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Health promotion in the workplace: changing the diet and physical activity behaviour of nurses

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Abstract

It has been estimated that unhealthy diet and physical inactivity are responsible for 15% and 9% of premature deaths, respectively. These lifestyle behaviours can modulate biomedical risk factors of non-communicable diseases (NCDs), which are the leading cause of death in all developed countries. The importance of healthy diet and physical activity (PA) behaviours for reducing the risk of NCDs is well known, but changing these behaviours is complex and challenging. The workplace can be both an environment that challenges lifestyle behaviours, or an ideal setting to promote these. Nurses have a stressful occupation, in which shift patterns and job demands promote irregular eating patterns, frequent energy-dense snacking, fatigue and inactivity. In addition, 60% of nurses are overweight or obese. The nursing workforce in Australia is aging, with 28% of nurses being over the age of 50 compared with the average 15% in other workforces. Age, job demands and lifestyle behaviours make it clear that nurses are at increased risk for NCDs. Poor health in nurses can lead to loss of productivity and increased health care costs, which can compromise quality of care.

However, little is known on how to improve nurses' lifestyle behaviours, with the literature showing inconclusive results on the effectiveness of specific strategies to promote such behaviours. There is a clear need for additional studies that are designed using a rigorous and systematic approach which is underpinned by established behaviour change theory. The Intervention Mapping (IM) framework is an example of such an approach. The aim of this thesis is to address this gap in knowledge and add to the literature by developing, implementing and evaluating an intervention using the IM framework. This is among the first studies to undertake a comprehensive process for the development, implementation and evaluation of a workplace intervention designed to promote diet and PA behaviours in nurses.

A systematic review of diet and PA interventions for nurses was conducted, as first part of the Needs Assessment (NA) of the target group. Nine intervention studies with a total of 737 participants were included in the review. Results indicated a modest increase in some measures of PA and a positive effect on participants' body mass index and body composition, but results for other outcomes were inconsistent between studies. Intervention strategies that assisted with promoting behaviour change in nurses included pedometers, step challenges, and nurse champions. However, studies often used tools

that were not validated or self-report to measure intervention outcomes. Studies provided little rationale for study design, and/or lacked a theoretical framework. The review identified a relative paucity of diet and PA interventions for nurses in the literature and highlighted a clear need for more and better-designed studies.

The second part of the NA included a qualitative study with nurses who were potential participants for the intervention study. Using focus group interviews, I explored participants' determinants for diet and PA behaviours, and consulted with them about intervention design and materials. Results suggested that lack of breaks and consequent hunger dictated nurses' diet behaviour, while fatigue and lack of time undermined PA behaviour. Nurses described a desirable intervention as a simple program that could help them monitor their diet and PA, set goals, and receive social support from colleagues.

The NA informed the intervention development, the rational for behaviour change theory and materials selection, study design, and outcome measures. A 3-month intervention was implemented to evaluate changes in diet and PA. The main outcome measures were diet quality, average daily steps, and patterns of PA. Results indicated a significant improvement on fruit and vegetable consumption (+4% daily energy intake), at the end of the intervention. . However, at the same time-point, the percentage of total time spent on MVPA significantly decreased from 3.0 to 2.5%, and average daily steps decreased from 8435 to 7929.

Following the intervention implementation and evaluation, process and economic evaluations were conducted to analyse the scalability of this intervention. The process evaluation followed the RE-AIM framework and aimed to shed light on the observed intervention outcomes and explain the contradictory results. Findings showed that materials were not adopted as planned, and that there was a mismatch on what participants desired in the intervention and what they were actually ready to do and use. Participants also discussed their difficulty to change both behaviours at once, with the majority finding it easier to focus on diet only. The economic analysis calculated the costs for intervention delivery and participation, and cost-effectiveness of each intervention outcome. Results indicated that only dietary outcomes were cost-effective, but in its current shape the intervention's small effects make it difficult to define stakeholders' willingness to pay.

Nurses are at risk for NCD because of their poor diet and PA behaviours; however, the promotion of such behaviours in this group remains very difficult because they are an extremely hard-to-reach group. This challenged recruitment, engagement and retention, leading to a small sample size and modest change in diet and PA outcomes in this study. Hospital management involvement and advocacy for workplace health promotion interventions is mandatory to ensure a better reach in future studies. Such involvement could facilitate work environment manipulation, such as better shift pattern or provision of healthy snacks, and selection of paid nurse champions who encourage colleagues and ensure intervention's implementation and maintenance.

Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

I have clearly stated the contribution of others to my thesis as a whole, including statistical assistance, survey design, data analysis, significant technical procedures, professional editorial advice, and any other original research work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution. I have clearly stated which parts of my thesis, if any, have been submitted to qualify for another award.

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Publications during candidature

Peer-reviewed papers

Torquati L, Pavey T, Kolbe-Alexander T, Leveritt M. Promoting diet and physical activity in nurses: a systematic review. American Journal of Health Promotion. 2015. *In press*

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Conference abstracts

Torquati L, Kolbe-Alexander T, Persson C, Pavey T, Leveritt M " Changing diet and physical activity behaviour in nurses using Intervention Mapping: Study protocol" Poster presentation. FENS - Federation of European Nutrition Societies, October 2015 – Berlin, Germany.

Torquati L, Kolbe-Alexander T, Persson C, Pavey T, Leveritt M "Obesity and the workplace: the hidden case of nurses". Oral presentation. CECON - Central European Congress on Obesity, October 2015 – Budapest, Hungary

Torquati L, Kolbe-Alexander T, Persson C, Pavey T, Leveritt M " Caring for the carers: a focus group study of nurses' diet and physical activity behaviour to inform lifestyle change programs". Oral Presentation. School of Human Movement and Nutrition Sciences Postgraduate Student Conference, April 2015 – Stradbroke Island (QLD).

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Torquati L, Pavey T, Leveritt M. Changing lifestyle behaviour in nurses using Intervention Mapping: Study protocol. The Australian Society for Medical Research Queensland Postgraduate Conference, 28th May 2014, Brisbane, Australia.

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Contributor	Statement of contribution
Author: Luciana Torquati	Designed experiments (40%) Extracted data (100%) Conducted quality assessment (30%) Wrote and edited paper (60%)
Author: Dr Toby Pavey	Designed experiments (30%) Supervised data extraction (100%) Conducted quality assessment (70%) Supervised review (60%) Wrote and edited paper (20%)
Author Dr Tracy Kolbe-Alexander	Wrote and edited paper (10%)
Author: Dr Michael Leveritt	Designed experiments (30%) Supervised review (40%) Wrote and edited paper (10%)

Torquati L, Kolbe-Alexander T, Pavey T, Persson C, Leveritt M. Diet and physical activity behaviour in nurses: a qualitative study. International Journal of Health Promotion and Education. 2016 Apr 30:1-5.

Contributor	Statement of contribution
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Author: Dr Toby Pavey	Interpretation of results (10%) Wrote and edited paper (10%) Supervised analysis (25%)
Author: Christina Persson	Transcription (40%) Designed experiments (30%) Interpretation of results (20%)
Author: Dr Michael Leveritt	Interpretation of results (10%) Wrote and edited paper (10%) Supervised analysis (25%)

Contributions by others to the thesis

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Statement of parts of the thesis submitted to qualify for the award of another degree

Data from Chapter 4, in particular from one of the four focus group interviews, was submitted for one of the authors' MPhil thesis (Ms Christina Persson), degree awarded on 2014 at Gothenburg University (Sweden). At the moment of submission, only one interview was conducted and the study was presented as a pilot study.

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Keywords

Diet quality, physical activity, health behaviours, workplace, health promotion, intervention mapping, systematic review, qualitative research, process evaluation, cost-effectiveness,

Australian and New Zealand Standard Research Classifications (ANZSRC)

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111712 Health Promotion, 30%
110699 Human Movement and Sports Science not elsewhere classified 20%

Fields of Research (FoR) Classification

1111 NUTRITION AND DIETETICS, 50%
1117 PUBLIC HEALTH AND HEALTH SERVICES, 30%
1106 HUMAN MOVEMENT AND SPORTS SCIENCE, 20%

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List of Abbreviations used in the thesis

AIHW	Australian Institute of Health and Welfare
APPS	Smartphone application
ARFS	Australian Recommended Food Score
A$	Australian Dollar
BMI	Body Mass Index
BP	Blood pressure
CE plane	Cost-effectiveness plane
CEA	Cost-effectiveness analysis
CHD	Chronic heart disease
CVD	Cardiovascular disease
DQI	Diet quality score
% E	Percentage energy from total energy intake
ER	Emergency room
FFQ	Food frequency questionnaire
FG	Focus group
HEI	Healthy eating index
HFI	Healthy food index
HR	Heart rate
HREC	Human Research Ethics Committee
ICER	Incremental Cost-Effectiveness
IM	Intervention Mapping
ITT	Intention-to-treat analysis
MREC	Medical Research Ethics Committee
MVPA	Moderate-to-vigorous physical activity
NA	Not applicable
NCDs	Non-communicable diseases
NHMRC	National Health and Medical Research Committee
NUMs	Nursing Unit Managers
PA	Physical Activity
PICO	Patient Intervention Control Outcome tool
RCT	Randomised Controlled Trial
RE-AIM	Reach Efficacy Adoption Implementation and Maintenance

SD or ±	Standard deviation
SDT	Self-Determination Theory
T2D	Type 2 Diabetes
vs	Versus
WHPP	Workplace Health Promotion Program

CHAPTER 1
INTRODUCTION

It is widely agreed that physical activity and diet are strong independent predictors of all-cause mortality.[1, 2] They play a major role in both obesity development and onset of other non-communicable diseases such as coronary heart disease (CHD), type 2 diabetes (T2D), and breast and colon cancers.[3, 4] In Australia, T2D and cardiovascular disease (CVD) are the most common non-communicable diseases (NCDs), with a prevalence of 5% and 22%, respectively.[5] Although cardiovascular disease has slightly decreased in the past 10 years, it is still the leading cause of death in Australia, accounting for more than 20,000 deaths in 2014.[6] Risk factors for these chronic diseases include obesity, hypertension, glucose intolerance, and altered blood lipids (HDL/LDL ratio, total cholesterol and triglycerides levels),[7] with 62% of the Australian population being overweight or obese. Because all these risk factors can be modulated by physical activity and diet, these lifestyle behaviours play a crucial role in the onset of NCDs.[2, 8]

Diet and physical activity are modifiable risk factors, and therefore represent important lifestyle behaviours when aiming to prevent and/or treat obesity and NCDs. In fact, lifestyle change has been evaluated in several clinical trials and has been shown to have the most effective long-term results on health outcomes and CVD prevention.[9-11] Interventions have shifted their focus to workplace settings in recent years. Over the last decades, economic and social changes have led to individuals spending more than a third of their waking hours at work.[12] Therefore, the potential impact of workplace interventions on employee's lifestyle behaviours is great. Workplace health promotion interventions have the potential to enhance workers' overall health and productivity, by decreasing absenteeism and the incidence of chronic diseases, with a mutual economic and health benefit for both the employer and the employee, respectively.[13]

Several meta-analyses and systematic reviews have found moderate evidence supporting the efficacy of workplace health promotion interventions.[14-17] While physical activity interventions have shown significant positive effects on physical activity behaviour, fitness, body mass index (BMI), and work attendance and stress,[14, 15] those that included both physical activity and diet components, significantly improved weight related outcomes

(e.g. body weight, BMI and body fat percentage).[17] However, it was noticed that the use of a theoretical framework and design principles when developing interventions, had a positive influence on the resultant outcomes. Poor quality studies often led to smaller effects without provide valuable information on associations between process and observed outcomes.[16, 18]

If planned correctly, workplace health promotion is a promising approach to improve individuals' diet and physical activity behaviours. Still, because not all occupations are the same, and most of the reviewed studies were targeted to office employees (thus with "normal" 9:00 to 5:00 shifts), it is unclear whether other populations with different jobs and shifts would respond to such interventions. This is the case of shift workers or occupations that are characterised by a 24/7 service, such as direct health care workers.

The largest segment of the health care workforce is nursing, which account for 55% of total health professionals in Australia.[19] Nursing is a stressful occupation, and recruiting and retention of nurses at work is often a challenge, due to high physical and emotional distress associated with the job. Overtime, irregular shifts, and physical and emotional stress, have been associated with the development of unhealthy behaviours such as smoking, risky alcohol consumption and an unhealthy diet in nurses.[20-23] Indeed work-related stressors and coping strategies have a negative impact on nurses' health and active lifestyle.

In order to better explore determinants for retention and recruitment, but also the health status of this workforce, a nurses and midwives e-cohort longitudinal study was developed in Australia, with more than 6000 participants.[24] From here, a cross-sectional study reported that 60% of nurses are overweight and obese, describing in particular that night shift was a strong predictor of weight gain.[25] As 86% of nurses are females, [26] if compared to the Australian female population (56% overweight and obese),[7] it is evident that nurses have a higher prevalence and risk of obesity. Shift-work was described as a determinant of BMI in this cohort, while being a part-time or casual worker was associated with 20% reduced risk of having excess weight (OR 0.81, 95% CI 0.70-0.94 and OR 0.75, 95% CI 0.59-0.96 respectively). On the other hand, longer working years and older age increased excess weight risk (OR 1.37, 95% CI 1.04-1.80).[27] Clearly, there are many factors associated with the specific nature of the job that have a negative influence on nurses' health.

Almost 50% of nurses have low levels of physical activity or do not exercise at all [28]. Further studies showed similar results, with low levels of self-reported physical activity, which fail to meet recommended guidelines.[29-31] Eberly and Feldman [32] noted that this is particularly the case of night-shift workers, like nurses, who lack energy to engage in physical activity. Although it could be argued that most nurses "move all the time" during their shift, occupational physical activity is not always intense enough to be classified as moderate physical activity.[33] Thus, it may not contribute to achieving the recommended 150-300 min/week of physical activity.[34] Occupational energy expenditure has actually been negatively associated with leisure time physical activity [35] Moreover, working long hours and overtime, represent the main barrier to incorporate physical activity into an employee's schedule.[13]

Nurses are therefore at increased risk of obesity and CVD, given the barriers towards healthy diet and physical activity behaviours, associated with their working environment. Health promotion initiatives have previously been conducted in hospital and health care settings, improving employees' physical activity levels, BMI and diet patterns. However, they were targeted to all staff, and they did not provide detailed outcomes, in order to identify the specific impact on nurses.[36-43]

Current data shows a lack in number and quality of intervention studies, which promote healthy lifestyles in the nursing population. In fact, most of the intervention studies related to nurses, so far, aim to improve patient/nurse safety, productivity, ergonomics,[44, 45] or if the studies are related to lifestyle interventions, nurses are seen as an element of patient support and education.[46, 47] A recent systematic review highlighted the lack of published studies aiming to improve nurses' lifestyle behaviours. This study also highlighted the subsequent need for more studies, which could assess the effectiveness of such interventions in nurses. [48]

Therefore, the need for interventions designed to improve diet and physical activity behaviour in this population is clear. Moreover, because strong methodological approaches are able to better show associations between process and observed outcomes,[16, 18] a sound theoretical framework should guide the intervention development and evaluation. This process will provide valuable information about factors influencing effectiveness, adoption and sustainability of behaviour change in nurses. Intervention

Mapping (IM) is a framework that provides a rigorous and systematic approach to develop health promotion interventions underpinned by established behaviour change theory. [49] IM provides a comprehensive framework to develop evidence-base behaviour change interventions, by clearly linking knowledge, target group's characteristics and desired outcomes. In addition, IM comprises a process and economic evaluation of the intervention designed to inform changes and adaptations needed for scalability of the study.

An economic evaluation represents a key component to determine an intervention's cost-effectiveness and allow a better understanding of the investment needed to improve specific health outcomes in nurses. This approach is pivotal for the scalability of health promotion interventions, from small settings to multisite studies, to community and state level, and eventual translation into policy.

The overall aim of this PhD project is to design, implement and evaluate a workplace intervention, to promote diet and physical activity in nurses, with healthy diet and increased physical activity being the main outcomes. Moreover, by using a framework that combines intervention design based on the target group's needs/characteristics and process evaluation, it will be possible to understand which factors facilitate intervention's inputs and outputs. This will provide information to other health promoters and stakeholders willing to design similar interventions in this workforce. If effective, this intervention could have the potential to be easily applied to other health care facilities and/or similar workforces.

SECTION 1
RESEARCH FRAMEWORK

The aim of this thesis was to design, implement and evaluate a workplace intervention to promote diet and physical activity in nurses using the Intervention Mapping framework as a guide.

The ***main outcome*** measures included:

- Physical activity behaviour, as increased time spent in moderate intensity physical activity per week, and reduced time spent in sedentary behaviours.
- Diet quality, as improved Australia Eating Survey and Australian Recommended Foods scores (ARFS).

Given the nature of the intervention program, we also measured other ***secondary outcomes,*** involving CVD risk factors, such as:

- Body weight
- Blood Pressure
- Waist circumference

This workplace diet and physical activity intervention was developed using the Intervention Mapping process as a guide.[49] IM proposes a systematic way to proceed from knowledge to intervention methods and strategies, through the production of intervention matrices.[49] This approach focuses on the search and promotion of determinants for the required behaviour change, instead of predictors of present behaviour. It includes several advantages, such as:

- Theoretical framework selection based on the population characteristics (not chosen *a priori* by personal preferences or trend)
- Intervention tailored to target group preferences (improves adoption and effectiveness, desirable in a hard-to-reach population like nurses)
- Described to be effective in particular for diet and physical activity behaviour change [18]

- Successfully applied in previous workplace interventions, achieving significant effects on older workers' diet and physical activity behaviours, and need for recovery.[42] Moreover, is has also shown to be a feasible way to reduce sedentary behaviours at work [50]
- Evidence-based approach (e.g. methods, materials, evaluation)

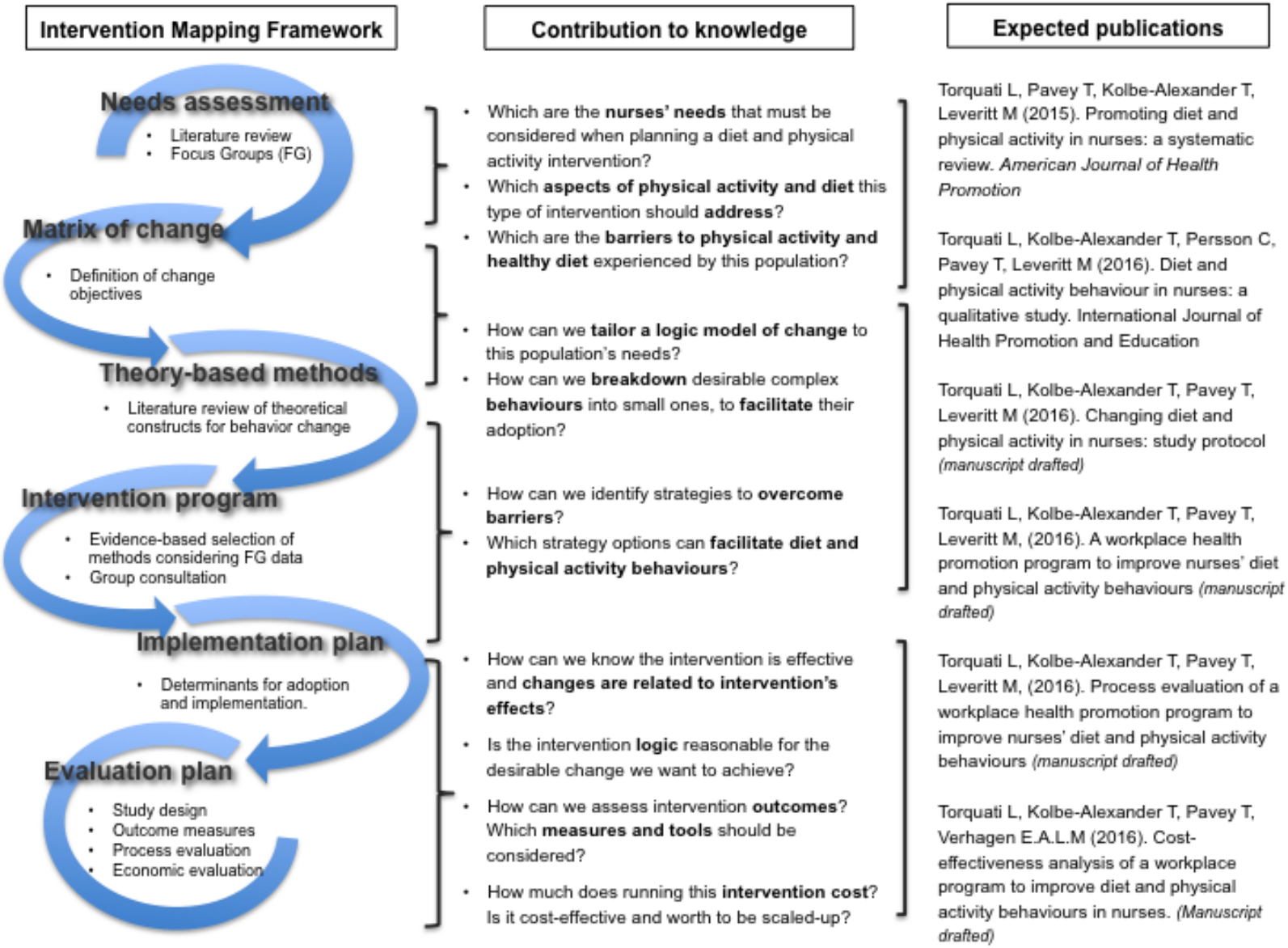
The IM framework contains 6 steps that map the whole intervention development and planning, [51] as shown below. These steps mapped the progression of my PhD candidature and expected publications (*see* Figure 2.1)

1) Conduct a Needs Assessment
2) Create matrices of change objectives
3) Select theory-based intervention methods and practical applications
4) Organize methods and applications into an intervention program
5) Plan for adoption, implementation and sustainability of the intervention
6) Generate an evaluation plan

These steps mapped the structure of this thesis, providing a comprehensive outline of research questions linked to each study. The research outline is summarised in Figure 2.1, which describes the progress of the thesis and how each study/chapter provides answers that contribute to the body of knowledge. This figure also shows the systematic progress towards achieving the overall aim of this thesis.

Using the Intervention Mapping framework provided a rigorous approach to move from knowledge to practice, showing how the literature and target group informed each step of the intervention development and implementation. It also provided a clear methodology to evaluate the whole process and intervention outcomes, and how these fit with the goals set at the beginning.

Figure S1.1 – Research framework



CHAPTER 2
LITERATURE REVIEW

Preface

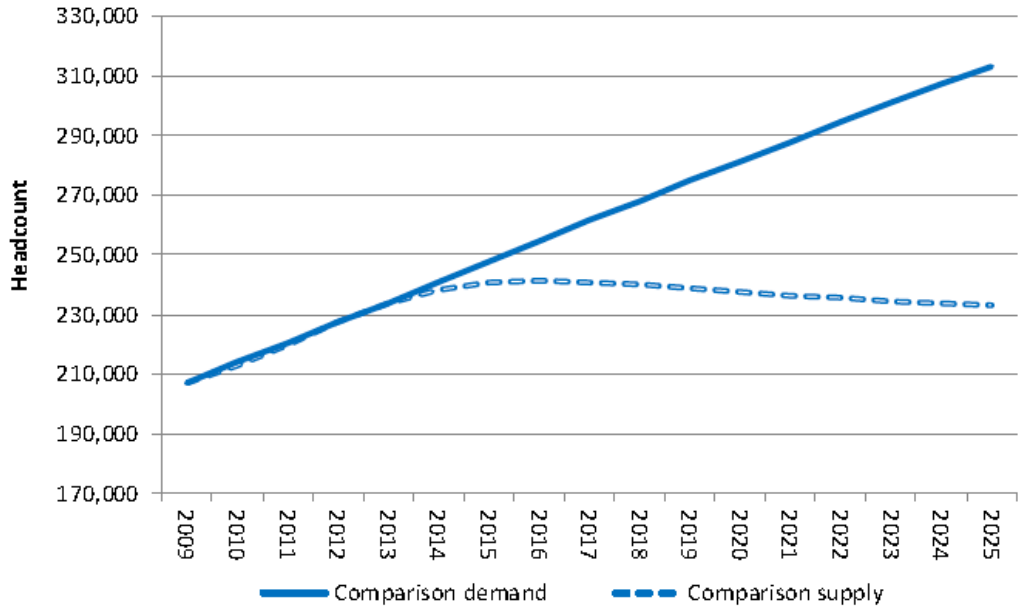
The interplay between lifestyle behaviours, the environment and health outcomes have long been studied and described in the scientific literature, dating as far back as Hippocrates in the Ancient Greece.[52] While genetics and the environment are significant contributors to health and disease, there is a large body of evidence supporting the role of physical inactivity and unhealthy diet as predictors of morbidity and mortality.[53, 54] Yet, we still need to better understand how to successfully improve population's diet and physical activity behaviours in a sustainable way.

For the purpose of this thesis, the Literature Review will focus on providing an appropriate background of the rationale behind the research project and thesis conception. The review will focus on the target population, lifestyle behaviours and determinants, and the role of the workplace as an avenue to promote diet, physical activity, and health.

2.1 NURSES

The Health Care Industry is the biggest employer of Australia, with nurses being the largest group of all health professionals in Australia, accounting for 52% of the total health workforce (~300,000 nurses).[19] As the incidence of non-communicable diseases have increased in recent years, which require long-term care, the demand of health care services, workers (nurses) and costs has increased as well.[26, 55] In a case-modelling scenario, the gap between the demand of service and supply of nurses has been estimated to be -88,000 hospital nurses by 2025.[56] The demand for health care services has been projected to increase in the next years given the current and projected rates of non-communicable diseases incidence. In the same time frame, the nursing workforce has been predicted to decrease in most cases because of low retention (*see* Figure 2.1).[56, 57]

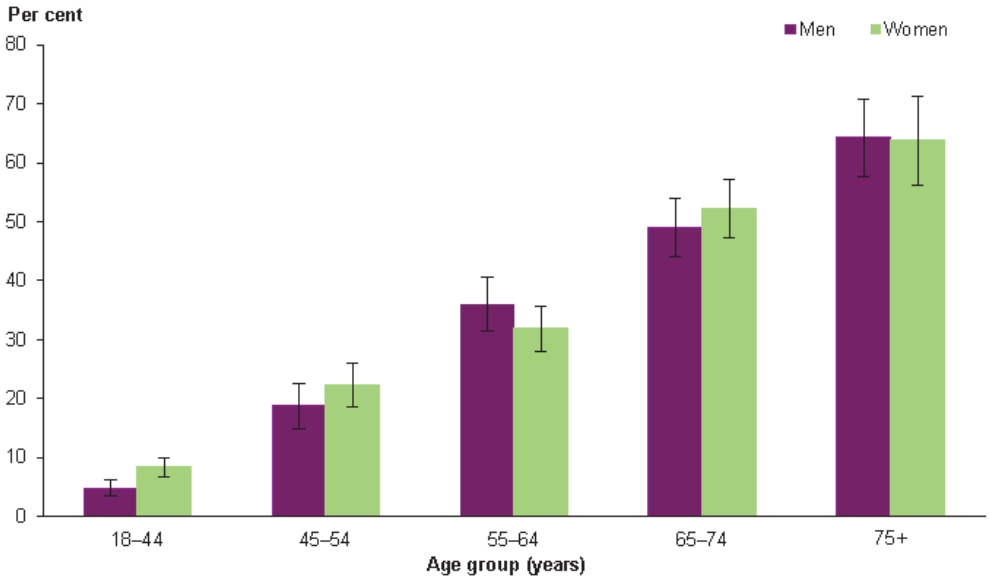
Figure 2.1 – Comparison supply and demand projections, registered nurses, 2009 to 2025



From Health Workforce Australia [57]

To understand appropriate workforce planning and correctly address the supply/demand for these workers, a recent e-cohort study including nurses and midwives from Australia, New Zealand and England has been undertaken.[24] Authors explained that low nursing retention due to high rates of turnover and early retirement are common in this workforce.[24] As a result, the nursing workforce in Australia is ageing, as the average nurse is 43.5 years old, and more than half of nurses are over 40 years old.[24] Compared to the 15% of general population workforce being over 50 years of age, 28% of nurses are over the age of 50.[24, 58] Age is a recognised risk factor for NCDs, such as coronary heart disease and Type 2 Diabetes (T2D), which affect quality of life and lead to increased disability. In Australia the prevalence of cardiovascular disease in people aged 50 years and over is more than 50% (see Figure 2.2) Moreover, these conditions challenge nurses' productivity at work and retention rates, which will negatively affect health care delivery.[26]

Figure 2.2 - Prevalence of Cardiovascular Disease (CVD) in Australia by age groups



From Australian Institute of Health and Welfare [5]

2.2 BURDEN OF DISEASE AND HEALTH BEHAVIOURS

Non-communicable diseases (NCDs) are the leading cause of death globally.[59] In Australia, NCDs contributed to 85% of total burden of disease, with CVD being the leading cause of death, accounting for almost 20,000 deaths in 2013 alone.[60] Type 2 Diabetes (T2D), another NCDs, has increased since 1998 with nearly one million Australians reporting having this condition in 2013.[5] NCDs require long-term care and thus have a negative impact on the quality of life, which means individuals might have to live with and treat these conditions for decades. Because NCDs are the major causes of disability and loss of productivity in Australia [61], they have a considerable economic impact on health and welfare systems. In 2008-09, 36% of total Australian Health expenditure budget, or $27 billion, was allocated to cover direct-costs of only four major chronic diseases (cardiovascular disease, oral health, mental disorders, musculoskeletal). [61]

Non-communicable disease are the result of the interaction of genetic, biomedical and lifestyle factors[62]. Biomedical factors include, for instance, high-blood pressure (hypertension), altered lipid profile (dyslipidaemia) and impaired glucose tolerance or insulin resistance. These factors are common to major NCDs such as T2D and CVD (stroke, heart failure, coronary heart disease). High blood pressure is the strongest predictor of CVD events and is critical for the development of T2D complications (i.e.

chronic kidney disease, retinopathy) [7]. It is responsible for more deaths and disease than any other health risk factor, accounting for 20% of health loss in adults >70 years old and 1 in 5 deaths in US alone. [63, 64]

While biomedical factors may be determined by genetics, they can be modulated by lifestyle factors.[3, 4] Because the latter depends on individuals' choices, these are considered modifiable factors and include tobacco, alcohol, diet, physical activity, and obesity. [63] It has been estimated that tackling six major behavioural and biomedical factors could reduce the probability of premature death by 33% from CVDs, 12% from lung cancer and 5% from T2D by 2025.[59] These factors included reduced alcohol intake, smoking, salt intake, high-blood pressure and glucose.[59] On the other hand, not addressing lifestyle risk factors can lead to increased morbidity and mortality.[63] Dietary risk factors and physical inactivity collectively accounted for 10·0% (95% UI 9·2-10·8) of years lost to ill health (DALY- Disability Adjusted Life Years) in 2010 alone.[63] The role of poor diet and physical inactivity in the development of major NCDs in Australia are shown in Table 2.1.

