INFORMATION TO PARTICIPANTS:
We would like to invite you to be a part of a study into ***The role of monitoring Meals on Wheels recipients to improve health***. This study aims to investigate meal consumption patterns and physical activity levels of Meals on Wheels clients and the impact on their health to improve service provision and monitoring of clients to assist them to maintain independence.

CERTIFICATION BY SUBJECT

I, ... (name)

of ..... (Address)

certify that I am at least 18 years old* and that I am voluntarily giving my consent to participate in the study:
The role of monitoring Meals on Wheels recipients to improve health being conducted at Victoria University by: A/Prof Andrew McAinch; Ms Jacquie Krassie; Prof Lily Stojanovska Prof Remco Polman; Dr Jannique van Uffelen and A/Prof Craig Fry

I certify that the objectives of the study, together with any risks and safeguards associated with the procedures listed hereunder to be carried out in the research, have been fully explained to me by:

Researcher :.....

and that I freely consent to participation involving the below mentioned procedures:

During an interview in my home, research staff from Victoria University will:

- Ask about my food intake, meal ordering patterns, body weight and appetite.
- Ask me to complete a health survey that includes questions related to my mental and physical health.
- Have my activity levels measured in the lead up to the interview. Measured via wearing an Accelerometer.
- Provide me with an opportunity to comment on any aspects of the current Meals on Wheels service including those you like and those you would like to see changed
- This one on one interview will be conducted on 4 occasions over a 12 month period and I may receive a phone call before and 2 phone calls after each visit to provide some additional information .
- Depending upon the group I am allocated to, I may be visited by another member of the research team on 6 occasions every fortnight for 3 months or monthly for 6 months to participate in a further interview

I certify that I have had the opportunity to have any questions answered and that I understand that I can withdraw from this study at any time and that this withdrawal will not jeopardise me in any way.

I have been informed that the information I provide will be kept confidential.

Signed:

Date:

Any queries about your participation in this project may be directed to the researcher
A/Prof Andrew McAinch,
Phone 03 9919 2019

If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email Researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

[*please note: Where the participant/s are aged under 18, separate parental consent is required; where the participant/s are unable to answer for themselves due to mental illness or disability, parental or guardian consent may be required.]

V.1/2013 1 of 1

Appendix 4.3: The role of monitoring MOW recipients to improve health

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

Project: ***The role of monitoring Meals on Wheels recipients to improve health***

Thank you for participating in this research project.

As part of this study, you have been asked to wear a device called an accelerometer, via an armband. This device will measure your activity levels over the day while it is being worn.

You will be assisted to put on the armband at the end of the interview.

Please wear the armband for 7 consecutive days following the interview.

Wear the armband during the day and while you sleep. Only take the armband off when you are about to have a shower, a bath, or if you go swimming. Do not wash the armband.

There is no power button for the armband. It will automatically power on when you put it on and will make a series of audio tones when it is activated, approximately 5-10 minutes after putting it on.

The device may display some lights; this is an indication of battery life remaining. You should continue to wear the armband even if the colour of the lights change.

A member of the research team will organise a time to come back to collect the armband after the 7 days.

Please discontinue use, and contact the research dietitian (named below) should you experience any symptoms such as skin irritation, or have any concerns regarding wearing the armband.

Research Dietitian: **Melissa Holloway**

Mobile: 0466 520 633

Appendix 4.4: MNA®-SF

Mini Nutritional Assessment
MNA®

Nestlé Nutrition Institute

Last name: First name:

Sex: Age: Weight, kg: Height, cm: Date:

Complete the screen by filling in the boxes with the appropriate numbers.
Add the numbers for the screen. If score is 11 or less, continue with the assessment to gain a Malnutrition Indicator Score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe decrease in food intake
1 = moderate decrease in food intake
2 = no decrease in food intake ☐

B Weight loss during the last 3 months
0 = weight loss greater than 3kg (6.6lbs)
1 = does not know
2 = weight loss between 1 and 3kg (2.2 and 6.6 lbs)
3 = no weight loss ☐

C Mobility
0 = bed or chair bound
1 = able to get out of bed / chair but does not go out
2 = goes out ☐

D Has suffered psychological stress or acute disease in the past 3 months?
0 = yes 2 = no ☐

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems ☐

F Body Mass Index (BMI) (weight in kg) / (height in m²)
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater ☐

Screening score (subtotal max. 14 points) ☐☐
12-14 points: Normal nutritional status
8-11 points: At risk of malnutrition
0-7 points: Malnourished

For a more in-depth assessment, continue with questions G-R

Assessment

G Lives independently (not in nursing home or hospital)
1 = yes 0 = no ☐

H Takes more than 3 prescription drugs per day
0 = yes 1 = no ☐

I Pressure sores or skin ulcers
0 = yes 1 = no ☐

J How many full meals does the patient eat daily?
0 = 1 meal
1 = 2 meals
2 = 3 meals ☐

K Selected consumption markers for protein intake
- At least one serving of dairy products (milk, cheese, yoghurt) per day yes ☐ no ☐
- Two or more servings of legumes or eggs per week yes ☐ no ☐
- Meat, fish or poultry every day yes ☐ no ☐