Table 2.1 – Behavioural risk factors for major non-communicable diseases in Australia.

	Behavioural risk factors			
Conditions	Poor diet	Physical inactivity	Smoking	Alcohol consumption
Ischaemic heart disease	✓	✓	✓	
Stroke	✓	✓	✓	✓
T2D	✓	✓	✓	
Kidney disease	✓	✓	✓	
Arthritis		✓	✓	
Osteoporosis	✓	✓	✓	✓
Lung Cancer			✓	
Colorectal cancer	✓	✓		✓
COPD*			✓	
Asthma			✓	
Depression		✓		✓
Oral health	✓		✓	

***** *Chronic Obstructive Pulmonary disease*

Adapted from Australian Institute of Health and Welfare [5]

2.2 DIET

Diet is a key determinant for morbidity and mortality, with healthy eating alone being able to reduce mortality by 20% (HR 0.83; CI 0.75, 0.91).[2] On the other hand, low fruit consumption alone was associated with 4.2% of DALYs globally,[63] while unhealthy diet accounted for 11% of total burden of disease in Australia.[61]

2.2.1 Nutrients and health

Diet is not only an independent risk factor for disease and mortality, but it has long been studied for the role of nutrients in modulating biomedical risk factors for NCDs, such as high blood pressure, insulin resistance, dyslipidaemia.[8, 65] Examples of this interaction include high salt intake and hypertension; foods rich in cholesterol and trans-fat associated with dyslipidaemia, high sugar and glycaemic load responsible of increased body weight and insulin resistance.[11, 66-68]

In a recent systematic review, a comparison between 44 intervention trials with 52 controls shows how diet modification had a small but significant reduction in some CVD risk factors, such as total cholesterol (-0.15 mmol/l ,95% CI 0.06 to 0.23), LDL (0.16 mmol/l, 95% CI 0.08 to 0.24), blood pressure (- 2.61 mmHg systolic, 95% CI 1.31-3.91; -1.45 mmHg diastolic, 95% CI 0.68-2.22) and 24-hour sodium excretion (- 40.9 mmol/l , 95% CI 25.3-56.5), after 3-24 months.[65] Two of the intervention trials presented longitudinal data (10 and 15 years follow up), which indicated that sodium restriction could probably lead to a reduction in cardiovascular events (combined fatal plus non-fatal events) and revascularisation (HR 0.59, 95% CI 0.33- 1.08, and 0.81, 95% CI 0.59- 1.12, respectively).[65]

Other studies, such as The Nurses' Health Study, have looked into the role of saturated fats, carbohydrates and fibre on health outcomes.[3, 66, 69, 70] Observational data from this study showed that an increase of 5% in energy intake from saturated fat was associated with a 17% increase in the risk of coronary disease. Instead, substituting 5% energy with unsaturated or 2% of non-hydrogenated fats was associated with a 42% and 53%, reduction in risk.[70] These findings provided evidence to shift from previous recommendations on reducing total fat intake [71] to focus on the quality of the fat consumed

by replacing saturated and trans-fats with non-hydrogenated unsaturated fats.[72] A more recent study with longer follow-up (20 years), confirmed the distinct role of these two types of fat with polyunsaturated fat intake being inversely related to CHD risk.[66]

Another important health promoting nutrient is fibre, which is present at variable concentrations in foods of vegetable origin (i.e. fruit, vegetables, nuts, grains and their derivate products). Diets high in fibre have been associated with a 25% decreased mortality and morbidity (HR 0.76; 95% CI: 0.72, 0.80) [73], with a 10 g of daily fibre intake associated with a 17% reduction coronary heart disease mortality (95% CI: 2%, 30%). Short-chain fatty acids, produced when fibre is fermented in the intestine, have also shown a protective action towards cancer by reducing the risk for colorectal cancer (OR=0.66, 95%CI= 0.45-0.96),[74] ovarian cancer (OR = 0.81, 95% CI = 0.67–0.98),[75] and gastric cancers (OR= 0.75, 95% CI= 0.63–0.90).[76] Whole grains and fruit intake (whole grains, fruit, nuts, and green leafy vegetables) were inversely associated with CRP, IL-6, homocysteine ($p \leq 0.001$), and sICAM-1 ($p= 0.034$), which are biomarkers of endothelial inflammation, a key risk factor for CVD.[77]

While the effects of nutrients on biomedical risk factors has been well documented, such effect in in vivo or real world settings may be different. During digestion, nutrients in food can interact and influence each other's bioavailability and absorption, making difficult to assign a particular effect for specific isolated nutrient.[78] Because we do not eat single isolated nutrients, but whole foods and more types of foods, diet health outcomes are to be associated to dietary patterns, or the combinations of foods we eat.[79]

2.2.2 Dietary patterns and health outcomes

The role of single nutrients on health outcomes has been widely described in the literature; however, since evidence comes from epidemiological data, results can be influenced by interaction with other nutrients/foods in the diet, risk factors or data collection methods.[74, 80] Because this is the main limitation for interpreting evidence, the study of 'dietary patterns' is a more realistic approach to describe the interaction between diet, health and disease.[81]

The Nurses Health Study was one of the first cohort studies to investigate the associations of “prudent” vs “western” dietary patterns on plasma biomarkers and NCD risk.[82,83] These patterns were defined based on the types of food most frequently consumed by individuals, with a high intake of vegetables, fruit, legumes, whole grains, and fish and other seafood, constituted a “Prudent” dietary pattern. On the other hand, a “Western” dietary pattern, was characterised by a high intake of high-fat dairy products and butter, processed foods, red meat, eggs, and refined grains.[83]

The “western” pattern was significantly correlated with increased insulin, C-peptide, leptin, and homocysteine (markers of CVD risk) and low folate concentration (indicating increased risk).[83] On the other hand, lower insulin and homocysteine, and higher folate concentrations, were correlated with “prudent” pattern.[83] These results indicated how combinations of foods, rather than single nutrients, have a pooled effect on modulating biomedical factors and thus influencing the onset of obesity and CVD.

Similar dietary patterns have been described to reduce CVD risk by a recent Cochrane review on dietary advice.[65] A “prudent” pattern seemed to be strongly associated with reduced endothelial dysfunction (e.g. first step towards atherosclerosis), with a positive effect on other chronic conditions such as obesity, hypertension, T2D and some cancers.[65, 78, 82-84] Other dietary patterns that have been associated with health outcomes include the Mediterranean Diet [85] and more recently the Nordic Healthy diet.[86, 87] Pooled results from cohort studies that analysed the adherence to the Mediterranean Diet found a positive association with reduced over-all mortality (RR= 0.91; 95%CI=0.89;0.94), CVD mortality (RR=0.91, CI=0.87;0.95), cancer incidence (RR=0.94, 0.92 to 0.96), and mortality and Alzheimer’s Disease incidence (RR=0.87, 0.80 to 0.96).[88] Similarly, reduced over-all mortality (RR= 0.96 (0.92–0.99), and a reduction in colon cancer incidence (IRR, 0·65; 95 % CI 0·46, 0·94) was found in individuals that adhere with the Nordic Healthy Diet.[89, 90] A summary of these and other dietary patterns that have been described in the literature are presented in Table 2.2.

Table 2.2 – Major dietary patterns associated with health benefits

	Mediterranean Diet[91]	**Nordic Diet** [86]	**Prudent Pattern**[83]	**Japanese**[92]
Geographic Region / **Key Components**	Mediterranean (Italy, Spain, Greece)	Scandinavian (Denmark, Sweden, Finland)	North American (USA)	Asian (Japan)
Vegetable	✓	✓	✓ Legumes	✓ Soy, Seaweed Mushrooms
Fruit	✓	✓ Berries	✓	✓
Whole grains	✓	✓	✓	✓ Rice
Alcohol	✓ Wine	↓	N/A	N/A
Low-fat milk/dairy	✓	✓	✓	↓
Meat/meat product	↓	↓	✗	↓
Dietary oil	✓ Extra-virgin olive	✓ Rapeseed	N/A	N/A
Recommended ratio PUFA, MUFA, SFA*	✓	✓	N/A	✓
Fish consumption	✓	✓ Local	✓	✓ Including raw

**** PUFA** Polyunsaturated fatty acids**; MUFA** Monounsaturated fatty acids; **SFA** Saturated fatty acids ✓ Positive association with pattern/consumption recommended; ↓ reduction on food group recommended; ✗ Food group excluded by pattern; **N/A** food group not addressed or considered by the pattern*.

2.2.3 Diet quality

Diet can be analysed, as previously described, by defining patterns based on the type and frequency specific foods and group of foods are consumed. These can be analysed with diet quality indexes, as a direct quantitative assessment to explore the association between diet and health outcomes.[93] Understanding dietary patterns and the food categories considered to be healthy (i.e. fruit, vegetables, whole grains, fish) is important to inform national dietary guidelines and promote their intake in the population.[94, 95]

In the study of Hu and colleagues,[83] diet quality was assessed using factor analysis. Diet data from Food Frequency Questionnaires (FFQ) and dietary records were extracted, and standard portion sizes were converted into a daily intake number, based on the frequency of the weekly intake of that food. For example 1 serving/week was converted to 0.14 servings/day (number of servings divided by seven days). Later, factor analysis was used to define patterns based on 40 food categories obtained from the two dietary assessment tools. In this approach scores were assigned to independent variables in a correlation matrix, in which the bigger the loading factor of a given food item or group, the

greater its contribution to the defined pattern. Thus, an individual's diet was classified based how close it fit to each of the two patterns. A strong point of using this methodology is that one can summarise many variables in a small number of behaviour categories.[79] However, the factor analysis approach could overestimate the correlation between foods, and thus distort the definition of the pattern.[81] Because the serving size and frequency of foods that constitute the patterns are not directly reported, it is difficult to directly assess and interpret diet quality.

Another approach used to analyse diet quality is to use a diet quality index, in which diet components receive a score based on how representative they are of a healthy diet.[96] Most diet quality indexes are based on food groups and nutrients, such as HEI (Healthy Eating Index) [97] and DQI (Dietary Quality Index);[98] while others are based on nutrients only like the HFI (Healthy Food Index).[99] For example, the 2005 Healthy Eating Index (HEI-2005) was used to compare health outcomes between the lowest and highest quartile of diet quality. Results showed that people in the 4th quartile (higher scores) were less likely to be overweight or obese (34%), and less likely to have elevated waist circumference (35%), blood pressure (26%) or metabolic syndrome (35%), and more likely to have higher HDL-cholesterol concentrations (21%).[100] From the original DQI and HEI, many other versions have been developed differing mainly in the scores given to foods, group of foods, and version of dietary guidelines.[101]

A more accurate and frequent way dietary index tools set their cut-offs is by adapting them to national dietary guidelines. This allows not only to readapt to the guidelines of the country where the sample is taken from, but also to have a more health-related scoring, since guidelines are usually developed with a strong evidence-based process. Meeting national dietary guidelines has been previously associated with decrease overall mortality,[93, 102] cancer mortality among men,[103] and inversely associated with CVD risk factors,[100] waist-to-hip ratio, and systolic blood pressure (men only).[104]

However, because the majority of the quality index studies used American guidelines, most tools needed to be readapted to assess diet quality and health outcomes in other countries or regions. For this reason, the Australian Institute of Health and Welfare (AIHW) developed the Aust-HEI (Australian Healthy Eating Index), based on previous DQI and HEI, and using data from the National Nutrition Survey 1995, Food Frequency Questionnaire (FFQ) and short dietary questions (SDQ).[96] Aust-HEI consists in 7

categories, which have previously been described as related to chronic disease risk, and hence have been weighted equally. Categories were based on the Dietary guidelines for Australian adults,[96] and are shown in Table 2.3

Aust-HEI was evaluated for internal consistency and construct validity, with individuals who scored low in any component also scored low in others, meaning that the overall score gives a balanced representation of the three health-related key elements.[96] The Australian Institute of Health and Welfare recommended further modification of this index to better represent current food choices and guidelines, which leaded to several modified versions with different scoring and categories. Some of these include the Australian Recommended Food score (ARFS),[105] the Dietary Guideline Index (DGI),[104] the Aussi-DQI,[103] and the Dietary Guidelines Index (DGI-2013).[106] Main differences from the Aust-HEI involved different scoring and number of food categories and sub-groups. Higher scores in these indexes were generally associated with lower energy, total fat and saturated fat intake, and higher intake of fibre.

The Australian Recommended Food score has been recently validated with a sample of Australian adults [107, 108]. The calculation in this score was based on regular consumption of FFQ items that were in line with the most recent Australian dietary guidelines.[109] The method included a seven sub-scales with scores ranging from 0–74. The sub-scale scores were calculated from food groups with one point awarded for each item reported as being consumed at least once a week. Food groups and scores included: a) vegetables – 22 points; b) fruit – 14 points; c) protein foods – 14 points; d) grains – 14 points; e) dairy – seven points; f) fats – one point and alcoholic beverages –two points.[108] The maximum score is 74, reflecting the healthiest or most optimal diet quality score. Previous studies that used this tool described better self-reported health status, higher intakes of key nutrients, and lower intakes of total fat and saturated fat in subjects among the highest quintile of Australian Recommended Food score (ARFS), compared to those in the lowest quintile.[110] Therefore, ARFS described nutrition's impact on health based on dietary patterns rather than on single nutrients intake. Such characteristic is particularly appealing for intervention studies, where changes in dietary patterns and food groups can be assessed and linked to health outcomes.

Most health promotion interventions use short questionnaires to assess dietary outcomes, which often focuses only on fruit and vegetable intake.[111] While this approach has been widely used to assess changes in dietary outcomes after intervention, it does not provide accurate information regarding diet quality, which plays a more important role on health outcomes.[93, 100] Instead, using a dietary quality score to assess changes in diet quality after an intervention may represent a desirable and practical approach. In addition, dietary data can be gathered through validated tools such as food frequency questionnaires. These can increased the rigour of the study and minimise burden on participants at a relatively low cost. Because of its recent validation, good reliability, and moderate cost, the Australian Eating Survey represents a good fit for intervention studies.[107, 108] It provides information both on single foods and food groups' intake, and calculates diet quality score (ARF score) from these, which are useful to assess changes in diet quality. Finally, this tool has been used in previous intervention studies and effectively assessed changes after 3-month and 6-month.[112-114].

Table 2.3 – The Aust-HEI categories and scores

Component	Criterion for maximum score	Minimum score	Maximum score	Data source
Measure of variety	Total number of foods from each food group usually eaten at least once per week	0 (none)	10	FFQ
Measure of "healthy choices" *	All "healthy choice" foods usually eaten at least once per week	0 (none)	10	FFQ
Fruit consumption	Two or more serves per day	0 (none)	10	SDQ
Vegetable consumption	Four or more serves per day	0 (none)	10	SDQ
Low-fat milk chosen	Low-fat or skim milk	0 (no)	5	SDQ
Trim fat off meat	Usually (or do not eat meat)	0 (no)	5	SDQ
High saturated fat, low nutrient density foods	Total number of foods eaten once per week or more	0	10 (none)	FFQ
	TOTAL	**0**	**60**	

** Based on the recommended foods score of Kant et al., 2000. "Healthy choices" have been described in the National Nutrition Survey FFQ 1995, and include foods such as wholemeal bread, muesli, porridge, rice, pasta, zucchini, capsicum, sweet corn, mushroom, tomato, lettuce, celery, onion, soybeans, baked beans, lentils, fish and seafood;* ***FFQ*** *Food Frequency Questionnaire;* ***SDQ*** *short dietary question*

Adapted from Australian Institute of Health and Welfare [96]

2.3 PHYSICAL ACTIVITY

Physical activity (PA) is an independent factor for mortality and morbidity, with physical inactivity causing 6-10% of major NCDs, and 9% of total deaths.[4,115] It has been estimated that inactivity increases mortality risk by 30%, and reducing this factors by only 10% could prevent more than 500,000 deaths a year.[4] Because PA plays the main role in increasing energy expenditure, it is inversely associated with excess fat and obesity and thus with NCDs risk.[116] Regular physical activity and exercise can improve cardiovascular fitness, which is a stronger determinant of morbidity and mortality compared to obesity and excess weight.[115] Promotion of PA has gained interest particularly in Australia, given its positive effects on most conditions listed as national health priorities, such as obesity, CVD, T2D, mental health and musculoskeletal problems.[117]

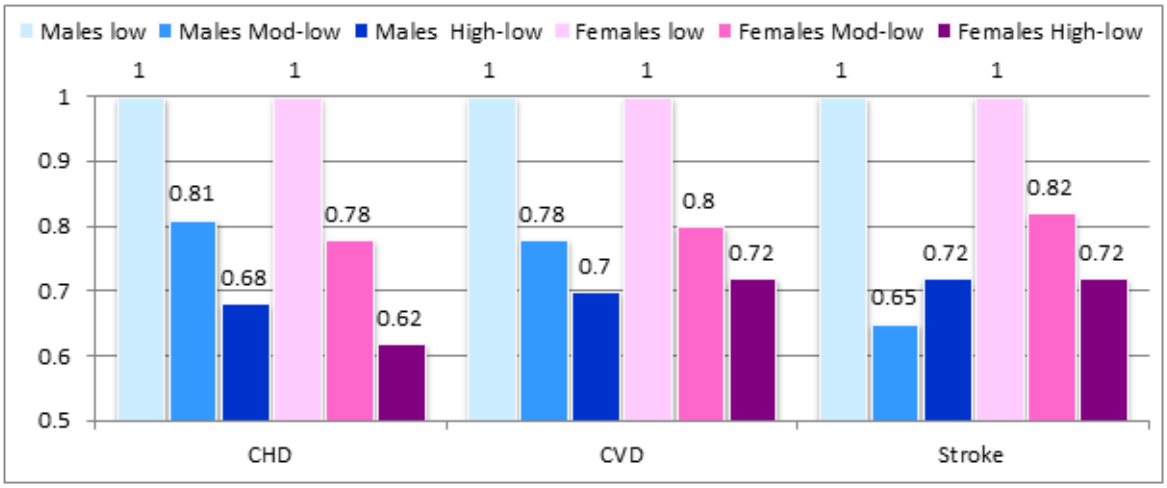
Physical activity modulates biomedical risk factors for CVD, which include reducing blood pressure, improving lipid profile, decelerating atherosclerosis, ameliorating endothelial dysfunction, reducing systemic inflammation, and improving insulin sensitivity.[118] Particularly in women, studies suggest that physical activity is inversely related to the risk of coronary events, in a dose dependent manner. When compared to women in the lowest quintile group for physical activity, those in higher quintile groups had a declined relative risks for coronary events: 0.77, 0.65, 0.54, and 0.46 (p-value for trend <0.001), respectively.[119] In another study nurses who walked three hours per week (moderate intensity) had a 35% reduction in their risk of stroke and CHD, with risk decreasing as the intensity and frequency/week increased.[120] Although both these studies were cohort prospective studies and thus the association between cause and effect cannot be proven, other studies have described similar dose-response trends.[121]

A meta-analysis comprising 30 studies assessing the physical activity dose and CVD risk reduction reported a decrease in relative risk (RR) for CHD as the level of physical activity increases, from sedentary to very active (0.78, 0.53, 0.61, p<0.0001, respectively). Same trend was observed for stroke 0.73 to 0.68, p <0.0001, and overall CVD RR= 0.82, 0.78, p<0.0001. When studies were combined by absolute walking amount, one hour of walking per week was associated with reduced risk for all CHD, stroke, and overall CVD (CHD: RR=0.60, CI=0.39–0.94, stroke: RR=0.78, CI=0.56–1.08; overall CVD: RR=0.80, CI=0.74–0.87). While these results could be the aggregate effect of more studies, it is

clear that regardless of the specific dose, there is dose-dependent trend of physical activity's impact on health.[121]

Physical activity can also improve health in populations with already a chronic condition.[122, 123] In a group of 30,000 men and women diagnosed with metabolic syndrome, physical activity appeared to have an impact on all-cause mortality and CVD.[122] After a 10-year follow-up, adults 65 years old or older who engaged into physical activity for at least 3 hours/week had 40% to 48% risk reduction for CVD and all-cause mortality, respectively.[122] Even at lower doses, adults who were diagnosed with CVD reported benefits when engaging in three or more weekly sessions of moderate to vigorous physical activity (all-cause mortality HR = 0.52, 95% CI = 0.37–0.74; CVD death HR = 0.61, 95% CI = 0.38–0.98).[123] After adjusting data for medication among other factors, 12.8% and 15.4% of the risk reduction was attributed to the effect of physical activity on metabolic and inflammatory factors (e.g. CRP and HDL/cholesterol ratio).[123]

Figure 2.3 – Levels of physical activity and risk of coronary heart disease (CHD), cardiovascular disease (CVD) and stroke in males and females



From Brown *et al*. [33]

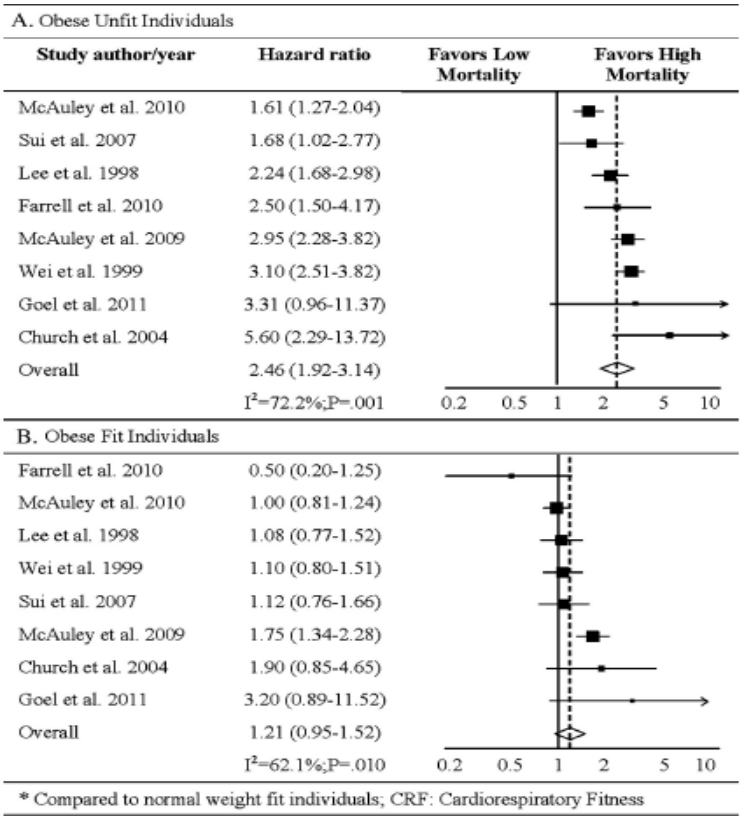
Further, several intervention studies explored and confirmed the associations between PA and health outcomes. Lifestyle interventions promoting PA and targeted to T2D patients showed positive effects, with 6% weight loss reduction, −5.33 mmHg (C.I.−5.80 to −4.86) systolic blood pressure, and −25.56 (C.I. −27.91 to −23.21) mg/dL triglycerides [124]. Fitness was independently associated to these biomarkers, contributing to additional improvements in blood glucose (+0.7%), HbA1c (+1.1%)[125]. Seemingly, other studies

reported a 58% reduction in T2D incidence.[126, 127] In particular, Knowler and colleagues [126] showed that lifestyle intervention is more efficient than Metformin, a drug used to lower blood glucose levels, which reduced the diabetes incidence only by 31%.

The Chinese Da Qing study is one of the first studies that assessed the effects of physical activity alone, showing a 25% reduction in the incidence of T2D [128]. The results of this study also revealed that health effects of exercise prevailed even in the absence of weight loss, but the incidence reduction was enhanced in the diet and exercise group. Data showed a 13.8% reduction in all-cause mortality, 11% cardiovascular mortality, and 19.2% diabetes incidence in the intervention group compared with controls at the 23-year follow-up.[129] A more recent meta-analysis supports the health benefits exercise, as improved cardiovascular fitness showed reduced morbidity and mortality regardless of excess weight.[115] This study showed that obese individuals who were physically active had reduced risk for morbidity and mortality compared to their unfit counterparts (*see* Figure 2.4).

Mental health is another area where physical activity has gained interest, as it can modulate neurotransmitters such as norepinephrine, dopamine, and serotonin, activate serotonergic system, and regulate endocrine response to stress.[130] These biochemical effects are also accompanied by physical changes, such as enhance blood flow to brain areas regulating emotions.[130]. Physical activity is associated with a decreased risk of developing mental disorders, depression, and anxiety in healthy populations.[131-134] These health benefits were also observed in people with mental illness, with a meta-analysis showing a large positive effect (*d*=0.80) of physical activity on depressive symptoms.[135] This effect did not significantly change when authors adjusted for individuals meeting the recommended volume of weekly physical activity (>150min, ACSM).[135, 136] Potential psychological mechanisms that could explain these relationships include changes in health attitudes and behaviours, shift of external to more internal locus of control, improved coping strategies, or simply distraction.[133]

Figure 2.4 – Meta-analysis of all-cause mortality in obese unfit and fit individuals



From Barry *et al.* [115]

2.3.1 Physical activity assessment

Physical activity can be measured in different ways, in order to monitor the trends and behaviours within populations, make cross-sectional comparisons or to measure the effects of an intervention. To assess physical activity behaviours one can use two types of tools, namely self-report or objective measures [137].

Self-report measures include questionnaires, activity diaries and recall interviews [137]. Self-report measures are widely implemented in large studies because of their low cost. Questionnaires in particular, represent a relative inexpensive way to estimate physical activity levels, and time spent in activities at different intensity in both epidemiological studies and national surveys [138]. Also, with this data respondents can be classified into activity categories (for example, meeting or not meeting PA guidelines), which is a useful approach when studying relationships between physical activity and health. Questionnaires commonly used in these fields include the 'International Physical Activity Questionnaire' (IPAQ) [139], and the 'Active Australia' survey in Australia [140, 141].

However, limitations on the use of self-reported measures remain, including social desirability when individuals do not report real data, as they feel they have to meet social expectations. [137, 138]. Other limitations are incomplete data because of inaccurate completion, or under/over estimation because of recall bias when individuals do not remember amount or frequency of physical activity [137, 138]. Surveys are not recommended when assessing young children, older adults or individuals with impaired mental conditions that can limit the ability to recall activities [142].

Objective measures, instead, are not biased by individuals' trustworthiness or memory, as they assess physical activity based on real body movement and/or physiological responses to it.[138] Thus, they either measure energy expenditure (e.g. calorimetry, doubly labelled water, heart rate), or acceleration of the body (e.g. accelerometer or pedometer counts).[138] Accelerometers and pedometers use motion to measure activity in one or several planes of movement, and are often used to reflect the habitual physical activity of an individual. Hence, they are frequently adopted to assess the effectiveness of interventions aimed to improve physical activity behaviours [143]. Also, they are more reliable than self-report measures, since they give a more precise measure of physical activity. However, pedometers cannot be used to measure intensity, duration, and frequency of activities as they are only able to steps accumulated during ambulatory activities like walking and running.[143] Thus, they are commonly used in interventions as a practical and motivational tool to increase steps in the target group.[144, 145]

On the other hand, accelerometers are able to collect data on duration, frequency, patterns, and intensity of physical activity over days. Therefore, accelerometers are considered a better instrument to assess actual changes on physical activity behaviours [137]. Some limitations with this tool include inability to measure aquatic activities, to provide context or type of activity performed, and higher costs than pedometers [137, 138]. Yet, accelerometers represent a good method to assess changes in physical activity interventions, because of their good compromise between cost and accuracy [146]. In addition, they eliminate participants' reporting bias, which are inevitable in physical activity surveys and could represent a confounding factor for the intervention effect.

With the advance of technology, mobile technology and smart devices are growing in popularity as they can easily track physical activity and provide real-time feedback to the user [147]. Devices such as wrist activity trackers (e.g. Fitbit) are able to measure heart rate

and have in-built accelerometers that can track energy expenditure, intensity and activity. Most of these smart devices are synchronised to mobile apps that offer researchers the possibility to measure activity in real-world settings, while also promoting physical activity and motivate behaviour change [148]. Most activity tracker that are commercially available have been validated and showed strong validity for step counting and moderate validity for physical activity tracking, with some models being more accurate than others [147, 149]. However, their cost represent a limit if one is to use them in intervention studies with a limited budget.[139]

2.4 DETERMINANTS OF LIFESTYLE BEHAVIOURS

While four major lifestyle behaviours (regular exercise, healthy diet, no smoking, and reduced alcohol consumption) have the ability to reduce morbidity and mortality,[63] population data shows that most people do not adopt these behaviours [61 150]. The implementation of health behaviours, in particular diet and physical activity, is not a straightforward "process".[151] Behaviour implementation is influenced by several determinants including individual, social or interpersonal, and environmental determinants according to the Ecological models of behaviour change [152]. Other determinant models are described by behavioural theories that can guide behaviour change interventions, such as Social-Cognitive Theory, Theory of Planned Behaviour, and Self-Determination Theory[153-155].

At the individual level, health behaviours are determined by different factors such as health knowledge, skills, preferences, and ability to perform the behaviour.[151, 156] Also, habits and affective and emotional states can contribute to health behaviours and their maintenance [157]. On the other hand, determinants that could promote behaviour change include self-efficacy, motivation, self-regulation.[154, 155] Examples of individual determinants include knowing the negative health consequences of fast food consumption could discourage this dietary choice, or having the ability to cycle could determine whether an individual will engage with this type of exercise. However, knowing negative consequences is often not enough to trigger behaviour change. As Self-Determination Theory states, the intention to perform a behaviour (motivation) is a condition for behaviour's implementation.[158] In this case, internal motivation is a key factor to implement or change behaviour. Self Determination Theory can be used to understand the interplay

between intrinsic motivation at personal and individual level, extrinsic motivation from the social environment, and adherence to health behaviours.[159]

Social determinants are those found at the interpersonal level and are described as the influence of the social environment namely friends, peers at work, partner, family and social norms.[152] These provide the individual with information, social support, and social modelling, which can shape individuals' behaviour.[160] Social-support presents different features that include companionship, intimacy, and a "buffering" function that can assist the individual with stress coping, health behaviours and wellbeing.[161] On the other hand, social modelling or peer influence can directly influence self-efficacy towards a behaviour. By observing or hearing about success stories of peers facing similar situations and barriers, individuals are motivated to overcome their own barriers and perform a similar behaviour as their peers.

Environmental factors can include the built environment where individuals live or work, and other factors such as organizational structures and the community.[152] Some environments are complex as they are not limited to objective attributes (i.e. physical and social characteristics), but they also have subjective qualities (i.e. stressful or relaxed environment).[151] At the same time, environments can either undermine or promote a behaviour, such as in the case of neighbourhood walkability and its influence on physical activity behaviour.[162] Another example is whether individuals' ability to make good choices can be influenced by the environmental context where they live or work.[151]

2.4.1 Determinants of health behaviours in nurses

Nurses face strong environmental determinants such as job-related tasks, workload, and physical and psychological stress, all of which could influence their lifestyle behaviours.[163, 164] Job demands and shifts depend on the 24h delivery service and an unpredicted demand.[165, 166] Furthermore, nurses often work irregular and long shifts, with some studies showing that more than 25% of nurses work >12-h shifts.[21] Rotational shifts were established based on the difficulty to find permanent night shift staff and the perception that night only nurses did not keep up with changes in practice.[165] However, night shift limits time for sleep recovery which causes physiological imbalances, increasing the already existent job stress.[167, 168] The deleterious effects of night work and disruption of the circadian rhythm, affects the regulation and modification of food intake as the interpretation of endogenous signals (e.g. from the "body clock", the gut, etc.) and

exogenous signals from the environment are altered.[169] Such disruption leads to a failure in control of food intake, which can result in an energy imbalance, and a higher energy intake resulting in overweight and obesity.[170]

The relationship between night shift and excess weight has been supported by several studies. [169, 171, 172] Nurses who either changed from day shift to night shift or maintained night shift increased their BMI by almost 0.5 units at 2-year follow-up (*see* Table 2.4) However, those who changed from night to day shift showed a decrease of −3.02±5.45 units of BMI during the same period of time.[172] This trend is in line with a larger study (n=107,663), in which a multivariate analysis showed an increase of 0.17 units in BMI (95% CI 0.14–0.19) and a 0.45 kg weight gain (95% CI 0.38–0.53) for every 5-years increase in shift work.[173] Recent evidence suggests not only an association between shift work and body weight, but also with other metabolic risk factors (see Table 2.4).

The prevalence of overweight and obesity in the nursing population ranges from 62-65%.[30, 174] In a large Australian longitudinal study, it was found that 62% of nurses were overweight and obese.[27] This prevalence is much higher than the Australian female population (56%), indicating the nursing population is at higher risk of non-communicable diseases and disability than the general population.[7] Differences in health behaviour and obesity rates are paradoxical given nurses' role as health educators and healthy role models. [29]

Table 2.4 – Evidence for the relationship between shift work and metabolic risk factors

Association between shift work and metabolic risk factors	
Body weight	
- *BMI, body weight, obesity*	✓
- *Waist circumference*	?
Blood glucose	
- *Blood glucose, HbA1c*	?
- *Impaired glucose tolerance*	✓
Blood lipids	
- *Total cholesterol*	?
- *HDL, LDL, triglycerides*	?
- *Hypercholesterolemia*	?
Blood pressure	
- *Systolic and/or diastolic blood pressure*	?
- *Hypertension*	?

✓ Strong evidence; **?** Insufficient evidence

Adapted from [175]

2.4.2 Determinants of diet and physical activity behaviour in nurses

The increased weight in nurses can be attributed not only to night shift, but also to the effects of the environment in their diet and physical activity behaviours. Nurses experience many traumatic events in their workplace such as patient injuries, suffering, death, and, even in some cases, verbal and physical aggression [176]. As a consequence, nurses are at increased risk of anxiety disorder, occurring as a result of experiencing an emotionally traumatic event. This is especially true and more frequent in Emergency, Oncology and Paediatric care [177]. Fear, anger or anxiety, are emotional arousal states that can prompt emotional eating [178]. A cross-sectional survey, showed that 66% of nurses reported abnormal emotional eating, and that those working >4 night shifts/month, were 3 times more likely to exert such behaviour [179]. In addition to emotional eating, irregular meals schedule, frequent high fat and high sugar foods as well as high-energy snacking have been reported in nurses [167, 179, 180]. Other factors contributing to their dietary patterns include habit, time pressure, social factors, and decreased enjoyment of food [181]. Other unhealthy lifestyle behaviours associated with nurses' psychological and physical stress include smoking and increased alcohol consumption [20-23].

Likewise nurses' job characteristics have a negative impact on their physical activity behaviours, in particular for night-shift nurses, who lack of energy to engage in physical activity or to exercise [32]. Studies suggest that almost 50% do not have an active lifestyle and fail to achieve the physical activity guidelines [29-31]. An Australian longitudinal study described the health status of nurses and midwives, and found that only 8.5 % could be classified as having a healthy lifestyle profile [23]. A healthy profile was defined as having adequate intake of fruit and vegetables, low alcohol intake, no smoking, sleeping ≥7.5hours/day, and meeting physical activity guidelines [23]. Thus, nurses' risk for obesity and non-communicable disease is increased because of their diet and physical activity behaviours.

Although there is rich data on nurses' health and risk of disease, to date research on nurses tended to focus on observational rather than interventional studies [24 182, 183]. Observational studies have been focused only on risks linked to nurses' profession, such as injuries and biological, chemical, physical, mechanical, psychosocial and environmental hazards [183]. Other studies focused on the association of nurses' night shift work and increased risk of obesity, alcohol intake, and work related injuries and stress [27 172].

However, no intervention studies aimed to improve nurses' lifestyle behaviours arise from these investigations.

So far, the majority of lifestyle and health promotion interventions in the nursing population focused on improving nurses' working conditions or included them for delivering interventions in primary care, community or workplace settings [46, 47, 184]. There have been a few interventions promoting healthy lifestyle behaviours in nurses, including diet and physical activity.[48] Yet, it is clear that nurses could benefit from such interventions, as promoting these behaviours could limit early onset of chronic disease and disability, and improve absenteeism and productivity [12]. Increasing the quality of life years in nurses could decrease costs in the Public Health sector [185]. Given the negative influences of the work environment in this group, but the potential high reach of this setting, diet and physical activity interventions at the workplace are desirable.

2.5 WORKPLACE HEALTH PROMOTION

Since individuals spend more than a third of their waking hours at work and the majority of the adult population is in the workforce,[186] the potential reach in this setting is considerable. This characteristic was firstly addressed by the International Labour Organization/World Health Organization, in 1950 and later updated in 1955 (WHO, 2002). However, health promotion interventions aimed to improve employee's health through healthy lifestyle behaviours, have increased in number in recent years.[13] Workplace health promotion enhances worker's overall health and productivity, decreasing absenteeism and the incidence of chronic diseases. Thus providing mutual economical and health benefits, for both the employer and the employee, respectively.[13] This is important given the rapid increase of non-communicable diseases in the population, which can potentially lead employers having to pay the cost of employees' morbidity.[13]

There is mixed evidence supporting workplace health promotion efficacy targeting diet and/or physical activity. While there are good quality studies in this field, the majority of the interventions are usually moderate to low quality. Thus, when analysed in systematic reviews and meta-analysis, intervention effects are small providing low to moderate evidence.[14, 15, 17, 187] A summary of these findings is presented on *Table 2.5.*

Studies with strong intervention designs, such as Groeneveld *et al.*[188] implemented professional counselling as a strategy to improve diet and physical activity behaviour. However, after the 6-month intervention there was a significant increase in fruit intake (β=1.7, 95% CI 0.6 - 2.9), but no improvements in physical activity. Another good quality study, implemented a different approach including team competition to encourage exercise, and goal-setting and self-monitoring for both diet and physical activity promotion.[189] In this case, weigh-loss at 10 weeks was significant (-1.9 kg, $p<0.005$), and was maintained at 1-year follow up. Other small, but significant ($p<0.001$) changes included total cholesterol (- 7.7mg/dL), systolic and diastolic blood pressure (-2.6 and -1.9 mmHg, respectively), and waist circumference (-3.6 cm).

Although the two interventions aimed to promote diet and physical activity, effects cannot be easily compared either between them, or to the results of the systematic reviews and meta-analysis, as the outcome measures were clearly different. One study had no information on BMI or body weight outcomes and diet behaviour was limited to fruit intake;[188] while another study had no outcome measure for diet quality or physical activity, but did have body weight and health related outcomes (CVD risk).[189]

Thus, it is evident that difficulties arise when interpreting results and calculating intervention effects because of heterogeneity of studies, physical activity and diet assessment (self-report), and different primary outcomes.[14, 15] Systematic reviews and meta-analysis of interventions targeting physical activity only showed a small significant effect on physical activity behaviour, fitness, work related outcomes (e.g. job stress, absenteeism), and some anthropometric measures (e.g. BMI, fat percentage, body weight).[14, 15] Instead, there is moderate evidence for the effects of diet and physical activity interventions on body weight.[17] As previously explained, many studies of this effect size were penalised by the quality of the reviewed studies.

Table 2.5 – Workplace diet and physical activity interventions effect

Study	Number of studies/ pooled participants	Length of studies	Type of interventions	Results*
Conn *et* al., 2009 [14] Meta-analysis, Physical activity only	138 Studies n= 38,231	5 weeks - 12 years	• Organizational-level policy - Free/reduced memberships to fitness centres - Fitness facilities at the worksite • Employees designed interventions. • Supervised exercise • Motivational/educational sessions	• Physical activity, d= 0.21 • Fitness, d= 0.57 • Anthropometric measures, d=0.08 • Work attendance, d= 0.19 • Job stress, d= 0.33 • Difference of + 3.5 VO2max, impact -0.2 Cholesterol/HDL ratio, -12.6mg/dl fasting glucose
Verweij *et al*., 2011 [17] Meta-analysis, *Diet and physical activity*	22 studies n= ~46,320	5 weeks – 6 years	• Health Risk Assessment • Educational module • Exercise program • Environmental component	• Body weight (-1.19 kg, 95% CI -1.64 to -0.74), • BMI (-0.34 unit, 95% CI -0.46 to -0.22) • Body fat, sum of skin-folds (-1.12%, 95% CI -1.86 to -0.38) • Environmental component showed larger weight reduction
Hutchinson & Wilson, 2012 [187] *Meta-analysis*, *Diet and physical activity*	31 studies n= 12,411	9 ~18 months	• Education • Cognitive-behavioural • Motivation enhancement • Social influence • Exercise	• Social influence *d*=0.62 for weight loss • Education based interventions *d*=0.69 for cholesterol • Motivational enhancement: *d*=1.66 for cholesterol, *d*=2.00 for physical activity.
To *et* al., 2013 [15] *Systematic review, Physical activity only*	20 studies n= 9865	6 weeks – 2 years (one study 6 years)	• Social/environmental level (walking and stairs use promotion) • Intrapersonal level (pedometers, education, physical activity opportunities)	• Physical activity behaviours: +205.8 to +887.25 MET-min/week +126 to +3451 steps/day • BMI: - 0.04 to - 1.0 unit • Daily energy expenditure176.18 to 370 kcal/d

**** d** = Standardised mean effect size, here indicated a positive effect on health outcomes.*

For instance workplace educational group sessions about lifestyle changes, and workbooks with activities, had a significant impact on body weight (- 4.4 kg), BMI (-1.6 units), and body fat percentage (- 2.4%) in the treatment group, with no significant changes on the control group.[190] Instead, a similar study based on lifestyle education and same duration (6-month), but poor quality, showed a slight increase in BMI that was lower than the control group.[191] In this case, the outcome measured was described as "limit weight gain", while in the previous study the outcome was to "reduce body weight", thus making it hard to compare or define effectiveness. In addition to this, the populations were very different, with health care workers in one study,[190] and fire fighters in the other.[191] Hence, changes on BMI in the fire fighters study could have been attributed to gained muscle mass, given the job characteristics of this group.

This suggests that not all workplaces and employees are the same, especially for some jobs which are strongly characterised by shift work, and almost inevitable long shift hours, such as truck drivers, airplane crews, and health care workers. In particular, health care services run 24/7 to overcome a demand, which cannot be programmed, controlled or predicted. Therefore, the settings and employees widely differ from normal office workers, which are generally the target population of workplace interventions.

Some workplace interventions in hospital and health care settings have been conducted with the aim of improving employees' health outcomes through diet and physical activity.[36-43] Although most of them had overall positive outcomes (*see* Table 2.6), they were all indistinctly addressed to technicians, administration employees, nurses and physicians. While in some studies low response and participation compromised the intervention effects,[37, 38] overall they reported positive effects on BMI and body fat percentage,[37, 39, 40, 43] increase in physical activity,[38, 41-43] fruit and vegetable consumption and water intake.[37, 41-43] Indeed, these results suggest that health promotion interventions targeting physical activity and diet in hospital and health care settings are possible.

Table 2.6 – Summary of workplace interventions promoting diet and/or physical activity for hospital employees

Authors	Study characteristics	Intervention	Outcomes
Barratt *et al.*, 1994	• n=683,73% female • Hospital, Sydney • Other: included if total cholesterol >5.2 mmol/l	*3-month intervention* • I1: Workbook + quizzes + shopping guidelines+ recipes+ 3-min video with suggested dietary change • I2: 5x1 hour group session led by dietician concerning fibre, fat and dietary change + workbook+ tasting recipes • C: Screening only • Baseline, T1 (3 months), and T2 (6 months)	• Body weight decrease: I2 -0.9kg (T1), -0.35 kg (T2) versus C • Fibre intake increased: I2 +0.6 vs I1 and C (p=0.04) • No significant change cholesterol
Cockcroft *et al.*, 1994	• n=297,76% female • 16% medical and nursing staff • Hospital, London (UK)	*6-month intervention* • I: health measurements + personal advice + leaflets + individual targets for change in 6 months • C: Health measurements only (height and weight, blood pressure, self-report diet, alcohol, exercise, smoking, stress and health perceptions). • Baseline, 6 months	• 1/3 of I significantly increased exercise • Decreased 0.52 units of BMI, p=0.02 • n=214 not re-attending second session (6-month follow up)
McCartney & Scheuer, 2005	• n=1129(A),n= 610 (B) • Both 95% female • Hospital/clinics, Wisconsin (US)	*16-weeks intervention (A)* • Goal 40.000 miles (1 minute moderate activity =10 miles). Prize when completing goal • Logs for Physical activity, weekly emails for tips and support *12-week intervention (B)* • Set personal point goal (1min=1point), and at least5 serves of F&V. Prize when completing goal • Logs for daily PA and fruit/veg, Information through emails/Web links • Baseline, 12-week or 16-week.	• Program goals met by 20.5% in A, 31% in B. • PA increased in subjects with good/excellent fitness levels: 46% (95%CL=40.5,52.3) to 70.7% (95%CL=65.3,76.0), p>0.05 (A) • Change in BMI: -0.58 vs. 0.48, p=0.01 (A) • No significant changes in BMI, blood pressure or cholesterol (B). • Participants preferred setting their own goals.
Lemon *et al.*, 2010	• n= 806, 84% female • 64% patient care occupation. • 6 Hospitals, Massachusetts (US)	*24-month intervention* • Ecologic intervention • E-mail newsletter, website and printed material with information • Signs promoting stairs taking, walking maps, nutrition info on cafeteria. • Interpersonal support and group activity, monthly education sessions. • Group and individual prizes were given. • C: no intervention • Baseline, T1 (12-month) and T2 (24-month)	• No significant change in BMI. • For each unit increase in intervention participation (range: 0–100), there was a decrease of 0.012 BMI units (95% CI= -0.025, 0.001; p=0.06) from baseline to 24 months. • Only 35% participant did not gain weight.

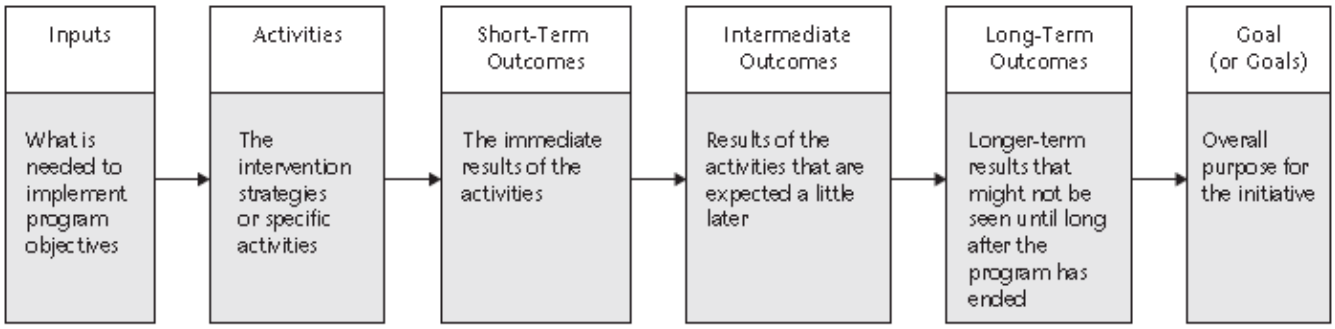
Hess *et al.*, 2011	• n=399, 92.8% female • Liverpool Hospital, NSW • Other: 3 categories (nurses, doctors and allied health)	• 12-week intervention • Information leaflet about how the challenge works; • Measure Up campaign resources and pack: pedometer, healthy eating logbook, water bottle, sandwich box, 'Healthy Food Fast' cookbook. • Record daily steps on campaign website. • Food log of fruit, vegetable, water and healthy breakfast consumption • Control: none • Baseline, 12-week	• Nurses and doctors lowest completion rate (56.8%) • Increased median minutes walked 125 to 200* • Increased vigorous physical activity 30 to 85 minutes* • + 16.8% of participants reaching ≥150 minutes of physical activity per week* • +23% average participants meeting fruit & vegetable daily consumption*
Christensen *et al.*, 2012	• n=98, 100% Female • Health care workers • Elderly care facilities, Denmark • Other: included if overweight	• 12-month intervention • Weekly 30min counselling, final 3 months on healthy behaviours in social context/situations • 0–3 months: Dietary records, dietary advices (weight loss, diet changes) • 3–12 months: weight loss maintenance + progressive increase physical exercise +cognitive behavioural training. • Control group: monthly 2h oral presentation during working hours, dietary recommendations • Baseline, T1 (3-month), T2 (12-month)	• Reduced body weight by 6 kg*, BMI by 2.2 units * and body fat percentage by 2.8%* • No significant change W/H ratio, but significant in circumference cm. • No statistical reductions in the control group.
Thorndike *et al.*, 2012	• n= 330, ~86% female • Hospital, Massachusetts (US)	• 10-week intervention • Initial 10-wk program + 9 month Internet only intervention • Team competition, on weight loss, exercise, diet and steps • Weekly 30min teams meeting and 45min individual team meetings. • Personalised website for goal-setting and feedback + self-monitoring + minimal personal support (every 3 months meeting with nutritionist or personal trainer) • Control: Intervention but without personal support. • Baseline, 10-wk, 1-year follow up	• Drop-out 28% • 65% of subjects maintained weight loss at 1 year* • No difference in weight loss, PA or dietary behaviours between groups at 10 week vs 1-year. • Increase on healthy behaviours: (1year) F&V intake 3/day (I:57% vs C:38%)* • Fatty foods /snacks intake (70% vs 51%)* • Sugary foods and beverages (42% vs 26%)* • Participation in any aspect (74% I group) vs less participation -4.2 vs -1.2 lbs at one year**
Strijk *et al.*, 2012	• n=730, 74% female • 2 academic hospitals, Netherlands • Other: included if 45 years old or older	• 6-month intervention • Intervention Mapping (IM) protocol • Weekly 45 min supervised exercise and yoga +45 min/week unsupervised vigorous PA • Free fruit • Three counselling sessions • Control: information about a healthy lifestyle in general (diet, PA and relaxation). • Baseline, 6 months	• PA - Sports (min/week) +75 vs +30: p=0.05 • Fruit intake +5.7 vs +2.7 pieces/week β = 2.7 pieces/week, 95% CI 0.63 to 4.7) • Need for recovery -3.2 vs C:0.6 (β =-3.5, 95% CI -6.4 to -0.54), with stronger effects for high workout compliance (β = -5.3, 95% CI -9.3 to -1.3) • No effects on vigorous physical activity, aerobic capacity, or mental health.

***** *p<0.001;* ****** *p< 0.10;* ***F&V*** *Fruit and vegetables;* ***wk*** *week;* ***I*** *intervention;* ***C*** *control*

2.5.1 Rationale for health promotion interventions

In health promotion interventions, the design and development of an intervention needs to follow a well design process coupled with a theoretical framework. This provides guidance on how to develop an intervention plan, or how to act on the factors that might have an impact on health outcomes, and set program objectives that are related with an improve health status of the target group.[192] Thus, a logic model is usually developed to show the relationship between resources (inputs), and activities and expected results (outputs) (*see* Figure 2.5). Furthermore, a theoretical construct is used to describe this logic model procedure, which will explain why individuals would change their behaviour based on a validated behaviour theory. Thus, a theory can explain and identify why a problem exists, or guide the intervention methods and evaluation. When concepts from a theory that have been often tested separately, are called constructs.[192]

Figure 2.5 - Schematic logic model



Source: Adapted from W. K. Kellogg Foundation, 2004.

From Fertman *et at.* [192]

Factors influencing individuals' health behaviours mainly involve personal and environmental factors. Because of its focus on how the environment can influence individual's behaviour, the Social Ecological Model has been a popular model used to develop behaviour change interventions. [157, 193] This concept acknowledges, for example, that multiple levels influence the individual's adoption and maintenance of physical activity. It describes different levels of interactions including individual, intrapersonal, interpersonal, organisational, community, and policy. This theory has been used in several nutrition and physical activity interventions involving, for example, pedometers for self-monitoring

(personal), team challenges and competition (intrapersonal) and staircase promotion and walking circuits (environment).[194, 195]

On the other hand, many interventions have used self-efficacy, which focuses on the individual, thus intrapersonal level only, arguing that an individual will perform behaviour if he/she feels confident and able to do so. This is a theoretical construct from the Social Cognitive Theory.[196] Interventions using this concept usually include one-to-one counselling,[197] or exercise classes and web-based information.[198]

However, the choice of a theory should begin with identifying the problems and the nature of the targeted population, instead of selecting a behaviour change theory because it is familiar or in vogue.[157] Choosing a behaviour change theory that is inappropriate for the target group's needs could challenge intervention's effects and outcomes. To overcome this, one should use a clear framework to select a suitable theoretical construct. Intervention Mapping (IM), is comprehensive framework for effective theory and evidence-based intervention development.[51] This framework includes a model that links the determinants of behaviour change in the assessed group, and the selection of suitable theory/ies that can better assist in achieving the desired changes.[51] By identifying a logic model of change, one can better understand whether the observed intervention outcomes can be attributed to the chosen theoretical construct or to other casual factors. [199] IM is commonly used in health promotion interventions, but its rationale is particularly appealing for interventions promoting diet and/or physical activity behaviours.[18]

2.5.2 Process evaluation of health promotion interventions

While an appropriate process system is important and necessary to design behaviour change intervention associated with successful diet and physical activity outcomes, this association is often not clear in the literature and is not always well reported.[16] For this reason a framework should include an evaluation process, to help understand the link between intervention inputs and outputs (effects), and to provide information for internal and external validity.[200] This type of evaluation can provide information regarding factors associated with the implementation and effectiveness of the intervention.[201] This is a necessary step as many effective interventions subsequently fail to be adopted in a wider scale or translated in real-world settings, with barriers at patient/participant, staff and organisational level.[202]

Many process evaluation frameworks like “RE-AIM” [203] are increasingly being used to evaluate interventions targeting behaviour change and obesity.[202] RE-AIM follows a logical sequence of evaluation in different aspects of the intervention, including its Reach, Effectiveness, Adoption, Implementation, and Maintenance.[203] Reach dimension explores the ability of the intervention to reach the target population, while Effectiveness measures the intervention effects on main outcomes. Adoption and Implementation show whether participants engaged with the intervention materials and if the intervention was executed as planned, respectively. Finally, the Maintenance dimension evaluates the sustainability of the intervention in the long term, including maintenance of effects at the individual level or intervention program at the organisation level, after the intervention is finished. This evaluation process can identify barriers to successful implementation of each dimension, which can inform program changes for scalability or improved effectiveness, or study design of future interventions.[203]

2.6 SUMMARY

The Literature Review showed that nurses are at increased risk of non-communicable disease (NCD) given their stressful job, age, and poor diet and physical activity behaviours. There is a large body of evidence describing nurses’ barriers to healthy behaviours, including stress and emotional eating, long working hours, irregular shift patterns, night shifts, and fatigue. The negative health outcomes linked to those behaviours are also well known, including a high prevalence of overweight and obesity (60%). While the literature described the workplace as an ideal setting for promoting diet and physical activity, to date there have been few interventions designed for nurses. But the studies conducted in this population have provided inconsistent conclusions about their effectiveness, and did not provide a clear evaluation process. Therefore, given nurses’ poor health profile, increased NCD risk factors, and lack of information on effective ways to promote diet and physical activity in this population, well designed and rigorous workplace interventions targeting such behaviours are needed in this population.