0.0 = if 0 or 1 yes
0.5 = if 2 yes
1.0 = if 3 yes ☐☐

L Consumes two or more servings of fruit or vegetables per day?
0 = no 1 = yes ☐

M How much fluid (water, juice, coffee, tea, milk...) is consumed per day?
0.0 = less than 3 cups
0.5 = 3 to 5 cups
1.0 = more than 5 cups ☐☐

N Mode of feeding
0 = unable to eat without assistance
1 = self-fed with some difficulty
2 = self-fed without any problem ☐

O Self view of nutritional status
0 = views self as being malnourished
1 = is uncertain of nutritional state
2 = views self as having no nutritional problem ☐

P In comparison with other people of the same age, how does the patient consider his / her health status?
0.0 = not as good
0.5 = does not know
1.0 = as good
2.0 = better ☐☐

Q Mid-arm circumference (MAC) in cm
0.0 = MAC less than 21
0.5 = MAC 21 to 22
1.0 = MAC 22 or greater ☐☐

R Calf circumference (CC) in cm
0 = CC less than 31
1 = CC 31 or greater ☐

Assessment (max. 16 points) ☐☐☐
Screening score ☐☐☐
Total Assessment (max. 30 points) ☐☐☐

Malnutrition Indicator Score

24 to 30 points	☐	Normal nutritional status
17 to 23.5 points	☐	At risk of malnutrition
Less than 17 points	☐	Malnourished

References
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For more information: www.mna-elderly.com

Appendix 4.5: Semi-structured interview – social support and independence

1. This question is about the amount of social support you receive from your family, friends, and the like.

When you have the need to talk to someone or go on outings with friends and/or relatives, do you feel there is someone who fulfils these needs?

Would you say you have a (please choose one of the below options)?

- High degree of social support. (Much support is either given or is available, if needed, from family and friends.)
- Above average degree of social support. (Given or potentially available from family and friends.)
- Average degree of social support from family and friends (is given or potentially available.)
- Below average degree of social support. (While some support is available from friends, there is no family member from whom help can be obtained.)
- No support or potential support is available from either family or friends.

2. How often does a friend or relative visit you in your home?
   - Daily
   - Several times a week
   - Weekly
   - Several times a month
   - Monthly or less often

3. Are you able to get to places that are beyond walking distance?
   - Without help
   - With some help
   - I am unable to travel unless special arrangements are made

4. Can you prepare your own meals:
   - Without help?
   - With some help?
   - Unable to prepare any meals by self?

5. Can you go shopping for groceries:
   - Without help?
   - With some help?
   - Unable to do any shopping by self?

Appendix 4.6: Semi-structured interview – consumption and utilisation of MOW meals

NON-MOW MEALS CONSUMPTION

1. On average how many days per week would you eat:
   - A meal that you made (prepared or cooked) at home? _____ days.
   - A meal prepared by a friend or family member (either at your home or their home)? _____ days.
   - At a club or restaurant? _____ days.
   - Take-away? _____ days.

MOW MEALS CONSUMPTION

2. Why did you start to receive MOW meals?
   - Referred by Doctor.
   - Referred by Hospital.
   - Referred by Dietitian.
   - Referred by Specialist.
   - Referred by Friend.
   - Other (please list).

3. How long have you been receiving MOW meals? (months)?

4. Is this the first time you have received MOW? Yes/no?

5. How many previous times have you ordered MOW meals?

MOW MEALS ORDERING

6. How many MOW meals do you receive per week?

7. In general, how often do you order (the following items) in a week?
   - Soup – number of times per week (can include "0").
   - Main meal – number of times per week.
   - Dessert – number of times per week.
   - Salad – number of times per week.
   - Sandwich – number of times per week.

8. When do you eat (time of day)? Note you can tick more than one:

	Breakfast	Lunch	Dinner	Morning tea/Afternoon supper
Main meal				
Salad				
Sandwich				
Soup				
Dessert				
Juice				

Appendix 4.6: Semi-structured interview – consumption and utilisation of MOW meals (cont.)

9. Please clarify any additional comments relating to eating times:
    - Do you put the meal on a plate before eating it? YES/NO.
        - When?
            - Before heating.
            - After heating.

MOW MEALS REHEATING

10. How do you cook / heat your meals?
    - Microwave.
    - Other (please explain).

MOW MEALS THROWING OUT

11. Are there times that you have had to throw the meal out? YES/NO. Please explain.

MOW MEALS DELIVERY

12. Is it always the same person that delivers your meal? YES/NO.

13. Do you chat with them? YES/NO.

14. Do they:
    - Bring the meal inside? YES/NO.
    - Replate the meal? YES/NO.
    - Heat the meal? YES/NO.

15. Do you feel that this (meal delivery) is a social time of your day? YES/NO.

MOW MEALS COMMENTS

16. Is there anything else you would like to tell me?

17. Are there any particular aspects of the MOW meals and service that you like and wouldn't want to change?

18. Are there any aspects of the MOW meals and service that you would like to change?