CHAPTER 3
PROMOTING DIET AND PHYSICAL ACTIVITY IN NURSES: A SYSTEMATIC REVIEW

This chapter represents the first part of the Needs Assessment to inform the intervention development. The content of this chapter has been published in the American Journal of Health Promotion, May 2015. The second part of the Needs Assessment includes focus group interviews and is presented in the following chapter (Chapter 4).

Citation:

Torquati L, Pavey T, Kolbe-Alexander T, Leveritt M. Promoting diet and physical activity in nurses: a systematic review. American Journal of Health Promotion. 2015. *In press*

3.1 INTRODUCTION

As described in Chapter 2, nursing is an occupation where overtime, irregular shifts and both physical and emotional are common. Although nursing seems to be an occupation that includes frequent walking, almost 50% of nurses reported low physical activity levels, [28, 31, 39, 167, 204] with occupational energy expenditure negatively associated with leisure time physical activity and meeting physical activity guidelines. [33, 35] Other unhealthy behaviours associated with this job include emotional eating, irregular meals, and frequent high-energy snacking. [32, 167, 179, 180] Physical activity and diet play a major role in obesity development, with 60% of nurses being overweight and obese [25] (compared to 55% reported for the Australian female population).[205] These behavioural factors are crucial for the onset of non-communicable disease, and strong independent predictors of all-cause mortality.[3, 4] For these reasons, they represent key targets of interventions designed to prevent chronic disease.[9, 206, 207]

As nurses spend most of their time at work, the workplace represents a desirable setting to promote diet and physical activity in this group. Workplace interventions in hospital settings have effectively improved staff's physical activity levels, BMI and dietary patterns.[36-43] When designing workplace interventions, previous studies are usually used to inform methods and rationale, but these cannot be easily translated when the target group are nurses. Previous hospital interventions, included a mixed group of allied health, technical and administrative staff, who have similar shifts but are different from nurses. Nurses' shifts are usually longer and more irregular due to the 24-h patient care service. [208] Nurses' working environment is also different, as it has been described as particularly hostile and unsupportive.[165] Therefore, the nurses' job may impact their availability and time to engage with health promotion interventions, together with lack of motivation for self-care, as suggested by an online survey. [209] Because previous studies in hospital settings have not provided a nurse sub-group analysis, the extent of nurse participation and benefits from these diet and physical activity intervention is not well understood.

A 2012 systematic review of interventions aimed to improve a variety of health behaviours in nurses (e.g. smoking, alcohol intake, diet and physical activity) found just three studies.[48] However, only one study aimed to improve physical activity and the other two targeted smoking cessation. Thus, to inform the intervention design for this thesis, the literature needed to be systematically reviewed in an effort to find further studies in nurses.

3.2 AIM

The aim of this systematic review was to assess the effectiveness of any workplace intervention studies specifically promoting diet and/or physical activity behaviour in nurses.

3.3 METHODS

3.3.1 Data sources

This systematic review was performed according to the PRISMA statement (Preferred Reported Items for Systematic Reviews and Meta-Analyses) guidelines. [210] Relevant studies were identified through a comprehensive search, using four electronic databases (PubMed, Scopus, CINAHL, and EMBASE). PICO tool (PubMed-NIH) and snowball search from relevant papers were also used. Databases were searched from the earliest time point until October 2014 using a combination of key words related to population and limited to English language (e.g. ' Nurs*', 'Health care', 'health care worker'), settings (e.g. 'Workplace', 'Worksite', 'Hospital'), type of study (e.g. 'Lifestyle intervention', 'workplace intervention', 'intervention'), and intervention outcomes (e.g. 'Exercise', 'Physical Activity', 'Nutri*', 'Diet', 'lifestyle'). We used broad search terms in order to capture all relevant studies, including any intervention design and publication year.

3.3.2 Inclusion and exclusion criteria

Studies were considered eligible for inclusion if they met the following criteria regarding population, intervention, comparator, outcomes, and study design:

1. Nurses or nursing students currently working in a health care setting
2. Physical activity and/or nutrition intervention
3. Any control condition (e.g. usual diet and physical activity) or no control (e.g. pre-post test)
4. Outcome measures of change in either diet and/or physical activity behaviour. Secondary health outcomes such as BMI and weight were included in the review where reported.
5. Randomised or non-randomised controlled trials (cluster or individual), clinical controlled trials, quasi-experimental, pilot studies or single group pre-post studies with or without control group.

We excluded studies that were not published in a peer-reviewed journal, editorials, opinions, and studies available only as conference abstracts. Papers were excluded if the intervention was directed towards patients and led by nurses. Studies were also excluded if the main purpose was to treat other conditions in nurses (e.g. musculoskeletal pain, burnout and stress, anxiety, depression). Interventions that focused only on improving physical fitness and/or with supervised exercise, as opposed to physical activity, or aimed to change other lifestyle factors (e.g. limit alcohol intake and smoking), were also excluded.

3.3.3 Data Extraction

The study selection process followed three steps. First, one author (LT) reviewed all abstracts and titles and excluded irrelevant studies, which was checked by the second reviewer (TP). Secondly, full-text were retrieved for the papers selected in Step 1. All authors reviewed the full papers for eligibility and decisions on inclusions were made by consensus. Thirdly, two studies met all inclusion criteria except they included a mix of nurses and other health professionals. The authors of these two manuscripts were contacted to ascertain study population and availability of nurses' only data, leading to their inclusion. [211, 212] Third, one author (LT) extracted data following a standardised data extraction form. This process was checked by the other three authors (ML, TP, TKA). Data extracted included patient characteristics (e.g. sex, age, marital status), intervention characteristics (e.g. duration, delivery method), control group conditions, outcomes measures, and study quality. Study design was classified as randomized controlled trial (RCT), quasi-experimental and quasi-experimental pre-post test design (no control group).

3.3.4 Data synthesis

Results were grouped in three different outcomes of interest to the aims of the study: Physical activity, Diet and Body composition. Characteristics of studies, interventions and participants were summarised in tables. Risk of bias and study quality was assessed using previously published criteria relevant to controlled studies.[213, 214] Bias categories included 1) Random sequence generation (selection bias), 2) Allocation concealment (selection bias), 3) Blinding of outcome assessment (detection bias, patient-reported outcomes), 4) Baseline characteristics, 5) Statistical power calculation, 6) Intention to treat analysis; 7)

Missing data reported (incomplete outcome data), and 8) Handling of missing data addressed (attrition bias). All authors assessed study quality independently, agreeing on scores by consensus.

3.4 RESULTS

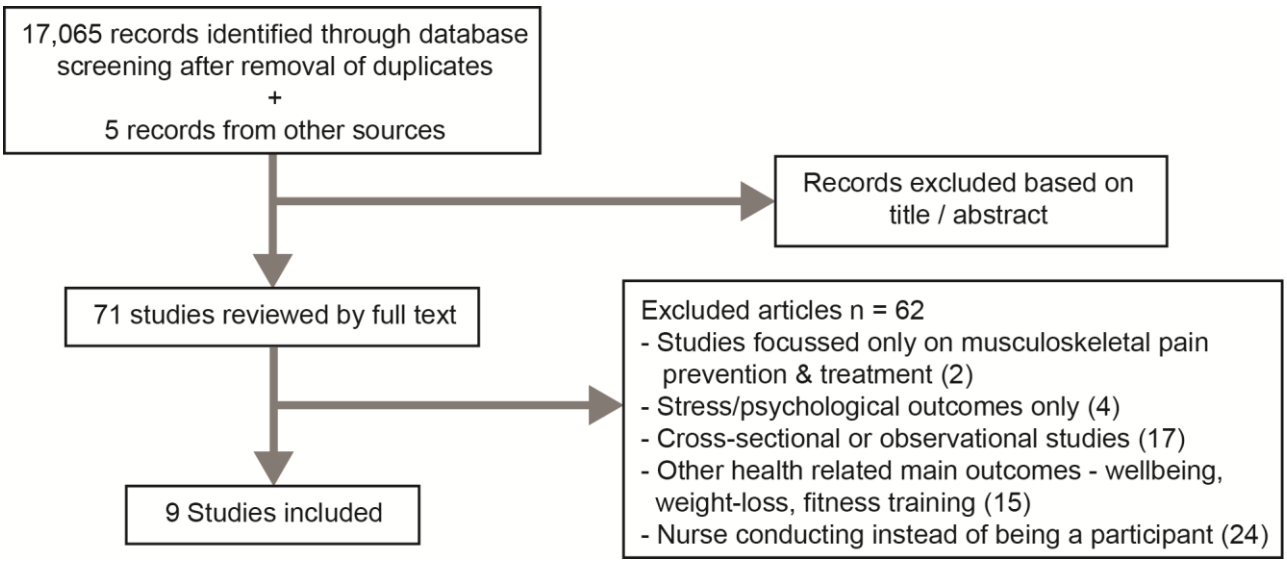
3.4.1 Search outcome

Our bibliographic search yielded 17,065 articles, from which 71 full-text manuscripts were retrieved. After full review, 62 articles were excluded, mainly based on type of study or type of outcomes (*see Figure 3.1*). Nine studies were identified as meeting the inclusion criteria.

3.4.2 Characteristics of the included studies

Characteristics of the included studies are summarised in Table 3.1. Of the nine studies, three were RCT [215-217] and six were quasi-experimental studies (from which two pilot[218, 219], and two pre-post design[212, 220]) with a total of 737 participants. Study settings were different across the interventions: three were based at University's Health services and Hospital, [212, 217, 221] two in nursing home/long term care, [216, 218] one within three medical surgical units, [219] and three in general hospitals and health centres.[211, 215, 220]

Figure 3.1 - Flowchart of research outcome and study selection



The shortest interventions were one and two days, [211, 221] and the longest was 6 months.[216] Six interventions were between 8 and 12 weeks in length.[212, 215, 217-220] Intervention strategies included individual-based exercise and self-monitoring of physical activity; [215] education material and individual planning to improve physical activity and diet; [217] lectures and workshops about physical activity and/or diet; [211, 216, 221] on-site exercise sessions, toolkit and manipulation of workplace with social reinforcement;[219] and a nurse champion to deliver information, on-going motivation and on-site exercise classes.[218] All studies collected data at baseline, and immediately after the intervention, with the exception of one study [221] where data was collected two months after the intervention. Only three studies performed additional follow-up measurements at six- and twelve-months. [212, 219, 220] Characteristics of interventions are presented in Table 3.1.

Inclusion and exclusion criteria varied across the studies; all studies included participants older than 18 years, and currently working as a nurse or nursing aid. One study included nurse managers only. [215] This study was included in the review because Furukawa *et al.* [215] reported that these participants face similar barriers to healthy lifestyle as Registered Nurses, in particular for physical activity. Only one study required participants have 1.5 years minimum of work experience. [219] Two studies restricted the target population to workers from minority groups, African American women, [218] and working mothers with children of 1-16 years old.[219] In the later, participants with chronic disease and current smokers were excluded. Pregnancy was considered an exclusion factor by three studies.[215, 218, 219]

Characteristics of participants are summarised in Table 3.1. The participants' age ranged from 19-67 years. All the participants were female in five studies, and the female participants in the remaining four studies ranged from 72-97%.[211, 216, 217, 221] The majority of participants were Caucasians (range 79.6-100%).

Intervention outcomes are presented in Table 3.1. Outcome measures varied between interventions and can be summarised into three key risk factors: physical activity, body composition, and diet. All studies included physical activity behaviour outcomes, such as: increasing number of daily steps, aerobic minutes, weekly exercise sessions and energy expenditure. Body composition was investigated in six studies, using different outcomes such as BMI, weight, fat/lean indexes and waist circumference. [211, 212, 217-220] Only four studies measured dietary outcomes using measures of fruit and vegetable intake, diet

behaviour and nutrition health promoting behaviour. [211, 217, 218, 221] Additionally, two studies mentioned nutritional education classes as part of the intervention, but no information about the strategy or expected outcomes was provided. [216, 220] Finally, two studies measured cardiovascular disease risk factors including glucose metabolism, insulin, lipid profile and blood pressure. [215, 218]

Table 3.1 - Summary of studies examining diet and physical activity interventions in nurses

Study, design, and intervention length	Participants and Setting	Intervention description	Main outcomes	Results
Furukawa *et al.*,2003 [215] • RCT • Duration: 12-weeks • 12-week follow up	• Ex: n= 26; con: n= 26 • Attrition: ex 8%; con 4% • Mean age: ex 40.8±5.1; • con 42.1±6.9 • Gender (female): 100% • General Hospital, Kinki, Japan	• Individual-based exercise plan • Walking pattern (encouraging brisk walking) and a target for level of exercise energy expenditure. • PA self-monitoring through electronic device • Control: oral information about brisk walking	• Total Energy Expenditure (kcal/kg/d) • Exercise EE (kcal/kg/d) • Steps	**+** **+** **+**
Brox & Frøystein, 2005 [216] • RCT • Duration: 6 months • 6-month follow up	• Ex: n=63; Con: n= 56 • Attrition: ex 27%; con 9% • Mean age: 42.5 • Gender (female): 97% • Nursing home in Norway	• 1-hour light aerobic exercise classes held twice weekly • Classes regarding nutrition and stress management • Control: No intervention, usual work.	• "Increase in physical activity"	**+/-**
Luszczynska & Haynes, 2009 [217] • RCT • Duration: 9-weeks • 4-month follow up	• Ex: n= 104; Con: n=78 • Attrition: 34% • Mean age: 28.7±9.51 • Gender (female): 89% • University South-Western England	• Handouts with education material • Planning forms to make own plans about PA • Nutrition handouts with education material • Making own plans about fruit & vegetable intake • Control: education materials	• Number of weekly PA sessions • Portions of fruit & vegetable • BMI	**-** **+** **+/-**
Shahar *et al.*, 2009 [211] • Quasi-experimental • Duration: 2-days • 6-month follow up	• Ex: n=41; Con: n=6 • Attrition: 0% • Mean age: 49.2±1.4 • Gender (female): 72% • Maccabi Health Services, Israel	• Demonstration and activities about PA • Lectures, demonstration and activities promoting healthy dietary choices • Control: No intervention, usual work.	• PA (hours/week) • Saturated fat reduction (1-10 likelihood) • BMI • Waist circumference	**-** **+/-** **+/-** **+/-**
McElligott *et al.*, 2010 [221] • Quasi-experimental • Duration: 1-day • 3-month follow up	• Ex: n=73; Con: n=85 • Attrition: ex 29%; con 17% • Age (range): 39 (23-64) • Gender (female): 95% • Academic medical centre, USA	• Eight-hour program with interactive lectures on the Collaborative Care Model • Design of self-care plan for PA based on HPLP II (Health Promoting Lifestyle Profiles II) survey results • Self-care plan for diet based on HPLP II results • Control: No intervention, usual work.	• PA (HPLP II scores) • Nutrition (HPLP II scores) • BMI	**+** **+** **-**

Table 3.1 – Cont. …

Study, design, and intervention length	Participants and Setting	Intervention description	Main outcomes	Results
Tucker *et al.*, 2011 [219] • Quasi-experimental **(pilot study)** • Duration: 10-weeks • 10-week follow up	• Ex: n=30; Con: n=28 • Attrition: ex 7%; con 0% • Mean age: ex 34±6.85; con 36±6.94 • Gender (female): 100% • Medical surgical units in USA	• One 30- to 60-min introduction session • Manipulation of the worksite and social reinforcements (e.g. cues for taking stairs) • Toolkit to promote PA at and away from work. • Daily 30-min walking treadmill/standing workstations. • Extra activity with Nintendo Wii, 3min Energy-Burst video • Control: No intervention, usual work.	• Mean daily steps • Fat index • Fat mass (Kg)	**+** **+** **+**
Flannery *et al.*, 2012 [218] • Quasi-experimental (pre-post, **pilot study**) • Duration: 3-months • 3 and 6-month follow up	• Ex: n=24; Con: n= 15 • Attrition: ex 25%; con 33% • Mean age: ex 43.3±13.07; con 39.3±13.06 • Gender (female): 100% • Long-term care facilities, Maryland USA	• Nurse specifically trained (WHIIP nurse) to deliver information, on-going motivation and lead PA. • 3x10-min physical activity breaks each day, exercise classes leaded by the WHIIP nurse. • One 30min group education lecture held by the WHHIP nurse, using self-efficacy enhancement techniques and daily diet tips.	• Mean steps • Mean 'aerobic' steps • Mean 'aerobic' minutes	**-** **-** **+**
Baschung Pfister *et al.*, 2013 [212] • Quasi-experimental (pre-post) • Duration: 12-weeks • 3 and 12-month follow up	• n= 22 • Attrition: 36% • Mean age: 53.43±3.92 • Gender (female): 100% • University Hospital of Zurich, Switzerland	• Step-up jogging training, delivered 2x/week by physical therapist • Program specifically designed for inactive women, aimed to train participants to run 5km. • Motivational flyers about exercise, behaviour change and health	• Energy expenditure (kcal) • BMI	**+** **-**
Lavoie-Tremblay *et al.*, 2014 [220] • Quasi-experimental (pre-post) • Duration: 8-weeks • 2 and 12-month follow up	• n=60 • Attrition: 15% • Mean age: 47.9±8.91 • Gender (female): 100% • Multisite health care centre, Canada	• Pedometer challenge (10,000 step goal) • Tracking PA and Health assessment on dedicated website • 1-hour lecture on PA and diet (baseline only) • Tracking fruit & vegetable consumption on dedicated website	• Total PA (METs) • Vigorous PA (METs) • Moderate PA (METs) • Walking (METs) • Steps • Sitting	**-** **-** **-** **-** **-** **+**

Ex: *experimental group;* ***Con:*** *control group;* ***kcal/kg/d:*** *kilocalories/kilogram/day;* ***PA****: physical activity;* ***BMI****: body mass index;* ***METS****: metabolic equivalents;* ***+****: p<0.05;* ***+/-:*** *marginal change or p value not reported;* ***-*** *: no significant change.*

3.4.3 Risk of bias and study quality

Table 3.2 summarises the results of risk of bias and study quality. Only the RCTs generated a random allocation sequence and detailed allocation concealment.[215-217] Although outcome blinding of participants and intervention staff is not always feasible for these types of studies, Brox & Frøystein[216] blinded outcome researchers, and Luszczynska & Haynes [217] blinded participants, where the the intevention was based on planning. The reporting of missing data was detailed for most studies, and the handling of missing data for five out of nine studies. Power analysis was reported for five of the nine studies, with intention to treat analysis only reported for the RCT studies.[215-217] All studies were similar at baseline. Overall the quality of the RCT studies was good,[215-217] the quality of the quasi-experimental studies was low,[211, 218, 219, 221] and the quality of the pre-post studies was low to moderate.[212, 220].The efficacy of interventions was not associated with the studies' risk of bias, as studies in the same category showed different results (e.g. of the three RCTs, one showed negative effects on physical activity outcomes[217], one showed minimal changes[216], and one showed positive effects[215])

Table 3.2 - Risk of Bias of the included studies

	Random sequence generation	**Allocation concealment**	**Outcome blinding**	**Similar baseline characteristics**	**Power analysis**	**Intention to treat analysis**	**Missing data reported**	**Handling of missing data**
Furukawa *et al.*,2003 [215]	+	+	-	+	+	+	+	+
Brox & Frøystein, 2005 [216]	+	+	+	+	+	+	+	+
Luszcynska & Haynes, 2009 [217]	+	+	+	+	+	+	+	+
Shahar *et al.*, 2009 [211]	-	-	-	+	-	-	-	-
McElligott *et al.*, 2010 [221]	-	-	-	+	+	-	+	-
Tucker *et al.*, 2011 [219]	-	-	-	+	-	-	+	+
Flannery *et al.*, 2012 ***[218]***	-	-	-	+	-	-	+	+
Baschung Pfitster *et al.*, 2013 [212]	N/A	N/A	-	+	-	-	+	-
Lavoie-Tremblay *et al.* [220]	N/A	N/A	-	+	+	-	+	-

+ : *Reported;* ***-****: not reported;* ***N/A****: not applicable to study design*

3.4.4 Physical activity outcomes

Six studies reported significant intervention effects in either energy expenditure [212] or physical activity levels. [216, 220, 221] Providing individual-based exercise plans and walking targets significantly increased steps (+1795±1630 vs. +629±1372 steps/day), exercise energy expenditure (+1.14±0.98 vs. +0.46±0.68 kcal/kg/d), and total energy expenditure (+2.3±2.2 vs. +0.9±1.3 kcal/kg/d) in the intervention group compared with the control condition.[215] Total energy expenditure was significantly enhanced in the intervention group (Baseline: 805.07±112.52, 3-month: 2235.57±259.87, 6-month: 2014.57±267.27 kcal/week) by a step-up jogging program specifically designed for inactive women. [212] Interactive lectures and 1h/week of aerobic exercise classes significantly increased physical activity levels.[216, 221] However, McElligott *et al.* [221] used the HPLP tool (Health Promoting Lifestyle Profile, identifies behavioural outcomes assigning overall and subscale scores) to report changes in the physical activity score. Brox & Frøystein [216] assessed physical activity with self-report methods without providing any p-values. Although reported to be significant changes, both studies showed small effects.

Having a nurse champion and 3x10-min exercise breaks at work, only increased average aerobic minutes at 12-weeks (60 steps/min and walk for at least 10 consecutive min[222]). This was 9.54±12.77 average daily minutes for the experimental group and 6.00±16.49 in the control group.[218] Sitting behaviour was assessed in one study.[220] Sitting time was significantly reduced from 356.68±250.52 minutes/weekday at baseline, to 286.60±193.90 minutes/weekday at the end of the intervention (8-week), to 249.19±166.51 at 6-month follow up, for nurses participating in a pedometer challenge and a website where they could monitor their physical activity. The remaining studies did not find any significant changes in the measured outcomes, including steps, MET/mins of physical activity and physical activity levels.[211, 217-219]

Overall, findings indicate that only half of the interventions showed significant changes in physical activity outcomes. These included steps, physical activity daily minutes, energy expenditure and sitting time.[212, 215, 220]

3.4.5 Diet outcomes

Although dietary behaviour and nutrition was targeted in six studies, only four assessed changes, and they all used different outcome measures.[211, 217, 218, 221] Luszczynska & Haynes [217] reported a higher fruit and vegetable intake in the experimental group (2.65±0.99 portions/day) compared to the control group (2.41±0.84 portions/day). They provided educational materials and encouraged participants to make their own plan to increase fruit and vegetable intake. Seemingly, McElligott *et al.* [221] asked nurses to design a self-care plan strategy to improve their diet. The Health Promoting Lifestyle Profile tool (HPLP) was used to assess health-promoting behaviours towards nutrition, with experimental scores increasing significantly at post-test (experimental group score: 2.33±0.64, control group: 2.25±0.76). Group education lectures achieved a significant increase of Diet Outcomes Expectations scores in the experimental group (9.71±0.76) compared to the control group (7.17±3.82). [218] Finally, in the fourth study, the frequency of avoiding saturated fat intake (1-10 scale) increased in the control group rather than the intervention group (6.7±12 vs 5.6 ±8.4, respectively). [211]

Despite some of the interventions providing diet and nutrition education, they did not perform pre and post intervention measurements.[211, 216, 220] These interventions included nutrition and stress management classes,[216] lectures and activities promoting healthy food choices, [211] and 1-h lunch lectures together with fruit and vegetable intake self-monitoring on the intervention's website. [220]

3.4.6 Body composition

Six studies assessed different body composition parameters as secondary outcomes,[211, 212, 217-220] but only two found significant changes.[217, 219] Tucker *et al.*[219] reported significant changes between intervention and control groups in fat index (-0.23 vs -0.04 Kg/m^2), fat mass (-0.60 vs -0.09 Kg), median fat mass (-1.06 vs +0.04 %), and median lean mass (+1.05 vs - 0.05%), respectively. The second study only found changes in BMI when doing sub-group analysis of participants with BMI>25 at baseline.[217] At 4-month follow up, BMI in the intervention group was 28.89±7.68 compared with 31.79±7.77 in the control group.

Overall there were modest improvements in participants' BMI and body composition. However, the inconsistencies in the physical activity and diet measures make it unclear whether changes were a result of increased physical activity, improved diet or a combination of both.

3.5 DISCUSSION

The main finding from this systematic review was that there is inconsistent evidence on the effectiveness of workplace health promotion interventions in nurses for diet and physical activity behaviour. The evidence is largely inconsistent due to the limited number and quality of studies, and the heterogeneity in outcome measures rather than an absence of effect. There was no trend on efficacy when comparing studies with low and high risk of bias studies. RCTs lacked appropriated outcome measures, which lead to unclear intervention effects despite having good scientific rigour.

Overall, there was a positive outcome on physical activity behaviour including energy expenditure, steps and sitting time. However, these outcomes were observed in only four out of nine studies.[212, 215, 218, 220] Strategies including tailored intervention programmes and pedometer challenges seemed to be more effective for promoting physical activity behaviours, compared with more passive strategies such as educational material and lectures. Education strategies also showed limited effects on diet outcomes. This is in line with current evidence in practice [223] and similar interventions in other populations and settings.[224-227] Compared with educational messages used in the control condition, tailored material (e.g. goals, information) [226, 227] and pedometers [224] favoured intervention group for increased physical activity.

Given the lack of proper diet behaviour assessment, there was insufficient evidence to support effectiveness or indicate which strategies are more effective at improving nurses' dietary behaviour. Among the six interventions that included a diet and nutrition component, three did not assess any diet outcomes; whereas the others presented heterogeneous outcome measures (e.g. fruit and vegetable intake, diet self-efficacy, diet behaviour based on a general lifestyle tool score). Quality of measurement tools and reporting was poor. Interventions used self-report and indirect behaviour measures of diet instead of validated tools, and in some cases, baseline measures were missing or were

reported without control and experimental group distinction. Clearly further research is warranted to determine if diet behaviours can be improved in nurse populations.

This review highlights the scarcity of interventions designed to promote diet and physical activity behaviours in nurses. This is consistent with the lack of studies promoting healthy lifestyle, reported by an earlier review that included only three studies (two targeted smoking behaviour and only one promoted physical activity).[48] Our review included eight additional papers that were not considered previously, which allowed for better consideration of the potential impact of interventions on nurses' lifestyle behaviours and health. Although the evidence on effectiveness was limited, our results add to the existing literature by indicating some strategies that could increase nurses' physical activity.

Nurses' poor dietary habits and low levels of physical activity places them at increased risk for chronic disease and should therefore be prioritised as a target group for workplace health promotion initiatives. Nurses' health can challenge both recruitment and retention rates, which have a significant impact on health care delivery.[24] Health and absenteeism are predictors of turnover. Health influences absenteeism, which increases the working pressure of the staff left behind. In turn, this negatively impacts remaining staff's motivation to go to work, triggering the withdrawal process that leads to turnover.[228] A cohort study showed how nurses with poor self-rated health were more likely to take long sick leave and resign (odds ratio 2.16 and 1.35, respectively). [229] Here, two in ten nurses who originally reported poor health left their job after only three years. Good health was also associated with less sick days in another similar study. [230] On the other hand, a nurses weight-loss intervention did not significantly change short sickness absence but did improve productivity after 3-months in the treatment group.[231] Promoting diet and physical activity has the potential to improve nurses' health and perhaps contribute to limit the current high rates of turnover. This is of vital importance for the Health Care industry, as turnover negatively affects both patient outcome and costs, which are estimated to be A$150,000/year per nurse.[185] The Health Care industry is the major employer of Australia, with nursing being the largest workforce here (55% of total health professionals).[19]

Prior studies in similar settings suggest that workplace interventions can be effective. Previous workplace physical activity and diet interventions in hospital and health care settings reported significant improvements on employee's health (physical activity levels,

BMI, fruit and vegetables and fat intake).[36-43] Strategies in these studies included cholesterol screening and dietary intervention,[37] lifestyle advice and setting of health targets,[36] information materials for diet and pedometer goals,[41] dietary advice and cognitive behavioural training, [40] worksite manipulation,[39] free fruit and tailored exercise program,[42] internet support, goal-setting and self-monitoring of weight, diet and exercise.[38, 43] However, the extent of nurses' participation and benefit was not clear in those studies, due to the targeting of all hospital employees (including technicians, administration employees, allied health, etc.), whose job and shifts are usually different from nurses'. Because of their occupation, nurses are exposed to many traumatic events in their workplace such as patient injuries, suffering, death, and even verbal and physical aggression.[232, 233] These events influence their attitude towards diet and physical activity behaviours.[168] Their workload is also different to other health professionals, as patient care is nurses' main responsibility and priority, directly influencing their working hours, shifts and days off. [165] Therefore, nurses' ability to engage with general staff health promotion interventions might be limited by their availability, time, job characteristics and needs. For this reason, nurse-only intervention studies are needed to determine effective strategies and factors influencing participation and effectiveness in this population.

Limitations

Every effort was made to reduce potential bias in this review. We conducted this study following the PRISMA statement and performing a comprehensive search that yielded high number of studies. We used electronic searches including searching of reference lists of included studies and predefined inclusion criteria, which were applied by consensus across two or more reviewers. However, some studies may have been overlooked, for example, as a result of the English language search filter. Further, due to the differing and poor outcome measurement tools we were unable to synthesize the data quantitatively through meta-analysis. Although the majority of studies were either North American or European, there was one East Asian and one Middle Eastern study to support the generalizability of the review.

3.6 CONCLUSION

We found inconsistent evidence on the effectiveness of workplace health promotion in nurses. Although there was a modest increase in some measures of physical activity and a positive effect on participants' BMI and body composition, results should be interpreted with caution. Future studies should include appropriate theoretical frameworks and validated objective tools for outcome measures. Understanding how best to promote diet and physical activity in nurses is important because they represent one of the largest health workforces at increased risk of chronic disease development.

CHAPTER 4
DIET AND PHYSICAL ACTIVITY BEHAVIOUR IN NURSES: A QUALITATIVE STUDY

This Chapter includes the second part of the Needs Assessment, and has been published in the International Journal of Health Promotion and Education.

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4.1 INTRODUCTION

Despite the need to improve nurses' diet and physical activity behaviours [13, 17], few lifestyle interventions have been implemented and reported in the literature [48]. Findings in Chapter 3 reported a small number of diet and physical activity workplace interventions targeting nurses. All the studies reviewed had little to no rationale behind intervention strategy choice and target group needs. Because of the low number and quality of studies, this Chapter provided no conclusions on whether interventions can be effective in changing nurses' behaviour and improving their health.

For effective workplace health promotion interventions, the study design should be guided by the target group's determinants of both current behaviours and desired outcomes [18]. A rationale linking the choice of intervention methods (strategies and theoretical constructs) to the target group's determinants of behaviour can be then developed. A Needs Assessment explores such determinants through qualitative research (e.g. surveys, focus groups) and review of the literature.[51, 199] Few studies have conducted qualitative research on diet and physical activity behaviours in the nursing population, which are limited to the impact of night shift or to the barriers of diet and physical activity behaviour.[168, 234]

With the use of an appropriate theoretical framework, qualitative data identifying both facilitators and barriers to diet and physical activity behaviours could be used as part of a Needs Assessment in this group. Nurses' opinions on preferred intervention strategies should also be included, as incorporating suggestions from the target group has been shown to increase the effectiveness, flexibility and sustainability of future interventions [51]. Because flexible and sustainable workplace health promotion interventions are particularly important in this hard-to-reach group, it is important to identify factors that could motivate nurses to improve their diet and physical activity behaviours.

Self-Determination Theory (SDT) defines the intention to perform a behaviour (motivation) as a condition and key factor of behaviour's implementation[235]. Motivation could be intrinsic or extrinsic depending whether it is coming internally from the individual (i.e. behaviour is personally important and interesting), or externally from the environment (i.e. social rules, peer pressure) Thus, SDT is useful for understanding motivational processes and adherence to health behaviours [159]. Understanding the interplay between

determinants at a personal, social and environmental level in the target group is a necessary step to effectively change diet and physical activity behaviours [18].

4.2 AIM

This study aimed to explore perceived barriers and enablers of healthy diet and physical activity behaviours, in a group of Australian nurses. The data obtained will be used as part of a Needs Assessment to inform a future intervention aimed to promote healthy diet and physical activity in nurses.

4.3 METHODS

We designed a qualitative study that used focus group (FG) interviews to gather information about both nurses' determinants for diet and physical activity and motivation towards healthier behaviours. The study aimed to have four to ten participants per FG, with group allocation based on homogeneity [236]. To promote a comfortable and casual environment, and encourage attendance, the FGs had the format of morning or afternoon tea group discussion sessions.

4.3.1 Setting

This study was conducted in three hospitals from the metropolitan area of Brisbane (QLD). Nursing Unit Managers (NUMs) based at hospitals identified as potential sites for the future workplace intervention were invited to participate in the research. The NUMs were asked to distribute information related to this study to their staff.

4.3.2 Participants

After NUMs sent all of their nurses an email informing them of the study, posters were placed in common staff areas (i.e. staff rooms, canteens, notice boards). Nurses interested in participating were asked to contact the FG moderator (LT) to set a date and time to attend the FGs. Therefore, these nurses represented a convenience sample of participants. The inclusion criteria for participation were: (1) currently working as a nurse (e.g. registered nurse, clinical nurse) and (2) employed at one of the potential intervention sites for a future intervention.

4.3.3 Procedure

Before the focus group started, information sheets were given to each of the participants. Participants signed the consent forms after reading the research information sheets and any additional questions they may have had, were answered. Participants were asked to sign the consent form and provide demographic information. The consent form and information sheet for this study are presented in Appendix I. The facilitator reminded participants that the FG would be audio-recorded, and that they were free to leave at any time. The only incentives that were provided were beverages and light snacks. This study protocol was approved by the Mater Health Services HREC (Human Research Ethics Committee) and The University of Queensland MREC (Medical Research Ethics Committee).

FGs (n= 4) took place in a private room at each hospital, at a time that was convenient for participants, which was either just before or after their shifts. Nurses from similar units, shifts and age ranges were grouped to create homogenous groups. Homogeneity is important, as participants are more willing to share personal experiences when they feel similar to others in the group [237] . FGs were organised and held until reaching saturation point, when no new information was found [236]. For this reason, we did not predetermine a sample size. The moderator (LT) facilitated the discussion, and an assistant (CP) observed and took notes (in addition to the audio recordings) about speakers' name and body language to facilitate transcription and interpretation of quotes.

4.3.4 Interview guide

An interview guide was created using 10 short open-ended questions formulated to sound conversational (see Table 4.1) and to facilitate discussion of personal opinions and experiences about health, nutrition and physical activity.[238] Based on SDT, we included questions that would generate discussion around participants' motivation to engage in healthy diet and physical activity behaviours. Questions related to the participant's interests and preferences for a future workplace intervention were also included. The questions in the interview guide were selected to fit study's aim and designed to be well phrased, sequenced in a logical order, and easy to understand for the participants [238]. When developing and scheduling questions, we follow Krueger and Casey's[238] approach and Ethics Committee's feedback. Questions were lined-up from general to more specific,

to foster conversation among the group and facilitate group dynamics. Questions related to the participant's interests and preferences for a future workplace intervention were also included.

After the first FG, some questions were modified slightly to generate better interaction and discussion between participants. For example, '*Do you consider yourself active?'* was changed to *'What motivates you to engage in physical activity?'*

Table 4.1 - Question guide

Type of question	Question
Opening	Tell us a bit about yourselves, your names and what made you chose nursing as a profession
Transition	What do you think defines a healthy lifestyle?
Key	What does physical activity mean to you? What motivates you to engage in physical activity? What is a healthy diet to you? Did your lifestyle change after you started to work as a nurse? Which strategies do you thing may help nurses improve their diet and physical activity?
Ending	Is there anything else you would like to add to the discussion?

4.3.5 Data analysis

The audio-recordings were transcribed verbatim and merged with notes taken during the interviews. The transcription was imported and coded in Nvivo10.0. Data was sorted and organized following the framework described by Krueger and Casey [238]. Data analysis followed thematic analysis with a realistic approach, where information was collated in themes. Themes aimed to report relevant information to the research question and to represent a patterned response through the data set [239] . By using this technique, the researcher first grouped statements into units using different coding. Similar coding units were grouped into different categories (nodes). Finally, the nodes were clustered into general themes that summarised the node content. Quotes were chosen from the transcript to represent each category in the results section. Two researchers (LT, CP) worked independently with the coding and categorisation process, and when the analysis was finished, results were compared.

The analysis was reviewed separately by each of the researchers (ML, TP, TKA). Following Braun and Clarke's [239] approach, themes were reviewed and refined by re-reading all extracts for each theme to check whether there was a coherent pattern. With this process, quotes that did not fit the pattern were either discarded or used to form new themes. The same process was done to check that all themes accurately reflected the data set and the research question. Deciding how well eventual themes would fit the focus of the study solved eventual disagreements in themes and codes allocation. However, no substantially different interpretations emerged. Finally, a summary including themes and categories was sent to all participants to check whether the analysis had reflected the participants' views accurately.

We used the Self-Determination Theory (SDT) as a framework for interpretation of themes. SDT states that humans have an inborn motivation to self-regulate health behaviours [154]. This theory is considered useful for understanding motivational processes and adherence to such behaviours [159]. Following this principle, we used SDT to organise themes (and their nodes) based on whether the determinants discussed represent internal or external factors influencing diet and physical activity. Motivation is seen as a continuum from intrinsic to extrinsic motivation, and varies in the extent to which it is autonomous (self-determined) or controlled. Results were interpreted considering SDT motivation and barriers to self-determined diet and physical activity behaviours, and are shown in Figure 4.1.

4.4 RESULTS

Four FGs were conducted with a total of n=17 nurses, who were mostly female and registered nurses. The average age was 40 years old with mean working experience of 15 years (*see* Table 5.2). The FGs ranged from 25 to 70 minutes, and the average duration was 48min.

Quotes were interpreted and classified in three main themes in line with the research questions: 1) Workplace determinants for diet and physical activity; 2) Personal determinants for diet and physical activity; 3) Strategies for futures workplace health promotion interventions. Finally, the resulting determinants of diet and physical activity were organised in a framework based on Self-Determination Theory [154] (*see* Figure 4.1).

Table 4.2 Participants' characteristics

Participant characteristics	
Gender	82% female
Mean age (range) (years)	39.5 (25-59)
Education (n)	
Graduate diploma	2
Bachelor of Nursing	10
Master of Nursing	2
Average working experience – years (range)	14.3 (1-35)
Role	
Registered Nurse	13
Clinical Nurse	4
Shift worked	
Day shift only	60%

4.4.1 Workplace determinants for Diet and physical activity

Night shift

Working the night shift was reported as one of the major extrinsic barriers for both following healthy diet and participating in physical activity. Some of the situations influencing diet behaviour included having irregular meal patterns and lack of breaks at work, which were more common during night shifts, leading to poor food choices at mealtimes. Nurses reported that they continuously consumed high-energy snacks, like chocolate and crisps, to help them stay awake during their night shift.

'You eat crisps to stay awake all night and coke…and by the end of the night you feel revolting!' (N2 (Nurse 2), FG2 (Focus Group 2))

'You got your breakfast and go to bed, then you wake up at lunchtime starving and eat then. And then you eat again all through the night.' (N2, FG3)

Long working hours and breaks

Long shifts (>8h) and insufficient breaks were described as extrinsic barriers to healthy diet. The work demands during a shift sometimes made it challenging to find opportunities to take a break. This led to nurses eating unhealthy food and overeating in general, which was a consistent topic raised in all the FGs. Nurses explained that they would eat as much

as they can when given the opportunity to take a break during long shifts. In some cases, they would even eat irrespective of being hungry or not.

'In some particular days you just stuff it down at the end (end of shift)' (N4, FG1)

'You don't know when you will be able to eat again' (N2, FG4)

Food availability

The nurses reported that the quality of their food choice was influenced by the food available in the hospital wards. For example, consistent presence of chocolates and treats in the wards would make nurses continuously snack on these, because they are available and accessible. As a result, this extrinsic factor challenged nurses' intrinsic motivation of self-control when making dietary choices. Participants perceived this as one of the main causes of overweight in this population.

'*You can't avoid the eating during the shift, because the nursing station is full of chocolate' (N1, FG2)*

'I'm not normally a chocolate person …except if it's right there in from of you' (N4, FG4).

'It's all very nice, but you can see yourself expanding over time' (N2, FG4).

On the other hand, nurses explained how having healthier options available at work could help them make better food choices. They reported that they would make healthy food choices when the healthy options are available to them.

'It would help with diet if there would be food provided… healthy food' (N1, FG3)

Work facilities to enable healthy behaviours

Some nurses mentioned their willingness to integrate physical activity with work when possible, by actively commuting to work or doing exercise before shifts. However, the lack of adequate shower facilities at work was an extrinsic barrier. Participants reported that small and insufficient shower facilities discouraged some nurses from actively commuting to work. Another barrier was the cost associated with using the onsite gym, which was small and accessible for both staff and patients, thus not "staff only".

'You get a reduced staff rate … and that's a big barrier. That's a big barrier when for most people I think their budget is pretty tight.' (N3 & N1, FG2)

4.4.2 Personal determinants for Diet and physical activity

Participants described their perceived benefits and enjoyment of regular physical activity. These benefits included reducing job stress and fatigue, feeling energised before work and relaxed after work. However, they were not always able to prioritise physical activity because other commitments, such as social and family activities, were considered more important.

Fatigue

Both working long hours and being tired were the main factors influencing physical activity. Most of the nurses mentioned lack of time or having competing priorities, such as family or social commitments. Shift work was an extrinsic barrier towards nurses' ability to keep active, mostly because of the associated fatigue. Even those nurses who were regularly physically active mentioned these barriers.

'I just find that I'm too tired' (N1, FG4)
'I want to do exercise, and I find I can't do that with the shift work' (N3, FG2)
'On a 12-h shift, I could not cycle in and cycle home' (N2, FG2)

Job stress

The participants directly linked job stress to dietary habits. Stress was related to emotional eating and craving on high-fat high-sugar food, such as chocolate, candy and fast food. When they tried to be mindful about their diet, being stressed or fatigued was enough to undermine this behaviour leading to lack of self-control over diet.

'You have a bad day, and before you know it you have five (chocolates) in your mouth' (N4, FG3).
'Your ability to be disciplined changes… because you are so tired' (N2, FG1).
'If you are depressed or something is upsetting you, you make comfort eating' (N1 & N2, FG1).

Enjoyment and stress relief

Nurses were aware of the positive impact of physical activity on their health and well-being. They viewed physical activity as a way to relieve stress and de-attach from work, representing intrinsic motivation for nurses. The main strategy to fit physical activity into their busy schedule was to exercise either before or after work, which was associated with improved health and increased energy levels at work. Two nurses in the total group reported that they enjoyed cycling to work and this was associated with improved quality of

sleep, especially after working night shift.

'I just go for a walk or something and that's really helpful. It de-stresses you' (N4, FG4)

'I find that if I am doing a little bit of physical activity before work, I feel energised.' (N1,FG1)

'I'd ride home and I'd definitely sleep better, yeah' (N2, FG2)

4.4.3 Strategies for future workplace health promotion interventions

Nurses felt their knowledge on healthy lifestyle, specifically diet and physical activity, were not enough to overcome the barriers towards improving these behaviours. They expressed an interest in workplace health promotion interventions to help them improve their lifestyle, and to help them overcome the barriers they experienced. Considering the determinants previously discussed and participants' suggestions, the nurses emphasized that one of the key concepts for future interventions is to keep them 'simple'.

'Because I know…what's healthy and what's not. I can't stop it putting food into my mouth!! You know?...I know the types of exercise I could be doing to reduce it all, and knowing that doesn't help and hasn't help, clearly.' (N2, FG2)

Social support

Social-support for diet and physical activity appeared to be a strong extrinsic motivator for nurses. For example, nurses suggested they could limit the intake of unhealthy snacks during night shift if there was a group/ward commitment towards this goal. In terms of physical activity, nurses indicated that social support could promote physical activity engagement. Exercising with colleagues was described as a way to socialise outside work, have fun, and promote team-building.

'*We said don't bring any chips, don't bring any cake, we are just gonna bring sensible food' (N3, FG2)*

'It was more about that collective group exercising together apart from doing what our normal job was. And it was really good' (N2, FG4)

Social media and apps

Participants discussed the use of technology to promote social support, communication and motivation. Some reported they tried to use social media (Facebook) to improve their diet and physical activity in the past. Apps were perceived as a strategy that could help them stay motivated and allow the nurses to receive weekly reminders.

'I suppose those app like say something positive everyday (…) or something like that, sort of encouraging the group' (N1, FG1).

'We had this kind of Facebook thing like 10-week challenge …there were a couple of us doing it too' (N2, FG4).

Self-monitoring

Self-monitoring was suggested as a simple way to improve current diet and physical activity behaviours. Having a pedometer to count daily steps accumulated was one of the strategies suggested to promote physical activity at work and at home. It could lead to intrinsic motivation to move more and could be used for a workplace challenge.

'A pedometer is a good motivational tool. Could you provide pedometers for everybody maybe? Like a workplace step-challenge or something…it could work!' (N2, FG4)

Goal-setting

Setting goals to promote healthy diet and increase habitual levels of physical activity was identified as a feasible and acceptable strategy. Goals could be set using a mobile app and these could promote intrinsic motivation towards diet and physical activity behaviours. Goal-setting was associated with social support, for example, having team-based challenges and goals.

'I think you have to have an app which has set 5-6 random goals… and then maybe have a different section where you kind of can put your own goals' (N1, FG2).

'I heard you gotta write goals, and you gotta stick to them and reward yourself kind of stuff' (N4, FG3)

Workplace culture

Participants often reported that incorporating physical activity in the workplace would help them to be more active. This was particularly important for those who found it difficult to exercise before or after work. A change in the workplace culture was seen as a necessary step to enable healthier lifestyle practices at work. This could represent an important extrinsic motivation towards healthy eating at work. Importantly, participants felt this change should come from management.

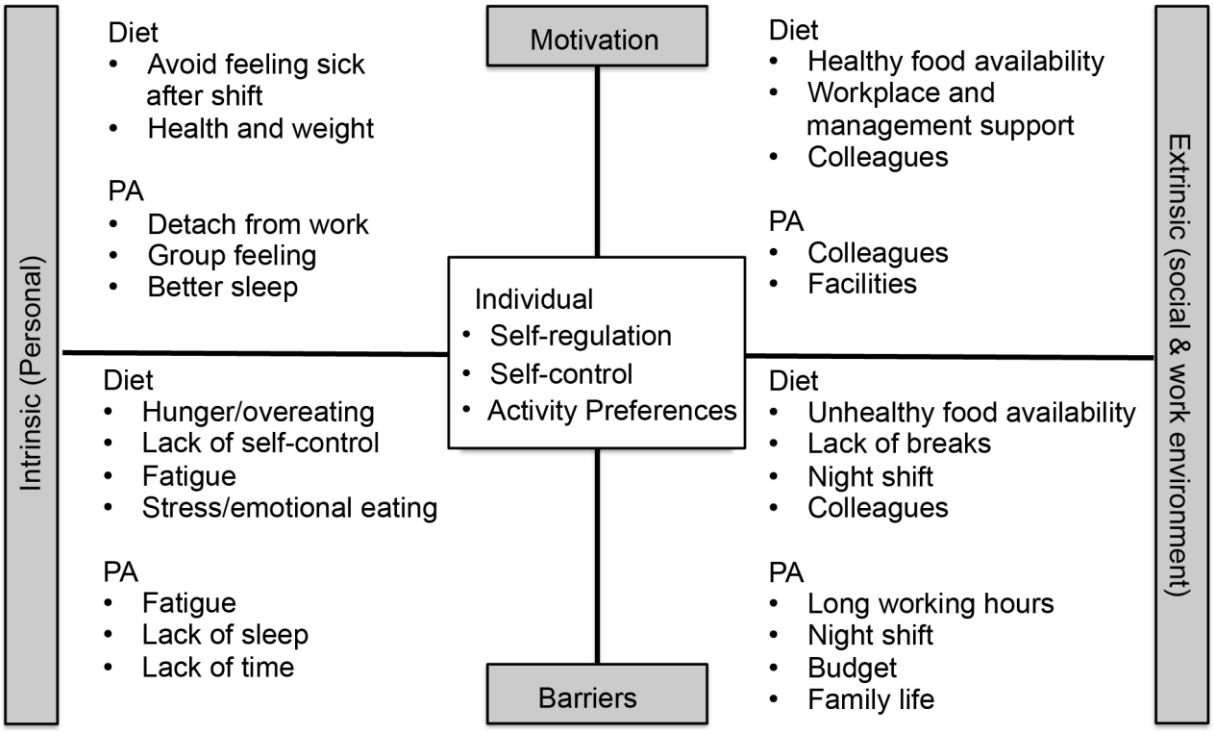
'And sort of a culture thing, where there is an encouragement of healthy lifestyle practices, encouraging commitment within departments to do that kind of thing' (N3, FG2)

'Making it a policy of the hospital… Get up to management and go "this is what I want to do, bring this in and make everyone do it".' (N2, FG3)

4.4.4 Interplay of behaviour determinants and Self-Determination Theory

The resulting determinants for diet and physical activity were organised and interpreted using the Self-Determination Theory as a framework (see Figure 4.1). Here, individuals' behaviour is placed in the centre with extrinsic determinants (social and work environment) on the right side, and intrinsic determinants (personal) on the left side. Determinants were organised in motivational determinants (upper-side) or barriers (bottom-side), and then classified based on whether they influence diet or physical activity. For example, health, wellbeing and weight management were intrinsic motivation cues for healthy eating and being active. However, fatigue and lack of self-control were intrinsic barriers to healthy behaviour, with work colleagues representing both extrinsic motivation and a barrier to healthy diet and physical activity.

Figure 4.1 Interplay of diet and physical activity (PA) determinants, and SDT.



4.5 DISCUSSION

The focus of this chapter was to explore perceptions and determinants of healthy diet and physical activity behaviours in nurses. This represented a component of a Needs Assessment to inform future workplace intervention strategies. Using the Self-Determination Theory as a framework, we identified the following factors influencing nurses' diet and physical activity behaviour: individual barriers and motivation (intrinsic), social support (extrinsic) and work environment (extrinsic). Based on what our participants felt and the interpretation with SDT, it appeared that extrinsic factors were perceived to have a greater influence on dietary behaviour than intrinsic factors.

The major factor influencing diet was a complex cycle between lack of breaks at work, being hungry, decreased self-control and leading to overeating and/or making unhealthy choices. This provided an insight of why long shifts and night shifts have been previously portrayed as a barrier.[168, 234] In particular, nurses working night shift have been described as more likely to adopt abnormal eating behaviours, like consumption of high-fat foods and snacks.[179] As with a previous study, our participants associated night shift work with increased body mass over time.[27] These results suggest the need to develop strategies for nurses to better cope with the negative impact of night shift to limit the onset and further development of obesity.

Job demands and work environment were extrinsic factors negatively impacting diet and physical activity. An example of this was availability of chocolates and candy at work and nurses eating them just because "they were there". Cheung [240] also found a high consumption in nursing staff with an average of 5.4 chocolate portions/day being eaten. Job demands and consequent fatigue discouraged nurses to be active after work and during their days off. Fatigue, long working hours and lack of time were found to be main barriers to physical activity, which is congruent with previous studies.[30, 168, 209, 234] Participants reported that having the necessary knowledge of healthy behaviours was insufficient to counteract these barriers. They discussed the need for a workplace health promotion interventions that could help them cope with their barriers and encourage them to improve their diet and physical activity behaviours.

Based on SDT, the mismatch between knowledge and behaviour could be explained as decreased motivation and self-efficacy to perform healthy behaviours, because of low perceived competence and autonomy.[241, 242] Low perceived competence is when individuals are not motivated enough to prioritise a behaviour when faced with other interests or demands of their time (i.e. participants not exercising because they prefer to doing other things in their free time). Decreased autonomy is when an individual starts and fails to maintain a behaviour (i.e. being mindful about food) by feelings of "having to" (controlled motivation) rather than volition, importance or enjoyment of that behaviour (autonomy). Nurses' difficulty to engage and maintain healthy behaviours further highlighted the need for a workplace intervention with appropriate strategies to improve their autonomy and competence.

One aspect that could contribute towards increasing nurses' autonomy and competence in physical activity, for example, is experiencing and focusing on the benefits of physical activity. Participants in the study felt motivated to engage in physical activity because of its health benefits. They described these as experiencing increased levels of energy before work, improved sleep quality especially after working night shift, and decreased stress levels. Further, nurses have previously described physical activity as a stress coping mechanism.[168] Given the stressful nature of nurses' job, the positive effects of physical activity, and the high incidence of overweight and obesity in this group, physical activity should be promoted in future workplace intervention both as a stress coping and weight management strategy.

The social and work environments were identified as the main factors that should inform the design and components of future interventions. Peers in similar situations, who provide support, understanding, and coping strategies, stimulate social support.[243] A recent intervention study showed that physical activity increased more in a walking support group with pedometers compared to the pedometer only group (10,064 vs 12,472 steps/day; $p<0.05$).[244] Support from colleagues for the promotion and commitment of limiting the amount of unhealthy food at work was mentioned across all groups. Social support from work colleagues could motivate nurses to make healthier food choices at work and be more active outside work.

Other strategies for future workplace health promotion interventions could include goal-setting and self-monitoring, as suggested by the participants in this study. Mobile apps could assist promoting these approaches. Diet and physical activity self-monitoring

has been shown to significantly reduce energy intake (1437±188 vs 2049±175 kcal/day, p=0.01) and BMI (31.5±0.5 vs 32.5±0.5 kg/m2; p=0.02) in app users compared to non-users at 6 months.[245] Participants in our study also referred to pedometers as a simple strategy to monitor their physical activity. Pedometers are widely used in health promotion, and have been shown to successfully increase physical activity.[244] Pedometers and apps have the potential to be included in future workplace interventions for nurses, as they are a practical low-cost tool to promote and motivate self-monitoring and goal-setting.[146, 246]

Participants felt that healthier behaviours could be promoted at their workplace if management were involved. Lemon *et al.* [39] showed how hospital employees' job perceptions changed with a diet and physical activity workplace interventions. Although BMI changes were small, employees' perceptions of organisational commitment significantly improved at 12 and 24 months.[37] Therefore, having management involved in future interventions will not only encourage enrolment and facilitate participation, but will also highlight the importance of the intervention itself.

One of the strengths of this study was the use of focus groups as a method to explore nurses' perceptions of physical activity and diet. Having semi-structured questions generated discussion among participants, providing richer data than previous similar studies.[30, 168, 209, 234] Although some barriers towards diet and physical activity are well reported in the literature, by using SDT as a framework, we were able to shed light on nurses' motivation to adopt healthier behaviours. As SDT states, motivation is the key for behaviour change and maintenance of new behaviours.[235] Another strength was having a question guide checked and adapted to avoid irrelevant or ambiguous questions. Having a question guide ensured consistency across groups and facilitated the comparison of data between groups.

However, the main challenge was the recruitment and participation rate, which led to a small convenience sample. The majority of the contacted nurses was busy and had little time to participate. As a result, it was difficult to find participants willing to stay outside working hours, and to find a suitable day and time for the each FG. For this reason, one of the FGs lasted less than one hour. This study aimed to provide preliminary data for the design of an intervention, and this was specific to the context and setting being investigated. Thus, determinants of diet and physical activity in nurses in other contexts and settings may be different.

4.6 CONCLUSION

The work environment was the major barrier towards healthy diet, while fatigue after work challenged physical activity behaviour. Long working hours and lack of breaks challenged nurses' diet self-control and self-regulation. Social environment at work seemed to be an effective external motivation to diet and exercise. Workplace health promotion interventions for nurses tailored to their needs and job characteristics are sought and long needed. Future interventions should foster social support from colleagues, implement workplace environmental changes, and seek the target group's feedback on the intervention's strategies and development. For effective workplace interventions, the study design and theory selections should be directed by the target group's determinants of both current behaviours and desired outcomes.[18] Thus the finding of this chapter provided the basis for the development of an intervention tailored to nurses characteristics, which will be describe in detail in the next chapter (Chapter 5).

SECTION 2
NEEDS ASSESSMENT APPLICATIONS AND RESULTS

The information and findings from Chapters 2, 3 and 4 were used to inform the Needs Assessment for this group, by following the PRECEDE model (*see* Diagram S2.1). This model explains the logic of change that will be implemented in the intervention study (Chapter 6).

The focus group data (Chapter 4) provided a better insight about potential participants, their barriers and enabling factors towards diet and physical activity. Determinants for behaviour change and intervention strategies for this target group (nurses) are summarised in Table S2.1, and included:

- Time, tiredness and family commitments were often the major barrier towards physical activity engagement
- Nurses reported that doing exercise help them relax and disconnect from job stress
- Exercising before work or actively commuting to/from a shift, helped nurses having a better sleep after work.
- Peers' success stories about healthy diet and exercise motivated and inspired nurses to overcome their barriers, because they can identify with such stories.
- Having a buddy/social support was often the main motivation for exercising.
- Pedometers were indicated as an easy and simple way to monitor one's activity and motivate walking.
- Nurses indicated they could limit the intake of unhealthy snacks during night shift if there would be a group/ward commitment about this. Some reported previous success stories about this approach.
- They expressed their desire to have a simple intervention that could help them become more active, and be more mindful about their lifestyle.

Chapter 5, will describe the translation of the PRECEED model and Needs Assessment data into the intervention design following the Intervention Mapping Framework. Chapter 6 will then describe the implementation of the intervention study and results from primary and secondary outcomes. Finally, the intervention study will be evaluated from a process and economic evaluation point of view in Chapter 7 and 8, respectively.

Figure S2.1 – Needs Assessment results using the PRECEDE model

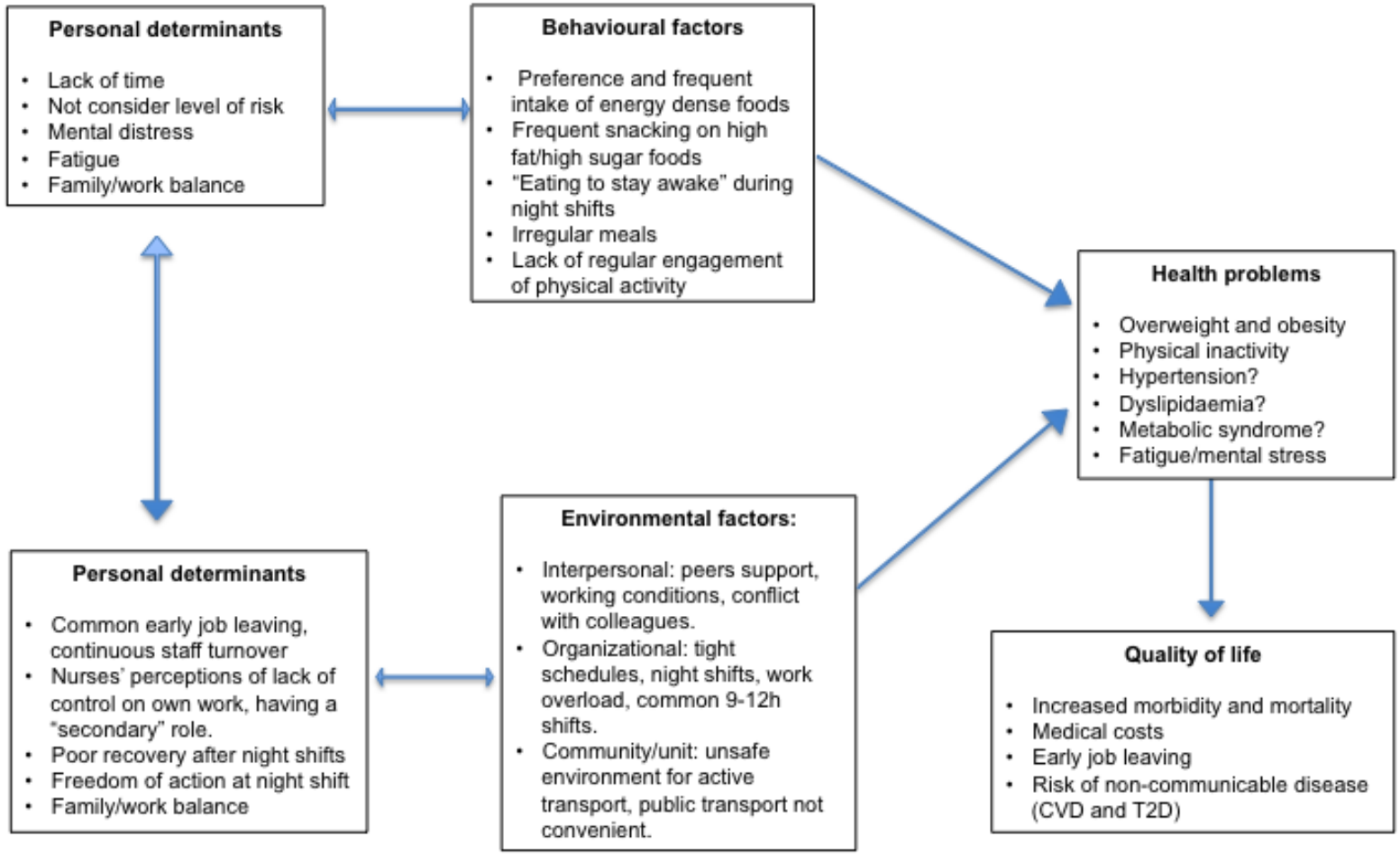


Table S2.1 – Summary of major themes across focus groups

Themes	Nodes	Environmental Factors	Individual Factors
Profession	• Environment • Low job control • Change from nursing • Choose nursing • Sleep patterns	Job culture Patient load Schedule/roaster Management	Health Lifestyle Stress Fatigue
Perceptions	• Diet • Physical Activity • Healthy lifestyle	Schedule/roaster Night-shift Family Social environment	Stress Health Balance Mental health
Barriers	• Depression • Time • Low job control • Nigh shift • Environment • Diet	Schedule/roaster Food availability Social environment Facilities Organisation support Job culture	Sleep patterns Fatigue "Eat whenever" Hunger Time Emotional stress
Motivation	• Intrinsic • Extrinsic	Social support Success stories Job culture (change) Workplace Facilities (change) Management/organisation support (change)	Health Weight Fun/relax Goals
	Intervention	**1. Pedometers** **2. Apps** **3. Social/peer support.** **4. Motivational messages** **5. Social media**	

Red indicates potential areas of intervention.

CHAPTER 5
STUDY PROTOCOL

This chapter describes the rationale behind the intervention study development, using information from the Literature Review (Chapter 2), the Systematic Review (Chapter 3), and the Needs Assessment (Chapter 4).

5.1 INTRODUCTION

The summary of the Needs Assessment (Section 2) provided a better understanding on the target group's health problem, and their determinants of diet and physical activity behaviours. However, to successfully achieve behaviour change, interventions need to be thoroughly designed using a strong theoretical rationale considering the determinants influencing diet and physical activity.[18]

Previous workplace interventions have achieved significant effects on diet, physical activity and sedentary behaviours in other workforce populations.[42, 50] While methods and intervention design cannot be translated straight forward from these studies, the framework used to develop them can be used as a guide. Intervention Mapping (IM) protocol is a framework that systematically guides the intervention design process with the advantage to provide a clear link between target group's needs, theoretical methods and health outcomes [18]. This approach focuses on the search and promotion of determinants for the required behaviour change, instead of predictors of present behaviour. Thus, developing a workplace intervention using IM could contribute to the knowledge of which intervention tools and theories are more suitable to promote behaviour change in in nurses.

5.2 AIM

To describe the development of a workplace intervention to promote diet and physical activity in nurses, using IM as a framework.

5.3 METHODS

This study protocol was developed following the IM framework.[18] The framework contains 6 steps, 1) Needs Assessment; 2) Matrices of change objectives; 3) Theory-based intervention methods; 4) Intervention program; 5) Plan for adoption and implementation; 6) Evaluation plan. Each of these steps are described below.

5.3.1 STEP 1: NEEDS ASSESSMENT

The first step of IM included the assessment of target group's health, need for, and interest in a workplace health promotion intervention, and previous evidence in intervention strategies. Data for the Needs Assessment were gathered through a) Review of the literature on nurses' health behaviours (Chapter 2); b) Systematic Review to identify evidence-based interventions (Chapter 3); and c) Focus group interviews with nurses (Chapter 4).

Review of the Literature

As described in Chapter 2, nurses provide a 24/7 service, with unpredictable demands and the obligation to maintain a minimum staff number on duty in every shift (minimum nurse-to-patient ratio).[166, 247] This means shifts are long and rotational, with nurses often not knowing when or if they will take a break.[166, 208] While rotational shift, and in particular night shift, were described as the main reason for irregular meal patterns;[179] low physical activity self-efficacy, and lack of time and social support were reported as the main barriers to an active lifestyle.[28, 30, 167] Determinants of diet and physical activity in nurses included stress, anxiety, and the work environment.[179, 209, 248]

Systematic Review on effective strategies

From the Systematic Review finding (Chapter 3), strategies that seemed to improve diet and physical activity behaviour included pedometers, walking stations, manipulation of worksite, and social support from a "nurse champion". For example, the "nurse champion" strategy increased diet self-efficacy and aerobic minutes of physical activity at 3-months [218], while pedometers increased nurses' daily steps after 3 weeks.[215] However, most of the reviewed interventions did not use a systematic design process. Thus, making it unclear if the small effects observed were possibly due to less than ideal intervention designs, or a genuine difficulty in influencing diet and physical activity behaviours.

Focus group interviews

Key determinants & risk factors for low physical activity and diet

In the focus groups (Chapter 4), nurses described a complex cycle of being hungry, lack of breaks, losing self-control and overeating and/or making unhealthy choices

challenged diet behaviours. Job demands and consequent fatigue discouraged nurses to be active after work and during their days off. Fatigue, long working hours and lack of time were the main barriers to physical activity. Perceived benefits of physical activity such as relaxation, feeling energised before work, and better sleep after working a night shift, were the main motivations for exercising.

Intervention input from focus group interviews

FG participants' indicated that social and work environment represented the main areas for potential intervention. Peers in similar situations, such as work colleagues, stimulate social support and coping strategies.[155, 243] Some FG participants indicated that their type of work often made it hard to find time to exercise, but having someone to exercise with could motivate them to engage in more regular physical activity. Participants also suggested using pedometers as a simple way to monitor their steps and see how much they are moving (self-monitoring). This tool could also help them set step goals and improve their physical activity levels. Setting goals was mentioned also in terms of diet. Participants felt that setting diet goals could be a useful strategy to make them more aware of what they are eating, and could facilitate diet changes. The findings from the FG showed that goal-setting, self-monitoring, and social-support are the most applicable strategies to motivate nurses to improve their diet and physical activity behaviour.

5.3.2 STEP 2: PERFORMANCE OBJECTIVES, DETERMINANTS, AND CHANGE OBJECTIVES

In this step, Performance Objectives were established in order to achieve desirable Program Objectives (identified on Step 1). The Needs Assessment indicated that job and work environment undermine nurses ability to maintain a healthy diet and active life. Therefore the Program Objectives, were identified as:

- Nurses improve their diet quality by limiting the amount of unhealthy snacks at work, and improving the quality of their meals.
- Nurses increase their physical activity by increasing their steps and minutes of daily physical activity, in particular during their days off work.

We defined Performance Objectives as small goals and actions that build-up the behaviours identified as Program Outcomes (i.e. improved diet and physical activity behaviours). Program Objectives were identified considering determinants that depend on

the characteristics of the target group (their beliefs, knowledge, motivation, etc.). Therefore, we used the information gathered from the Needs Assessment to choose relevant behavioural theories to influence the determinants of such behaviours (Personal and Environmental Determinants).[51] The interplay between determinants and performance objectives are described in the Matrix of Change (Table 5.1).

Table 5.1 Matrix of change

Program Objectives	Performance objectives	Personal determinants	Environmental Determinants
Nurses improve their diet quality	• Swapping energy dense snacks with nutritious ones to avoid feeling hungry and making unhealthy choices • Limiting the availability of sweets and chocolate on the floor/wards • Bringing healthy meals at work and try to have regular meal patterns • Colleagues influencing each other to adopt a healthier lifestyle. • Improving self-regulation on food choice	Perceived barriers Motivation Self-efficacy Self-regulation Attitudes/Habits	Social support Shifts Food availability
Nurses increase their physical activity levels	• Implementing active transport and other small changes to promote PA • Increasing daily steps and minutes of PA, especially in their days off. • Using PA to socialise with colleagues/friends. • Exercising before/after shifts • Sharing positive experiences to motivate each other	Perceived benefits/ relevance Skills Job-family balance	Opportunities Social support Time pressure

PA: physical activity

Determinants of behaviour change (Personal and Environmental)

Personal Determinants are described as subject to direct control or influenced by individuals, while determinants of environment depend on the external factors that mediate their behaviours, including social influences (norms, social support, reinforcement) or structural influences (resources, policies, climate). In the Needs Assessment (Chapter 4), we identified personal and environmental determinants for both diet and physical activity.

We found that food availability, social support, self-regulation, self-efficacy, and current habits to be the main determinants for diet. The main determinants for regular physical activity included social support, time, skill/ability, self-efficacy, motivation and personal health-beliefs. For example, nurses indicated they might be able to limit the intake of unhealthy snacks during night shift if there was group/ward commitment towards this. In terms of physical activity behaviour, exercising with colleagues was a way to de-attach from work and have fun, but also a team-building and social activity.

5.3.3 STEP 3: METHODS AND STRATEGIES

Theory-based intervention methods

Theory-based behaviour change methods and practical applications were explored to inform evidence-based intervention development. Since promoting internal motivation emerged as a key factor to achieve behaviour change (Step 1), we selected Self-Determination Theory (SDT) [158] as the theoretical basis underpinning this workplace health promotion intervention. SDT describes the intention to perform a behaviour (motivation) as a condition and key factor of behaviour's implementation.[235] SDT can be used to understand the interplay between intrinsic motivation (personal/individual) and extrinsic motivation (environment), and adherence to health behaviours.[159]

The nurses participating in our focus groups reported that setting goals would motivate them to achieve behaviour change. Goal-setting involves individuals choosing goals that will require a higher performance to be reached.[249] Personal meaning (importance) and self- efficacy (confidence to reach that goal) influence the goal choice. In the process of reaching their goals, individuals evaluate personal performance, which positively impacts personal satisfaction about the changes made to achieve the goal.[249] Goal-setting is a

promising strategy to promote diet and physical activity behaviour change.[250] Workplace health promotion interventions that have used this strategy showed increased time spent being physically active and increased vegetable/fruit intake. [43, 224]

Self-monitoring was also suggested as a motivational tool. This theoretical construct states that when individuals pay attention to their behaviour (monitor), they are more aware of these, which triggers self-regulation of their behaviour.[251] For example, by counting and recording food intake, the individual can learn to de-automate a problematic behaviour with known consequences, such as frequent consumption of chocolates or candy and weight gain.[252] Therefore, self-monitoring, together with self-evaluation and consideration of consequences, constitute a three-phase model that emphasises motivation for self-change.[252] This technique is often used in lifestyle interventions, especially those including weight management, diet and physical activity.[43, 253]

Finally, social support, a theoretical construct from Social-Cognitive Theory, was identified by our nurses as a determinant of healthy behaviours.[196] Social support can enable individuals to change their behaviour through vicarious experience, i.e. seeing peers succeed in the adoption of new behaviours (modelling).[155] Social support in workplace health promotion interventions has previously been used as an effective strategy to engage co-workers to initiate and maintain changes.[254] In nurses, a "nurse champion" to promote healthy diet and physical activity among colleagues, has resulted in increased diet self-efficacy and increased physical activity.[218]

5.3.4 Step 4: Intervention components and materials

Intervention materials

Strategy selection was based on the systematic and literature review, participants' suggestions, and feasibility of tools in the workplace setting. For example, nutrition counselling and group education sessions were used in this population before (Chapter 3), but these would not have been feasible for the potential participants of this study. Such activities would have been time consuming and hard to deliver at a suitable time, since the majority of the potential participants worked rotational 12-hour shifts. In addition, limited time commitment to the intervention was a desirable feature by the focus group participants, ethics committee, and nurse managers.

Facebook group

Web-based interventions have been shown to improve lifestyle behaviours, with greater improvements observed when these tools included behaviour change theories.[255] For example, in a university-based workplace intervention, participants using social media for social support increased their steps, and were more likely to reach their goals compared with those working individually.[256] Similarly, in a hospital-based study, nurses wearing a pedometer were divided into a socially-enabled group (i.e. can view other participants' steps on social media) and into a non socially-enabled group (i.e. can only see personal steps). Only those participants that could share and view others' steps significantly increased their steps.[257] Authors reported that participants enjoyed using social media to compare their steps and found it motivating.

Some FG participants indicated that their long working hours and shifts often made it hard to find time to socialise and exercise, but having an 'exercise buddy' could motivate them to engage in more regular physical activity. In a study that used social media to create a supportive network to promote physical activity, authors highlighted the importance of making participants feel part of and identify with a community.[243] Participants can identify with the social media group, for instance, when they have something in common (e.g. same workplace) or face similar challenges (e.g. same barriers towards physical activity).[243] We created a Facebook group to form an identifiable community for participants, making social support and interaction possible and feasible in this busy group. This tool also aimed to help interested participants to find an exercise partner, and be a platform to share information and motivation to achieve diet and physical activity goals. Participants in our study were encouraged, but not required, to post content and interact with the group and its members (e.g. share their progress or their difficulties to reach goals, comment on other members' posts, etc.).

Pedometer

In our focus groups, participants indicated that they could be more active if they had a self-monitoring tool. They suggested pedometers as a good self-monitoring tool as it can be used together with positive feedback from friends and colleagues, and to create pedometer challenges in workplace settings.

Pedometers are small portable devices containing a motion sensor sensitive to ambulatory activity, such as walking and running.[143] They represent an affordable instrument to measure physical activity by counting steps. However, because participants can access the display and see their steps in real-time, it is more commonly used to motivate and influence physical activity through self-monitoring.[146] The systematic review (Chapter 3) found one study that promoted physical activity self-monitoring and motivation through the use of pedometers, with inactive nurse managers showing an increase in their daily steps after 3 weeks.[215] In another study, that included mixed hospital staff, participants' average walking time improved by 200 minutes/week.[41] Our participants were encouraged to use a pedometer to monitor their steps and set daily step-goals, such as "try to reach 10,000 steps/day" (considered to be a sufficient level for health benefits).[143]

Smartphone Application (App)

Given the widespread use of smartphones and their potential to reach the general population, there is an increasing interest in smartphone applications (apps) to promote healthy behaviours.[258, 259] For example, mobile apps can be used to promote goal-setting and self-monitoring of diet and physical activity.[260] In a study that compared traditional versus app self-monitoring, app users achieved more positive results on energy intake and BMI, compared to non-users.[245] The participants in our study also discussed the use of apps to change diet and physical activity. Some of them reported using apps in the past for counting calories, and others referred to friends using them to track physical activity. Participants considered the "reminders" function in most diet and physical activity apps a desirable characteristic to keep them on track with their new behaviours (Chapter 4). They also felt that an app with positive messages and feedback could motivate them to be more active and mindful about their diet.

We searched the literature and internet to find a smartphone app that could address participant preferences, but also include behaviour change theories. We selected a free coaching app (Coach.me app - https://www.coach.me) that uses goal-setting and positive feedback to help users change their behaviours one step at a time. Users can select their goals from an existing list or create their own goals. Utilities of this app include setting reminders at desired times of the day, and positive feedback in real-time and through a weekly email when achieving a goal. Participants can invite friends to use the app, do a challenge together or simply share their results on the dedicated Facebook group.

Participants can also ask questions to the community about strategies to reach goals or share their experience, promoting social-support and modelling.

5.3.5 STEP 5: ADOPTION & IMPLEMENTATION PLAN

Implementation barriers and strategies

In this step, potential users of the intervention program were identified, including participants from the focus group (Step 1). Barriers and facilitators for program adoption and implementation were also identified. Nursing managers at the study sites were contacted to inform them of the workplace intervention and to verify if there was any other program currently being implemented. The researchers met with the managers to identify adoption and implementation barriers. Managers were interested and enthusiastic about the proposed study, but pointed out some barriers we could face during participants' enrolment and outcome measurements. These included nursing staff characteristics and working hours, such as difficulty for Emergency Room nurses to find a specific time to meet, or setting late afternoon/night meeting for night shift nurses. Another barrier was the limited availability of staff during non-working hours, and thus the need to have manager's permission to meet them during working hours to limit this attrition.

Managers suggested giving a pedometer as an enrolment gift, as a strategy to encourage participation. Another suggestion included getting participants baseline measurements and paperwork collected in 15-20 minute session. In this way, nurses could meet the researchers during working hours or right before/after their shifts. The nursing managers also suggested that participants be allowed to complete time-consuming forms, such as the Food Frequency Questionnaire, after work. Other implementation strategies included managers introducing both the researchers and the project to Nurse Unit Managers (NUMs) during staff meetings. NUMs were asked to present the intervention study, encourage participation and distribute flyers to all nursing staff via email. Nurses enrolled in the study were given small flyers to distribute in their staff rooms, and were asked to spread the word among colleagues (snowball recruitment).

5.4.6 STEP 6: EVALUATION PLAN

In order to assess intervention effectiveness, a quasi-experimental study was implemented. The intervention group was exposed to the intervention materials (Facebook group, smartphone app and pedometer), and was encouraged to improve their physical activity levels and diet quality. In the original protocol we described the control group as receiving no intervention. However, given the small numbers of recruited nurses, the study design changed into a pre-post intervention design. Primary outcomes for diet, physical activity and secondary outcomes are described in this section will be assessed at baseline, 3-month and 6-months.

Process evaluation will follow the RE-AIM framework, which will include performance objectives and determinants as expressed in the change objectives (Step 2). Finally, an economic evaluation will be conducted and discussed in a separate paper.

Study design

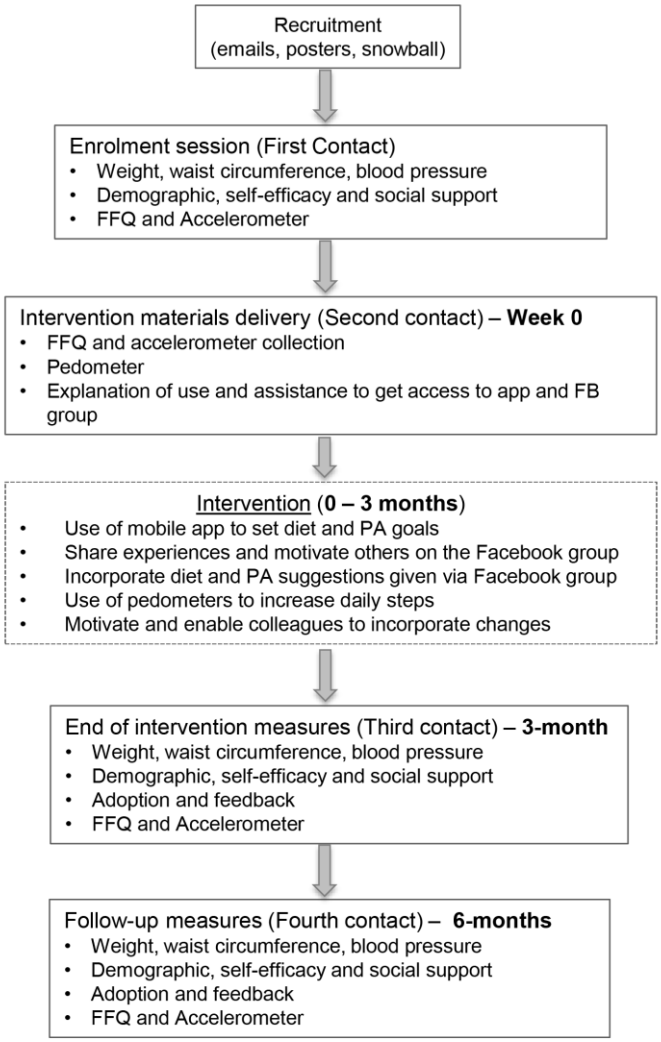
The study aimed to promote healthy diet and physical activity through goal-setting, social support and self-monitoring. The study had originally a quasi-experimental design, but given the difficulties in recruitment it was re-adapted to a pre-post test study that lasted three months, and included a convenience sample of nurses working at two hospitals. During the intervention, participants were encouraged to use 1) a coaching app for self-monitoring and goal-setting of diet and PA goals; 2) a dedicated Facebook group for social support; 3) a pedometer for self-monitoring, motivation and goal-setting to increase physical activity. Adoption was measured at the end of the intervention using a questionnaire to assess the frequency of materials' used. Questionnaires regarding changes in social-support and self-efficacy were measured to assess the impact of the intervention in these behaviour determinants, and to assess the correlation between observed behaviour change and determinants' change. The intervention design and time-point measurements are presented in Figure 5.1.

Population

Adult nurses (>18 years old) working at one of the two hospitals in Brisbane were recruited. Nurses working in patient care in either full-time or part-time basis were eligible for participation. Given the particular effect night shift has on nurses' health and lifestyle, we aimed to recruit nurses who work both night and day shifts. Participants were excluded

if they had uncontrolled hypertension and diabetes, unstable angina, orthopaedic or neurological limitations. Other exclusion criteria included current or planned pregnancy, or planned operation during the research period. Participants were screened for eligibility using a questionnaire during the first meeting with the researcher. Only participants that met the inclusion criteria and signed the consent form were included.

Figure 5.1 – Intervention design and implementation flowchart



Measurements

All measurements were taken at baseline, 3-month (post-intervention) and 6-month (follow-up at 36-week) time points. The primary outcomes were diet and physical activity behaviour changes. Secondary outcomes include weight/BMI, waist circumference, blood pressure, self-efficacy and social-support, general health.

Physical activity

Previous studies in this population lacked objective and reliable methods to measure physical activity, as shown in Chapter 3. Physical activity was measured using the Actigraph GT3X+ (Actigraph LLC, Florida US), which has been validated for the objective measurement of physical activity and sedentary behaviour.[261] Participants were instructed to wear this device for seven consecutive days. According to best practice guidelines, a

complete day was considered to have at least 10 hours of wear time, while a complete "week" had at least 4 complete days (including one weekend day).[262, 263] We collected information about duration, frequency (bouts), patterns, and intensity of physical activity (sedentary, light, moderate and vigorous).

Diet

Participants' dietary patterns were assessed using the Australian Eating Survey for Adults (New Castle Innovation). This was a Food Frequency Questionnaire (FFQ) used to collect information on food consumption in the past 3-months. Food intake was analysed using the Australian Recommended Food Score (ARFS).[105] The ARFS has been recently validated with a middle-aged cohort in the Australian Longitudinal Study on Women's Health. [108, 110] The calculation in this score was based on regular consumption of FFQ items that are in line with Australian dietary guidelines.[109, 264] The method included seven sub-scales with scores ranging from 0–74. The sub-scale scores were calculated from food groups with one point awarded for each item reported as being consumed at least once a week).[105] The maximum score is 74, reflecting the healthiest or most optimal diet quality score. Previous studies using this tool described better self-reported health status, higher intakes of key nutrients, and lower intakes of total fat and saturated fat in subjects among the highest quintile score compared to those in the lowest quintile.[110] Therefore, this tool was used to assess changes (pre-post intervention) in overall score, prevalence of healthy choices, and frequency of unhealthy foods.

Secondary outcomes

Anthropometric measures

A researcher measured weight and height from each participant using an electronic scale (Charder MS 3200, Hamburg, Germany) and stadiometer (SECA 217-172-1009, Hamburg, Germany) approximating to the closest 0.1kg and cm, respectively. These measurements were used to calculate BMI following the formula BMI= weight (kg)/height^2 (m^2), and criteria BMI>25= overweight; >30= obese.[265] Waist circumference was measured at the narrowest point (mid-point) between the lower costal border and iliac crest using a retractile measure tape, and following the protocol published by the World Health Organisation's expert report.[266]

Blood pressure

An electronic sphygmomanometer was used to measure blood pressure, and researchers took note of any factors influencing blood pressure, including caffeine intake and exercise. To ensure accuracy, all measurements were taken twice. In case of a difference >5% between the two numbers, a third measurement was taken.

Self-efficacy and general health

Self-efficacy and social support were measured for both diet and physical activity using validated questionnaires and scales.[267-270] Self-rated health (ranging from poor to excellent) was assessed using a single item question extracted from a validated tool (SF-36 Health Survey). [271]

Statistical analysis

The effectiveness of the lifestyle intervention was assessed using a repeated measures analysis (ANOVA) with the outcome measures at follow-up (3-months and 6 months from end of intervention) as the dependent variables, and adjusting for the baseline levels of the outcome measure. Both crude and adjusted analyses were performed. All available data of the participants was used for data analysis and missing data was managed with Intention-to-treat (ITT). All statistical analyses were conducted in SPSS version 23 (IBM Corporation). P-values based on two-sided tests were used and considered statistically significant at $p<0.05$.

Sample size calculation

The sample size calculations were based on the changes in daily steps we expect to see, measured by accelerometers. We based the calculation on a physical activity intervention for nurses, where baseline steps were 7801±1962.[215] To see an increase from baseline to follow-up of at least 3000 steps (i.e. 30min of physical activity), at least n=17 participants at follow-up in each group were needed. This would ensure $\alpha=0.05$ level, with 80% power in a two-tailed test. Based on previous studies in this population,[212, 217, 218] we expected at least a 35% loss at follow-up meaning n= 23 participants per group were needed to ensure statistical power.

Process evaluation

The process evaluation was performed using the RE-AIM framework to evaluate the different intervention components [203] and it is presented in Chapter 7. The RE-AIM model assessed 5 dimensions: reach, efficacy, adoption, implementation, and maintenance. The key components of this evaluation were the adoption of intervention materials and frequency of use, to establish a relationship between observed outcomes and intervention effect. At the end of the intervention, we asked participants to fill-out questionnaires to assess reach and frequency of material use (e.g. FB logs, use of pedometers, using app to set goals). Participants' feedback was gathered using a questionnaire with open-ended questions regarding more/least liked intervention components, and suggestions on how to improve the intervention strategy.

5.4 DISCUSSION

This chapter aimed to describe the study development and protocol of a diet and physical activity workplace intervention for nurses. This workplace health promotion interventions aims to fill the gap between the lack of interventions promoting diet and physical activity in nurses, and the need to improve these behaviours in a feasible and sustainable way. Using IM as a framework allowed us to develop an evidence-based intervention, including the target group's input for the selection of intervention strategies and behavioural theories.

Although we are confident of the feasibility of this study, challenges remained regarding recruitment and retention rates. However, previous studies reported good retention and modest effects on physical activity levels using pedometers, which is included in this intervention.[215, 220] The other two materials included in our workplace intervention, Facebook group and smartphone app, also showed positive results in retention and diet and physical activity outcomes.[245, 257, 272]

The importance and the need of promoting healthier behaviours in nurses, and the impact this could have in the health care system, are well described in the literature.[23, 26, 29] Nurses could improve their health by reducing their risk of obesity and other NCDs, and be promoters and role models of a healthy lifestyle.[23, 29, 273] Further, the health care system

could benefit as nurses' improved health can have a positive impact on absenteeism, productivity, and quality of care.[274]

Patients reportedly feel less confident with overweight or obese nurses' lifestyle advice,[275] with the majority of these nurses avoiding discussion about obesity issues and lifestyle changes with patients.[276] Moreover, a report from UK's National Health System (NHS) highlights the need to have healthy health care workers to ensure a better service.[277] This report called for more workplace interventions to be implemented, as hospitals should be the leading example for other workplaces.[277] [278]

CHAPTER 6
IMPLEMENTATION OF THE WORKPLACE INTERVENTION STUDY

This Chapter describes the implementation of the previously designed workplace intervention to promote diet and physical activity in nurses. Contents of this Chapter have been included in a manuscript to be submitted by July 2016.

6.1 INTRODUCTION

Job strain and limited leisure-time can impact individuals' lifestyle leading to inactivity and poor diet behaviours.[163, 279, 280] Nursing, for example, is a stressful job with long working hours (< 9-10h) that has been described to negatively impact nurses' lifestyle.[30, 167, 233, 248] Many studies have explored the impact of job demands and environment on nurses' lifestyle behaviours. In previous studies, nurses described fatigue and lack of time as the major barrier to be physically active (Chapter 2 and 4). Participants here identified long shifts and lack of breaks as the major cause of overeating and poor dietary choices.

The barriers that undermine nurses' ability to have a healthy diet and active lifestyle are of concern, as more than 60% of nurses in Australia are overweight or obese.[174] Poor diet and physical activity behaviours are key risk factors for non-communicable diseases (NCDs), such as obesity, diabetes and cardiovascular disease.[7, 281] Because of nurses' difficulties in maintaining a healthy diet and physical activity behaviours, they are to be considered an at-risk population for NCDs.

While the potential of the workplace as a site to enable and encourage healthy behaviours in nurses is appealing, few interventions have been implemented so far.[48] In Chapter 3, a systematic review of the literature found only 9 studies, and these showed little to no changes in diet and physical activity behaviours. Thus, there is no clear evidence on which strategies work best for nurses. For this reasons, in Chapter 4 we collected information for a Needs Assessment on the target group, to then inform the development of a workplace intervention to promote diet and physical activity as described in Chapter 5. This chapter describes the implementation and evaluation of intervention outcomes.

6.2 AIM

The aim of this chapter was to test the implementation and uptake of a diet and physical activity workplace intervention developed using target group's input and characteristics, as described in Chapter 5. The intervention also aimed to assess changes in NCDs risk factors (weight, Body Mass Index - BMI, waist circumference, blood pressure) as secondary outcomes.

6.3 METHODS

We designed a 3-month workplace intervention which aimed to promote healthy diet and physical activity through goal-setting, social support and self-monitoring. The study was developed using the Intervention Mapping (IM) as a framework (Chapter 5). This process included a Needs Assessment to inform intervention development by assessing target group's need for and interest in a workplace health promotion intervention. Information from Chapter 4, together with a review of the literature in Chapters 2 and 3, helped identify evidence-based intervention strategies. The rationale for study design, recruitment, intervention materials and behaviour change theory selection, and outcome measures were described in detail in Chapter 5. Therefore, these will be briefly mentioned in this section.

6.3.1 Intervention design

This study was a 3-month pre-post test study, and included participants (>18 years old nurses) recruited from two hospitals in Brisbane using emails, posters and word-of-mouth. Nurses working in patient care in either full-time or part-time basis were eligible for participation. Participants were excluded if they had uncontrolled hypertension and diabetes, unstable angina, orthopaedic or neurological limitations. Other exclusion criteria included current or planned pregnancy, or planned operation during the research period. Outcome measurements were assessed at baseline, at end of intervention to measure changes (3-months), and at 6-months follow-up to measure maintenance. The primary outcomes included changes in diet behaviour (measured by Food frequency Questionnaire - FFQ) and physical activity behaviour (measured by accelerometers). Secondary outcomes were markers for NCDs (weight, BMI, waist circumference and blood pressure). Changes in self-rated health, and diet and physical activity self-efficacy and social support were measured too.

At baseline, the researcher met each participant to explain the intervention program and take all anthropometrical measures, collect demographic data, and administer questionnaires about self-rated health, self-efficacy and social support. Finally, each participant was given the FFQ and an accelerometer. They were instructed to wear and return the accelerometer after a week, when they will be scheduled for a second meeting (*see* Figure 5.1, Chapter 5). The purpose of the second meeting was for the researcher to

collect FFQ and accelerometer, and to explain intervention materials. During this session, participants were shown how to use the pedometer, app, and intervention's Facebook group. Participants were shown how to set goals in the app and were asked about the type of changes they would like to do. Consequently, they were given examples of diet and physical activity goals relevant to the changes indicated by them (e.g. do not eat enough vegetables = bring salad to work for lunch, do not have time to exercise = active transport to work, snacks on candy during shifts = bring a healthy and filling snack to work). Participants were instructed to choose the frequency of their goals based on an achievable and confortable start point for them. For example, "bring salad for lunch" can be first set as a once every three shifts/ once a week, and then gradually increase to every shift/every day.

6.3.2 Measurements

Physical activity

Physical activity was measured using the Actigraph GT3X+ (Actigraph LLC, Florida US), which has been validated for the measurement of physical activity and sedentary behaviour.[261] Participants were asked to wear this device for seven consecutive days. According to best practice guidelines, a complete day was considered a day with at least 10 hours of wear time, while a complete "week" had at least 4 complete days (including one weekend day).[262, 263] Accelerometers were used to calculate the percentage of daily total time spent on sedentary, light, and moderate-to-vigorous physical activity, and average daily steps.

Diet

Participants' dietary patterns were assessed using a Food Frequency Questionnaire (Australian Eating Survey for adults - AES) (New Castle Innovation), and the Australian Recommended Food score (ARFS).[105] The AES was then analysed to calculate the ARFS. This score is based on regular consumption of foods that are in line with the Australian dietary guidelines, e.g. whole grains, low-fat dairy, fruit and vegetables.[109, 264] One point was awarded for each item reported as being consumed at least once a week with scores ranging from 0–74 (74 reflects the healthiest or most optimal diet quality).[105] We used this tool to assess changes (pre-post intervention) in overall score, energy intake, and percentage of total energy intake from fruit and vegetable and from discretionary foods.

Secondary outcomes

Weight and height were measured, and then used to calculate BMI following the formula BMI= weight (kg) / height $(m)^2$, and criteria BMI>25= overweight; >30= obese.[265] Waist circumference was measured at the narrowest point (mid-point) between the lower costal border and iliac crest, and blood pressure was measured using an electronic sphygmomanometer. To ensure accuracy, all measurements were taken twice. In case of a difference >5% between the two numbers, a third measurement was taken. The average between the two subsequent measures with < 5% difference was reported.

Validated questionnaires and scales were used to assess self-efficacy and social support for diet and physical activity, with a 1 to 5 scale to rate confidence level or frequency of support, respectively.[267-270] Self-rated health (ranging from poor to excellent) was assessed using a single item question extracted from the SF-36 Health Survey.[271]

6.3.3 Data Analysis

Data were analysed using SPSS 22.0 (SPSS Inc. Chicago, Illinois, USA). All available participants' data was used, and missing data was managed with Intention-to-Treat analysis.[282, 283] Descriptive statistics were calculated for demographic data, and primary and secondary outcome measures. Normality was tested using the Shapiro-Wilk test for all variables, with null hypothesis (normal distribution) rejected if $\alpha < 0.05$ and median values reported for those variables not-normally distributed. Repeated measures analysis (ANOVA) was performed using outcome measures at 3-month and 6 months as the dependent variables. Sub-group analysis for complete data only (i.e. participants that returned to follow-up session) was also performed. For all analyses, a two-tailed significance level of < 0.05 was considered statistically significant. Finally, a sample size calculation was performed to calculate the number of participants needed to ensure a statistical power of 80% and alpha level of 0.05. This calculation was done for those primary outcome measures that were not significant.

6.4 RESULTS

Forty-seven (n=47) nurses were enrolled in the intervention, of which 87% were females and 60% were married. Their average age was 41.4 years (range 23-71) and working experience of 18.2 years (range 1- 46). The majority of participants worked in a direct care wards (In patient, Intensive Care Unit, Emergency Room), with 55.3% of total participants based at a private hospital. More than half of the participants were working at least one night shift a week. At 3-month (3-m), the end of intervention time point, n=27 nurses were re-tested (40% drop-out) of which only n=12 attended the 6-month (6-m) maintenance time point. Participants' characteristics are described on Table 6.1.

Table 6.1 – Participants characteristics at baseline

Participant characteristics (n=47)	
Gender (female)	41 (87%)
Age	41.4±12.1
Married (yes)	28 (60%)
Tenure (years)	18.2±12.8
Hospital	
Private	26 (55.3%)
Public	21 (44.7%)
Unit	
In patient	23 (48.9%)
ICU	6 (12.8%)
ER	3 (6.4%)
*Other**	14 (31.9%)
Role	
RN	22 (46.8%)
CN/ Nurs Manager	14 (29.8%)
Nurs Ed/clinical facilitator	5 (10.6%)
Nurs Assistant/Midwife	6 (12.8%)
Education level	
Cert/Diploma	11 (23.4%)
Bachelor's	33 (70.2%)
Master's	3 (6.4%)
Shift work	26 (55.3%)
1 night/week	14 (29.8%)
2 nights/week	9 (19.1%)
3 nights/week	3 (6.4%)

** Education, Urology department and other nurse roles involving mostly deskwork.*

Baseline health and behaviour characteristics are presented in Table 6.2. The majority of nurses were classified as overweight or obese (66%), with a mean waist circumference of 86.5±13.2 cm. Only female participants' average waist circumference (85.6cm) was above the recommended threshold for NCD risk (80cm).[266] Average blood pressure was

within normal range 115/78 mmHg, which was lower than the recommended threshold of 120/80 mmHg.[284] In a 1 to 5 scale, self-rated health was "good" in average (3.1) and self-efficacy for diet and physical activity was 2.8 and 3.1 (3= moderately confident), respectively.

Table 6.2 – Participants baseline characteristics on primary and secondary measures

Baseline characteristics* (n=47)		National comparison**
BMI (kg/m^2)	28.3±6.1	
Overweight	31 (66.0%)	63%
Ideal Weight (<25)	16 (34.0%)	37%
Weight (kg)	76.3±17.4	71.1^
Waist circumference (cm)	86.5±13.2	87.5^
Systolic BP (mmHg)	114.9±15.2	
Diastolic BP (mmHg)	78.0±10.1	
Heart rate (bpm)	70.13±9.98	
Self-rated health (% poor to fair)	24.4	14.8%
Self-efficacy (1-5)		
Diet	2.4±0.8	
PA	3.1±0.8	
Social support (1-5)		
Diet	2.8±0.8	
PA	2.3±0.7	
PA behaviour (%) #		
Sedentary Activity	58.4±8.5	
Light intensity Activity	38.7±8.5	
MVPA	3.0±1.9	
Average Steps	8435±2540	
Meeting guidelines	45.2%	43%
Diet behaviour##		
Energy intake (kJ)	7530.8±3591.8	
ARF score (quality)	33.3±11.4	
%E Fruit & Vegetables	16.3±9.0	
%E Discretionary food	27.9±12.2	36%

±: *Standard Deviation;* ***BP:*** *Blood Pressure* ***#:*** *Physical activity as average % of total daily time,* ***PA:*** *Physical activity;* ***MVPA:*** *Moderate-to-Vigorous Activity****;*** ***##:*** *Food/nutrient groups as percentage (****%E****): of total daily energy intake;* ***Discretionary food****: category including chocolate, pastries, cake, candy and soft-drinks (energy dense nutrient poor foods).* ** *Data presented where available, source [61, 285], ^ female population values, given the majority of females in the study sample (86%)*

Physical activity

At baseline, participants spent almost 60% of their time in sedentary behaviour, more than a third of their time in light activity (38.7%), and 3% in moderate to vigorous physical activity (MVPA). The average time spent in MVPA was 24±16.2 min/day (*see* Table 6.2) and mean steps per day were 8435±2540.

Diet

At baseline, diet behaviour was poor, as the average diet quality score was 33.3/74 and the cut-off for good diet is ≥40. The average caloric intake was 7530.8 kJ, with a large variability (SD 3591.8). Fruit and vegetable intake represented 16.3% of total energy intake, while Discretionary foods represented one fourth of this total (27.9%). This category included energy dense-nutrient poor foods, such as pastries, cake, chocolate, and chips.

6.4.2 Efficacy of Intervention

Intervention results on primary and secondary outcomes are summarised in Tables 6.3 and 6.4. The proportion of participants meeting the physical activity guidelines decreased from 45.2% to 35.7% between baseline and end of intervention (3-months), and to 23% at 6-month follow-up. Both sedentary activity (-0.7%) and moderate-to-vigorous physical activity (-0.5%) decreased at 3-months but increased at 6-months. Only MVPA changes were significant at each time-point. Average daily steps decreased at both time-points but changes were significant only at 3-months (~ -506). Likewise, light activity increased (+0.8%) at the end of the intervention but decreased at follow-up. Similar trends in physical activity outcomes were observed when analysing average daily minutes of physical activity instead of percentage of total wear time, with only light activity showing different results (decreased instead of increased at 3-months).

There were small improvements in dietary behaviours. Vegetable intake increased (+0.7% of total energy intake) from baseline to 3-months and was maintained at 6-months. The intake of discretionary foods decreased (-0.8% of total energy intake) at the end of the intervention, with a further reduction from 3-month to 6-month (-4.5%). At 3-month, participants increased their intake of fruit and vegetables by 4.1%, with further improvements at 6-month (+1.9%). Energy intake increased slightly from baseline to 3-months (+175.8 kJ), but further decreased at 6-months follow-up. Only changes in fruit and vegetable intake were significant (p=0.04).

Table 6.3 – Intervention effects at 3- and 6-month on primary outcomes

Intervention effects on primary outcomes							
	Baseline (n=47)	**3-m (n=47)***	**6-m (n=26)***	**p-value 3m**	**p-value 6m**	**F****	**p-value**
Physical activity #							
% Sedentary Activity	58.4±8.5	57.9±8.7	59.1±8.8	0.70	0.51	0.226	0.70
% Light Activity	38.7±8.5	39.5±8.9	38.9±6.7	0.40	0.99	0.461	0.56
% MVPA (*median*)	3.0±1.9 (2.27)	2.5±1.9 (1.85)	2.5±2.0 (2.00)	**0.01**	**0.06**	46.23	**0.00**
Average Steps	8435±2540	7929±2250	7629±2342	**0.02**	0.32	3.617	**0.05**
Sedentary min	486.3±107.7	464.1±94.5	464.1±83.1	0.17	0.64	2.198	0.15
Light PA min	322.7±79.4	314.9±79.1	299.1±62.5	0.30	0.65	1.064	0.35
MVPA min (*median*)	24.0±16.2(19.7)	19.0±14.0(13.5)	19.3±15.4(16.1)	0.00	**0.07**	7.175	0.003
Meeting guidelines	45.2%	35.7%	23.1%			3.421[a]	0.18
Dietary behaviour##							
Energy intake (kJ)	7530.8±3591.8	7706.6±3601.2	7040.0±2381.4	0.45	0.21	0.485	0.62
ARF score (quality)	33.3±11.4	33.5±10.0	33.1±11.9	0.81	0.88	0.077	0.88
% Fruit & Vegetables	15.5±8.2	19.6±7.8	17.7±9.0	0.04	0.17	2.693	0.08
% E Discretionary food	27.9±12.2	27.1±11.5	23.4±11.8	0.38	0.22	1.840	0.18

** n=20 lost at 3-m, n= 15 lost at 6-m, missing data managed with ITT; ** **F:** F-value for repeated measurements; **p-value 3-m:** Between baseline and 3-m data points ; **p-value 6-m:** between 3-m and 6-m data point; **#:** Physical activity as average % of total daily time, median values for variables not normally distributed**; MVPA:** Moderate-to-Vigorous Activity; **##:** Food/nutrient groups as percentage (%E) of total daily energy intake; **Discretionary food:** category including chocolate, pastries, cake, candy and soft-drinks (energy dense nutrient poor foods); **a** Pearson Chi-square*

Changes in secondary outcomes are shown on Table 6.4, and included a small decrease in BMI and weight at 3-months (-0.1kg and -0.1 in BMI units), with no change on waist circumference. These changes were not significant. In terms of self-rated health, there were no significant changes, with participants who rated their health as poor or fair decreased by 6.6% at 3-months, and further by 10% at 6-months.

Almost half of participants had low diet and physical activity self-efficacy, which slightly improved at 3-months for physical activity self-efficacy (+2.3%) and at 6-months (+17.3%) for diet self-efficacy. Based on social-support scales, participants reporting appropriate diet social support increased at 3- and 6-months, by 3.4% and by 9.5%, respectively. Support for physical activity decreased by 4.6% from baseline to 3 months, and increased by 5.5% from 3-month to 6-month. During the intervention and follow-up, an approximately constant proportion (~30%) of participants reported frequent social support for physical activity at each time point. However, the percentage of participants reporting frequent diet support increased at each time point, reaching more than 50% at six-month follow-up

Table 6.4 – Intervention effects at 3- and 6-months on secondary outcomes

Intervention effects on secondary outcomes							
	Baseline (n=47)	**3-m (n=47)**	**6-m (n=26)**	**p-value 3m**	**p-value 6m**	**F***	**p-value**
BMI (Kg/m^2)	28.3±6.1	28.2±6.0	26.1±5.7				
Overweight	31(66.0%)	30 (63.8%)	13 (50%)	0.71	0.32	0.967	0.34
Ideal Weight (<25)	16 (34.0%)	17 (36.2%)	13 (50%)				
Weight (Kg)	76.3±17.3	76.2±17.1	70.4±15.7	0.74	0.14	2.061	0.16
Waist (cm)	86.5±13.2	86.5±13.1	80.8±10.8	0.64	0.43	0.418	0.56
Self-rated health [a]	3.1±0.8	3.2±0.8	3.4±0.8	0.04	0.78	3.467	0.05
Poor to fair (%)	24.4	17.8	7.7			3.124[d]	0.21[d]
Self-efficacy [b]							
Diet score	2.4±0.8	2.5±0.8	2.8±0.9	0.44	0.40	1.349	0.27
Not confident	*47.7%*	*47.7%*	*30.4%*			2.211 [d]	0.33[d]
PA score	3.1±0.8	2.9±0.8	3.0±0.9	0.21	0.15	1.178	0.30
Not confident	*50.0%*	*47.7%*	*47.6%*			0.056[d]	0.97[d]
Social support [c]							
Diet score	2.8±0.8	2.9±0.8	3.0±0.8	0.66	0.45	0.313	0.61
Often supported	*39.5%*	*42.9%*	*52.4%*			0.959 [d]	0.62[d]
PA score	2.3±0.7	2.3±0.6	2.3±0.7	0.89	0.34	0.722	0.45
Often supported	*37.2%*	*32.6%*	*38.1%*			0.279 [d]	0.87[d]

**** F**: F-value for repeated measures analysis; **PA:** physical activity; **a** in a 1-5 scale, from poor to excellent; **b** 1-5 score from not confident at all to very confident; **c** 1-5 score from never get support to always; **d** Pearson Chi-square*

Sub-group analysis

Only 26 participants presented for retesting at 3-month time point. As a result, the dropout rate was higher than expected at 40%. We analysed and compared characteristics of those who did and did not complete the intervention (lost at 3-month) using baseline measures (*data not shown*). Compared with those who finished the intervention, those who did not completed it had significantly higher BMI (30.8 vs 26.6, $p<0.05$), weight (82.5 vs 72.1, $p<0.05$), and waist circumference (91.6 vs 83.0, $p<0.05$) at baseline. Energy intake and diet self-efficacy were slightly lower in those participants who did not finish the intervention (6893.5 vs 7221.4 cal and 87.5 vs 58.3% participants feeling not confident, respectively), which tended to significance ($p=0.08$ and 0.11, respectively).

Further, we conducted a sub-group analysis comparing those participants who completed both follow-up measurements ("6-m completers") to those who did not. At baseline, compared to those who dropped at 3-m and 6-m time points, participants in the "6-m completers" group were less overweight and had a lower BMI and waist circumference (*see* Table 6.5). This subgroup also had a higher daily sedentary activity,

MVPA, and steps compared to the other participants at baseline. However, anthropometric and physical activity behaviour differences were not significant. The "6-m completers" group also reported higher caloric and discretionary foods intakes at baseline, while diet quality and intakes of fruit and vegetables were lower than their counterparts.

Table 6.5 – Baseline characteristics of participants attending 6-months data point ("6-m completers") compared to those who did not.

Baseline characteristics for "6-m completers"			
	Did not attend (n=35)	**Completers (n=12)**	***p-value***
BMI	29.0±6.33	25.9±4.9	0.13
	11(31.4%)	6(50%)	
	24(68.6%)	6(50%)	
Weight	77.8±16.5	71.8±19.8	0.30
Waist circumference	87.5±13.5	83.5±12.5	0.37
Self-efficacy*			
Diet	2.4±0.7	2.4±1.1	0.96
PA	3.0±0.8	3.2±1.0	0.66
Social support**			
Diet	2.8±0.9	2.9±0.9	0.61
PA	2.3±0.7	2.3±0.6	0.83
PA behaviour #			
% Sedentary Activity	58.0±8.6	59.3±8.4	0.65
% Light Activity	39.1±8.9	37.5±7.6	0.58
% MVPA Activity	2.8±1.8	3.1±2.0	0.71
Average Steps	8377±2410	8591±2371	0.81
Diet behaviour##			
Energy intake (kJ)	7394.3±3979.6	7826.6±2694.5	0.74
ARFS (score)	33.7±10.2	32.5±14.1	0.77
%E Fruit & Vegetables	17.1±9.4	14.9±7.4	0.47
%E Discretionary food	26.9±10.6	29.4±15.3	0.55

:** *1-5 score from not confident at all to very confident,* *:** *1-5 score from never get support to always;*
***#:** Physical activity as average % of total daily time,* ***PA:** physical activity;* ***MVPA** Moderate-to-Vigorous Activity;* ***##:** Food/nutrient groups as percentage (%E) of total daily energy intake**; Discretionary food:** category including chocolate, pastries, cake, candy and soft-drinks (energy dense nutrient poor foods);* ***a:** Pearson Chi-square*

Intervention effects were similar in the "6-m completers" sub-group analysis compared with Intention-To-Treat analysis, in terms of BMI, weight and waist circumference. However, a repeated measures analysis showed an effect on weight reduction that tended to significance (p= 0.10) in the "6-m completers" sub-group (*data not shown*). Consistent with the Intention-to-treat analysis, the "6-m completers" sub-group improved sedentary and light activity and decreased steps and MVPA at 3-months. Dietary outcomes at 3-months were similar in both analysis, with fruit intake improving in the "6-m completers" sub-group analysis. Contrary to the Intention-to-treat analysis, MVPA, steps and sedentary

time improved at 6-months in this sub-group analysis. At this same time point, dietary outcomes further improved with a similar trend to the Intention-to-Treat analysis.

Table 6.6 - The effects of the intervention on primary measures in participants who attended 3 and 6-month assessments

Participants attending 6m follow-up (n=12)					
	B	**3-m**	**6-m**	**F**	**p-value**
PA behaviour [#]					
% Sedentary Activity	59.3±8.4	58.0±8.0	56.9±6.1	0.374	0.62
% Light Activity	38.0±7.6	40.7±8.1	40.7±6.6	0.563	0.53
% MVPA Activity*(median)*	**2.8±1.6 (2.1)**	**2.0±0.8(1.4)**	**3.1±2.1(2.3)**	**3.642**	**0.05**
Average Steps	8591±2991	7663±1856	8184±2046	1.093	0.35
Diet behaviour[##]					
Energy intake (kJ)	7826.6±2694.5	8183.3±2804.4	7572.5±2798.3	0.520	0.57
ARFS (score)	32.5±14.1	32.8±10.1	33.1±12.7	0.036	0.95
%E Fruit & Vegetables	**14.8±7.4**	**19.1±7.0**	**16.9±8.5**	**1.809**	**0.19**
%E Discretionary food	**29.4±15.3**	**27.6±13.3**	**25.2±12.0**	**1.797**	**0.19**

 # Physical activity as average % of total daily time, median values for variables not normally distributed; ***PA:*** *physical activity;* ***MVPA*** *Moderate-to-Vigorous Activity; ## Food/nutrient groups as percentage (%E) of total daily energy intake; Discretionary food: category including chocolate, pastries, cake, candy and soft-drinks (energy dense nutrient poor foods);* ***a*** *Pearson Chi-square*

Sample size calculation

Using the available data from this study, we performed a sample size calculation to have more applicable calculation for future studies. Thus this calculation is different from the one presented on Chapter 5, as the current calculation is based on real data from our target group and not an estimation using previous studies' data. For physical activity measures at least n=119 participants should have completed the intervention to observe a significant difference on average daily steps (+1000 steps/day). For a significant sedentary time change, 30 participants completing the intervention with 5% change would have been necessary. For a 5% increase in fruit and vegetable intake and decrease in discretionary food intake, a total of 40 and 95 nurses should have participated and completed the intervention, respectively. Considering the drop-out rate observed (40%) and the highest number needed to see significant changes (n=119), at least n=199 nurses should have been enrolled in this study.

6.5 DISCUSSION

We conducted a 3-month workplace intervention which aimed to improve diet and physical activity behaviours in nurses. Some dietary behaviours improved at 3-months, including increased vegetable consumption and decreased intake of discretionary foods. While some physical activity outcomes improved (e.g. sedentary time and light activity), these were small and not significant. Average daily steps and moderate activity significantly decreased at the end of the intervention. This suggests that despite the intervention design process being informed by a comprehensive framework, which included a thorough Needs Assessment (Chapter 4), a 3-months workplace intervention showed few improvements in lifestyle behaviours in this population.

Baseline diet quality in our sample was very poor (34 out of 74 max ARFS, where ≥ 40 cut-off for good quality).[105] While this is in line with the literature about nurses eating behaviours [23, 167, 248], it is lower than a previous study, in which 61% of nurses scored ≥ 40.[27] However, the average ARFS of our participants was similar to the average score (33±9.0) previously reported in a cohort of Australian females.[105] We observed some improvements in dietary outcomes, with a small increase in fruit and vegetable intake and a slight reduction on discretionary food intake. According to the Australian dietary guidelines these foods should be consumed occasionally to limit their contribution to daily energy intake.[109] However, our sample's baseline intake of discretionary foods was greater than the general Australian population (27.5 vs 19.2%, respectively). Excessive "Discretionary" food intake was described as one of the main dietary issue in the Needs Assessment (Chapter 4). Thus, the observed trend towards reduced intake of these foods showed an encouraging small step for this group. Previous studies in nurses showed an improvement on dietary outcomes, but outcome measures varied from diet perceptions to self-reported serves of fruit and vegetables;[217, 218] thus the comparison with previous studies is difficult.

Our intervention did not result in positive changes for physical activity behaviour. Average daily time spent in sedentary activity increased, while MVPA and steps/day decreased. In addition, average steps per day at all time points were less than 10 000 steps per day, which has been promoted as a goal in order to achieve health benefits.[286] Our results are contrary to other interventions using pedometers, which typically show an increase in steps trend.[15, 194, 244, 287] Previous studies in nurses that used pedometers

showed a reduction in sedentary time (sitting) and increased physical activity [215, 220]. Baseline daily steps in our sample were similar to other studies (8435 vs 7801).[215] However, post-intervention steps in similar studies increased to 12 913 and 9596 after 8 and 10 weeks, respectively.[215, 220] Factors influencing the lack of physical activity improvements include the inability of the intervention to help nurses overcome major physical activity barriers (e.g. lack of time and fatigue). These could be explained by participants' low physical activity self-efficacy and social support at baseline, and the subsequent no change on these scales at 3- and 6-months.

Our sample had higher rates of overweight and obesity (66%) compared to the general population (63%), Australian females (56%), and Australian nurses (58.7%).[27, 61] Excess weight is a common barrier to engage in regular physical activity, and this could have added to the barriers nurses already faced, such as lack of time and fatigue (Chapter 4 and [288]). These barriers, together with anecdotal evidence from participants, suggested that changing two major behaviours was too difficult and led participants to focus on only one behaviour (diet). In line with this, a recent meta-analysis suggested that providing too many recommendations and aiming to change more than one behaviour at the time is associated with less efficacy.[289] Authors suggest that in short interventions (≥ 3-month), targeting one behaviour had a higher effect compared to moderate or high number of recommendations (*d*= 0.24 vs 0.12 vs -0.13, respectively).[289]

Reasons for a lack of findings and small intervention effects will be further explored in Chapter 7. However, preliminary results suggested that more frequent contact and support, and environmental changes, could have facilitated the implementation and maintenance of new behaviours. Thus, the small intervention effects seen in this study may suggest that work-related barriers might be too hard for nurses to overcome, if we promote individuals' change only. There is a large body of evidence in nursing research pointing at the work environment as the major contributor to nurses' ability to balance work and a healthy lifestyle. Examples of these included the role of shift-work alone on increased body weight,[172] long working hours and job duties impacting mental and physical health (stress, low-back pain, fatigue),[165, 290] poor work management and job dissatisfaction leading to disengagement with the workplace.[165] Studies that explored nurses' job and health outcomes recommended changes in the workplace, such as eliminating 12-h shifts, including permanent instead of rotating shifts, facilitating physical activity at work (e.g.

onsite gym) during paid hours, providing healthier food at on-site cafeterias and free fruit/healthy snacks in staff rooms.[23, 248, 290, 291 209]

Strengths and limitations

Previous workplace interventions in nurses did not provide a clear link between target group needs and study design, and use of appropriate tools to assess changes in physical activity and dietary behaviours. As described in Chapter 3, assessment methods in previous studies relied on single questions or non-validated questionnaires (diet) or self-report and pedometers (physical activity). To increase the rigour of our study, we used objective measurements for physical activity (Actigraph LLC, Florida US) and a validated Food Frequency Questionnaire for diet [108], and provided a comprehensive study design. In addition, our study design and intervention strategies were informed by consultations with the target group, and developed following a sound theoretical framework (Intervention mapping)

Many efforts were made to both recruit and schedule follow-up sessions with participants, which included multiple reminders (i.e. text messages, emails, in person) and flexibility with days and times to suit each participant. A staff room was booked in both study sites to facilitate participants' attendance to enrolment and follow-up session, before/during/after their shifts. The main researcher was available at the study sites from 14:30 to 19:00, Mon-Fri, to match the start of afternoon shifts (15:00), end of morning shifts (15:00, 16:00, 18:30), and beginning of night shift (19:00). During these times, the main researcher regularly went to wards to present the study and actively recruit those interested. In addition, approval was sought from most unit nurse managers (NUMs) to allow nurses to attend sessions during their afternoon tea break or during quiet periods in their respective wards. Nurse managers sent regular emails to NUMs to encourage participation of their staff, while few NUMs actively recruited staff during working hours or staff meetings.

Yet, recruitment was difficult, leading to a small sample size, which influenced the study design and statistical power due to large variability. As a result, the original quasi-experimental design with a control group was changed to a pre-post test study, with no control group (*see* Chapter 5). Having a control group would have provided a better comparison and analysis of intervention effects. Thus, results presented here should be

interpreted with caution, as intervention outcomes could have been influenced by seasonality and time of the year when the intervention and measurements took place.

We experienced a significant loss at follow-up (~40%), with drop-outs being more likely to be overweight. Although not significant, this could have influenced the intervention effects observed at 3-months. To overcome this drop-out limitation, we performed Intention-To-Treat analysis for all outcomes, and provided separated results for complete cases. In addition, we performed a sample size calculation to provide specific recommendations for future studies in this population. To ensure a statistical power of 80%, at alpha level of 0.05, at least n=119 nurses should complete the intervention per group (total n=238) to observe a significant changes on physical activity outcomes. For dietary outcomes, at least 95 nurses are needed at follow-up per group. Considering the highest number of participants needed (n=119 for daily steps) and our drop-out rate of 40%, future randomised control trials need to enrol at least 398 nurses to ensure that 119 nurses complete the intervention in each group.

6.6 CONCLUSION

Further research is needed to understand how we can better promote diet and PA in nurses, and how workplace interventions implementation, recruitment and participation can be enhanced. Having a larger number of participants is necessary to conduct future randomised-controlled trials and better understand intervention effects on diet and physical activity behaviours. To facilitate and foster such behaviour change and maintenance, environmental changes at the workplace should be included in future intervention studies. These could facilitate behaviour change in populations like nurses, where work characteristics are a barrier to engage in healthier behaviours. It is important that hospitals' and nurse managers advocate for and facilitate nurses' participation to these interventions. Hospital management involvement is the key factor to successfully implement future workplace interventions maximising reach and limiting drop-outs.

CHAPTER 7
PROCESS EVALUATION OF THE WORKPLACE INTERVENTION STUDY

This chapter describes the process evaluation for the implemented workplace intervention described in Chapter 6. Contents of this chapter have been included in a manuscript to be submitted by July 2016.

7.1 INTRODUCTION

As discussed in Chapter 2, the workplace has a high potential to reach a large proportion of the adult population and thus is a desirable setting to promote diet and physical activity behaviours [292]. While the workplace is a promising health promotion intervention setting, and Chapter 2 showed how nurses could benefit from such interventions, there is a limited number of interventions promoting diet and physical activity in this group (Chapter 3). In addition, the effectiveness and uptake of these interventions is not clear because of under-reporting of intervention outcomes, reach, maintenance, and sustainability (Chapter 3).

When reporting health-promotion intervention outcomes, it is important to describe and discuss factors associated with the implementation.[201] This is a necessary step, as many effective interventions subsequently fail to be adopted in a wider scale or translated in real-world settings, with barriers at patient/participant, staff and organisational level.[202] In addition, interventions often lack proper internal and external validity, and qualitative measures to help understand intervention's effects.[202] In response to this need, many process evaluation frameworks like "RE-AIM" [203] are increasingly being used to evaluate interventions targeting behaviour change and obesity [202]. RE-AIM follows a logical sequence of evaluation, starting from intervention's Reach, through Effectiveness, Adoption, and Implementation, and finally assessing Maintenance [203].

To address the gap in effective strategies to promote diet and physical activity in nurses, we developed a workplace intervention using the Intervention Mapping protocol (IM) in Chapter 5 to provide a rational for the intervention design. Results of this study included a significant increase of average fruit and vegetables intake, but also a significant decrease in average daily time spent in moderate-to-vigorous physical activity (MVPA) (Chapter 6). In this chapter, we describe the use of the RE-AIM framework to guide the process evaluation for this intervention to further understand and give context to the results. Describing each of the five dimensions in this framework aims to highlight considerations for future workplace interventions targeting nurses or similar hard-to-reach groups.

7.2 AIM

The aim of this chapter is to describe the process evaluation of a workplace health promotion intervention aimed to improve diet and physical activity behaviours. Reach, Effectiveness, Adoption, Implementation and Maintenance for this intervention will be assessed using the RE-AIM framework.

7.3 METHODS

7.3.1 Study population

Nurses working at in-patient units at two hospitals in Brisbane (Australia) were invited to participate between January 2015 and June 2015. Participants were recruited using different strategies, including staff emails and referrals from Nurses Unit Managers, posters in staff rooms, word-of-mouth and snowball from those nurses already enrolled or that participated to a previous Needs Assessment study (*see* Chapter 4).

Intervention program

The intervention was a pre-post test study aiming to improve diet and physical activity behaviours in nurses. This diet and physical activity workplace intervention included the use of pedometers, a smartphone app, and a Facebook private group. The intervention was developed using the intervention mapping protocol [51], with contributions and input from nurses and their managers during the development process. The main outcomes were improved diet quality, increased physical activity, and decreased sedentary behaviour. The study design and intervention have been described in detail in Chapter 5.

Self-Determination Theory (SDT) [158] was the underpinning theoretical framework of the intervention, which describes a way of understanding individuals' behaviours considering motivation as individuals' intention to perform a behaviour. Motivation can be originated internally (intrinsic) or externally (extrinsic), and it is a condition necessary for behaviour's implementation [235]. Goal-setting, self-monitoring and social support, were used to motivate participants to improve diet and physical activity. Social support in particular, was identified in the Needs Assessment as a key factor to promote and maintain behaviour change in this group of nurses (Chapter 4). Because interventions may have a direct effect on main outcomes and/or indirect effects on psychological mediators of behaviour [293], we measured

self-efficacy and social support for diet and physical activity to better understand the effects of this intervention.

7.3.2 *Data collection*

The process evaluation was performed using the RE-AIM framework (Reach, Efficacy, Adoption, Implementation, and Maintenance) to evaluate the intervention components.[203] The key aspects of this evaluation were the adoption of intervention materials and frequency of use, as this allows establishing a relationship between observed outcomes and intervention effect.

Reach was measured at the beginning of the intervention, based on the response rate (number of participants invited / participants enrolled). The different recruitment channels and strategies are also described in this dimension.

Efficacy was measured by changes in diet and physical activity behaviours and its determinants from baseline to the end of intervention at 3-month. Details on the methods and rationale of the outcome measurement have been described in Chapter 5. We assessed self-efficacy and social support using validated questionnaires and scales [267-270]. Self-efficacy questionnaires included statements to be rated by participants in a scale from 1= "not confident at all", to 5= "completely confident" (e.g. *"How confident you are that you can choose healthy foods, when you are craving unhealthy foods/snacks?"*). Social-support questionnaires aimed to measured how often participants receive support from colleagues, ranging from 1= "Almost never" to 5= "Almost always" (e.g. *"How often have your colleagues or friends have encouraged you to stick with your exercise program?").*

Adoption and *Implementation* were measured with questionnaires at the end of intervention to assess material use and frequency of use (e.g. FB visits, use of pedometers, using app to set goals). This was used to define the intervention dose received by participants. Facebook group views were recorded for each post to determine the number of participants viewing each post. Intervention dose delivered was measured by recording the number of face-to-face contact sessions per participants; number, date and type of posts delivered through Facebook; number of participants receiving pedometer and app instructions; and number of participants not willing to use a given intervention tool (i.e. join the Facebook group, download the app, or use the pedometer).

Participants also completed open-ended questions to report on the components they liked most and those that were less useful, together with suggestions to improve similar interventions in the future. In addition, interviews were conducted with participants that attended the 6-month assessment. Participants were asked to comment on changes in their job and lifestyle since the end of intervention, including behaviours they maintained or improved since then. Questions also aimed to explore factors that could motivate them to change those behaviours that did not improve after the intervention. Further, we contacted participants who did not attend the 3-month follow-up assessment to understand whether the intervention was not engaging enough for them and why. Only 2 out of 21 drop-outs agreed to meet for a one-on-one feedback session.

Maintenance was measured at the 6-month follow-up assessment. During the 6 months between the two data collection points there was no contact with participants or prompts to continue using intervention materials (i.e. no new posts of Facebook). Using the same outcome measurements as the end of intervention time-point (i.e. FFQ, accelerometer), we assessed whether participants maintained their changes in diet and physical activity. Participants who dropped out at 3-months were also contacted for suggestions on how to make the intervention more engaging. To encourage participation to this follow-up session, all contacted participants were offered the opportunity to enter a lucky draw for a $200 voucher.

7.3.3 Data analysis

Intervention effects on diet and physical activity were analysed with SPSS 22.0 (SPSS Inc. Chicago, Illinois, USA), using a t-test to compare baseline and post-intervention (3-month) with a two-tailed significance level of <0.05. We included data from participants that started and attended the 3-months data collection point, who were considered to complete the intervention. We compared effectiveness in this group with effectiveness using the whole sample with Intention-to-Treat analysis to manage missing data. Participants who attended the 6-months data collection session were included in the maintenance analysis. Descriptive statistics were used to describe the different RE-AIM outcomes. Direct quotes were used to summarise and present results from interviews with participants.

7.4 RESULTS

7.4.1 Reach

We contacted the Nursing Managers (n=2) from the two hospitals to inform them of the intervention and seeking their support. They invited us to present at a total of n=4 staff meetings, of which 3 were with ten nurses unit managers (NUMs), and one was with the nursing education team (n=8 nurse educators). NUMs sent emails to their staff, totalling at least 10 different wards, reaching ~1000 nurses. Only 65 nurses expressed an interest in the study and arranged a time to meet with researchers for their baseline assessment. Of these, 47 enrolled in the intervention. Common reasons given by those nurses interested but not enrolled, included lack of time, intervention materials not appealing, not a weight-loss program or a personalised diet prescription. Overall reach was poor, with only 6.5% of total potential participants being reached and 4.7% willing to enrol in the intervention.

Table 7.1 – Reach of the intervention

Contact points (number)*	**Purpose**	**Participants interested**	**Participants enrolled**
• Meeting with ten NUMs (n=3) • Email to two Nursing Directors (n=3 emails) • Meeting with eight Nurse Educators (n=1)	Email Poster to staff/ Encourage participation	16	12
• Snowball/ word of mouth (n= 20 participants)	Encourage participation	35	25
• Staff areas (1 poster per area) n=10 Lunch rooms n= 2 at Canteens n= 2 at connection bridges between hospitals	Promote study	14	10
	Total	**65**	**47**

***** *Indicates total number during the recruitment period ~5 months*

7.4.2 Efficacy

The previous chapter (Chapter 6) described the implementation and results of the intervention at 3- and 6-months. Intervention outcomes were analysed with Intention-to-treat approach, and results showed an improvement on dietary outcomes. At 3-month, participants increased their intake of fruit and vegetables by 4.1%, with further improvements at 6-month (+1.9%). The intake of Discretionary foods decreased by 0.8% at 3-month, followed by a -3.8% at 6-month. On the other hand, physical activity behaviour decreased after the intervention. Participants decreased their steps by ~ -506 steps per day at 3-month, and -300 steps/day at 6-month. MVPA decreased by 0.5% of average total daily time at 3-month and did not change at 6-month. Similar trends in efficacy on physical activity were observed when analysing data only from those participants that completed the intervention at 3-month (*see* Table 7.2). The percentage of time spent in light activity increased (+1.4%, 95% CI [-1.9, 4.7]), while time spent in sedentary activity decreased at 3-month (-0.65%, 95% CI [-4.1, 2.8]). However, both changes were not significant. On the other hand, average steps per day (-829 steps/day, CI 95% [-139, -1518]) and percentage of time spent in moderate-to-vigorous activity (MVPA) (-0.8%; 95% CI [-1.4, -0.2]) significantly decreased after the intervention.

Table 7.2 – Efficacy of a 3-month intervention on diet and physical activity measures

Intervention effects on Diet and Physical Activity measures*						
	Completers (n=26)			*All with ITT (n=47)*		
	B	**3-m**	**P-value**	**B**	**3-m**	**P-value**
PA behaviour #						
Sedentary Activity	59.2±6.7	58.5±7.2	0.70	58.4±8.5	57.9±8.7	0.70
Light Activity	38.3±6.1	39.7±7.0	0.41	38.7±8.5	39.5±8.9	0.40
MVPA Activity	2.5±1.7	1.6±1.2	0.01	3.0±1.9	2.5±1.9	0.01
Average Steps	8175±2596	7345±1921	0.02	8435±2540	7929±2250	0.02
Diet behaviour##						
Energy intake (kJ)	6954.2±2321.4	7221.5±2406.0	0.46	7580.6±3454.0	7200.4±3060.9	0.62
ARFS (score)	31.9±12.3	32.2±10.4	0.81	32.9±10.9	32.8±8.4	0.98
%E Fruit & Vegetables	15.5±8.2	19.2±7.8	0.04	16.4±8.8	18.2±8.6	0.04
%E Discretionary food	27.0±12.8	25.8±11.8	0.38	27.5±13.1	25.3±15.6	0.38

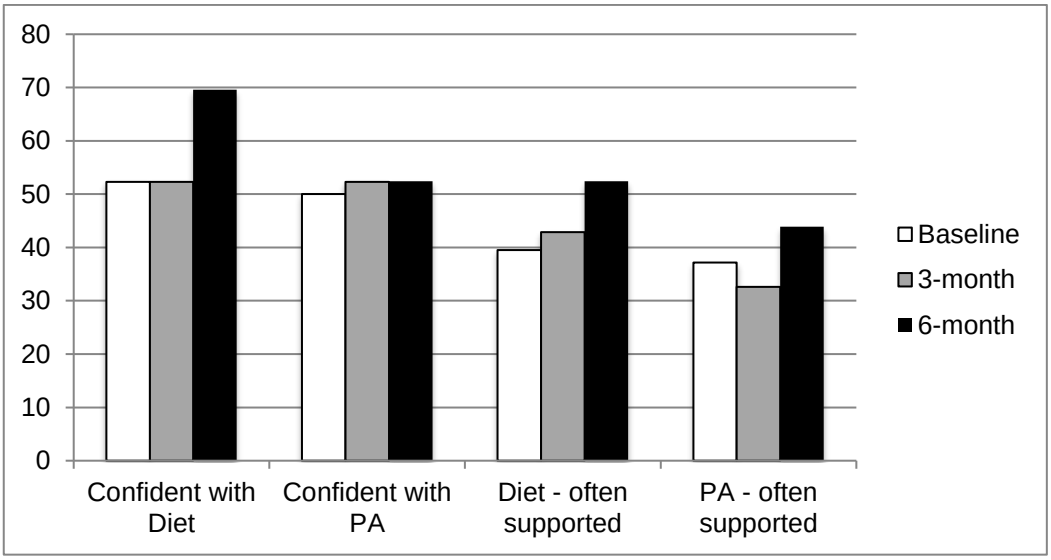
**** B:** Baseline**, 3-m:** 3-month time point, **±**: Standard Deviation; **#**: Physical activity as average % of total daily time, **PA:** physical activity; **MVPA:** Moderate-to-Vigorous Activity; **##:** Food/nutrient groups as percentage (%E) of total daily energy intake; **Discretionary food:** category including chocolate, pastries, cake, candy and soft-drinks (energy dense nutrient poor foods)*

Dietary behaviours improved at the end of the intervention, with similar trends as observed with Intention-to-treat analysis but effects. Some dietary changes were not significant, as both changes and sample size were small (n=26). The proportion of total energy intake coming from fruit and vegetables significantly increased (+3.6%, CI 95% [0.2, 7.1]), while that from discretionary foods decreased but not to a significant level (-1.2%, 95% CI [-3.8, 1.5]).

Changes in social support and self-efficacy scales

The intervention showed small changes in measures of social support and self-efficacy. Improvements were observed for diet social support with more participants feeling often supported at 3-months and further at 6-months, but these changes were not significant (F= 0.959, p=0.62). Diet self-efficacy improved only at 6-month, with more participants feeling able to control their diet (F= 2.211, p= 0.33). Physical activity self-efficacy improved, with more participants feeling confident about their control over physical activity at 3-month with no changes at 6-month (F= 0.056, p= 0.97). The proportion of participants feeling often supported towards physical activity decreased after the intervention but then improved at 6-m (F=0.279 p= 0.87). However, none of these changes were statistically significant.

Figure 7.1 – Changes on proportion of participants feeling confident and often supported about their diet and physical activity (PA) behaviours at 3 and 6 months.

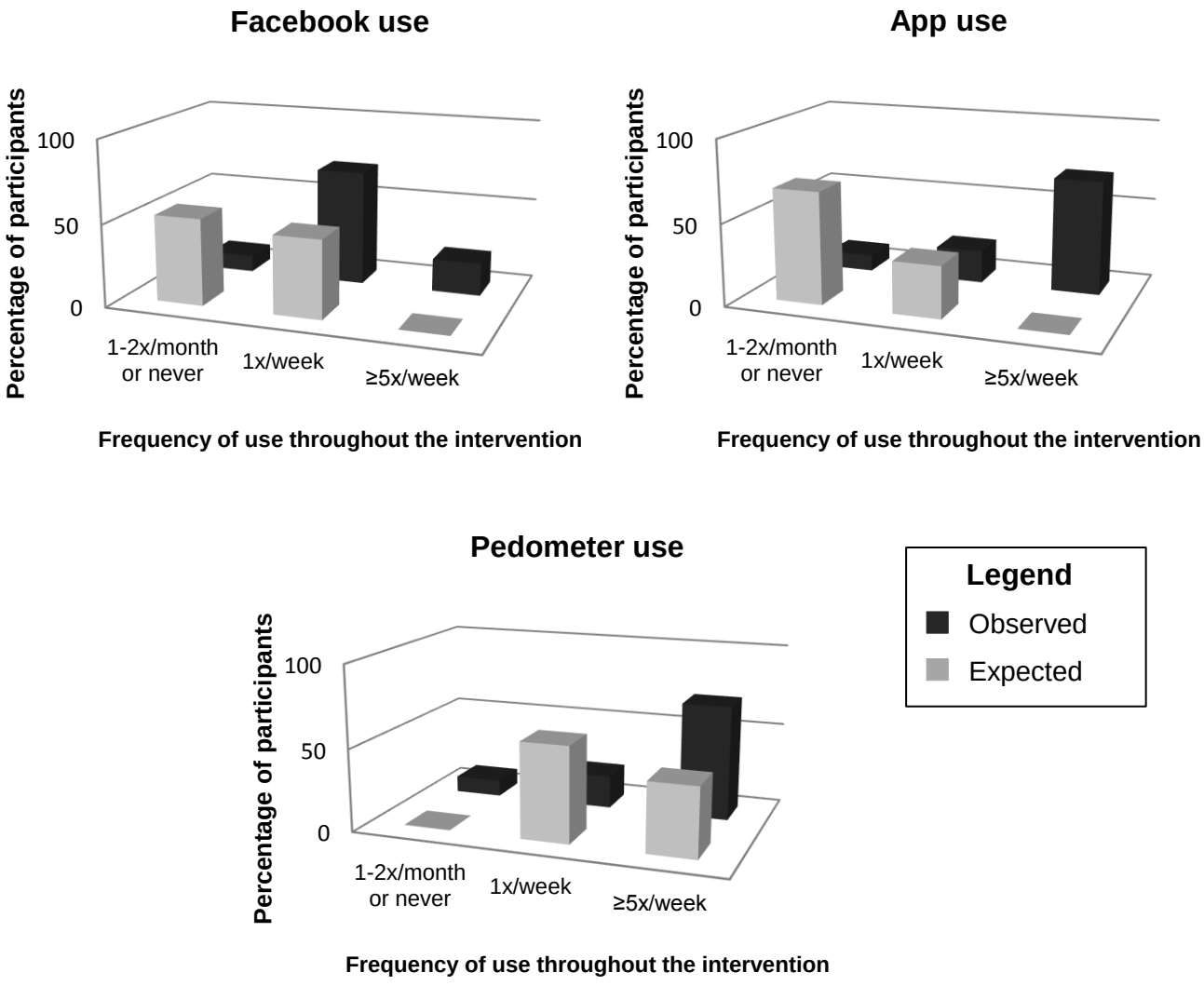


a:1-5 score from not confident at all to very confident, **b:** 1-5 score from never get support to always,
***:** Pearson Chi-square

7.4.3 Adoption and Implementation

Intervention adoption, calculated using the frequency of usage of intervention tools (i.e. pedometer, Facebook group, smartphone app), showed that 60% of participants used at least one tool. The majority of the participants (68.4%) used the app once a month or never, and they used the pedometer at least once a week (57.9%). Almost half of the participants (47.4%) engaged with the Facebook group at least once a week, while the rest did not use this tool or used it once a month.

Figure 7.2 – Use of intervention tools



The majority of participants reported that they set diet-related goals at least once a week (57.9%). Physical activity goals were set less frequently as 60% of participants reported that they did not set physical activity goals at all, or less than once per month. In terms of implementation, based on the expected versus observed behavioural outcomes on Table 5, most of the intervention was implemented as planned. However, improved physical activity as intervention objectives, and social aspects of behavioural outcomes were not met (*see* Table 7.3).

Based on the usage of intervention materials (Figure 7.2) and participants feedback (*see* Participants feedback section next) the behavioural outcomes for steps self-monitoring and diet goal-setting were partially met. The behavioural outcomes for the Facebook group tool were not met. While content was posted on Facebook by the researcher (LT) as planned (i.e. recipes, tips and motivational messages), participants did not use or interact with this tool as expected (see Figure 7.2). One participant posted content on Facebook once, but nobody else shared their daily steps accumulated, goals or tips as originally planned. Other aspects that were not implemented included nurses organising exercise sessions before/after shifts with their colleagues. Social support between participants was lower than anticipated, resulting in minimal encouragement of colleagues' enrolment and participation in the intervention. Although the connecting aspect was constantly promoted during enrolment, and through the Facebook group during the intervention, only four nurses encouraged at least one other colleague to participate in the intervention.

Table 7.3 – Implementation of intervention objectives and tools

Intervention Objectives	Performance objectives	Tool	Behavioural outcome	Implemented as planned
• Improved diet quality • Increased physical activity	1) Swapping energy dense snacks with nutritious ones to avoid feeling hungry and making unhealthy choices 2) Limiting the availability of sweets and chocolate on the floor/wards 3) Bringing healthy meals at work and try to have regular meal patterns 4) Colleagues influencing each other to adopt a healthier lifestyle. 5) Implementing active transport and other small changes to promote PA 6) Increasing daily steps and minutes of PA, especially in their days off. 7) Using PA to socialise with colleagues/friends. 8) Exercising before/after shifts 9) Sharing positive experiences to motivate each other	Facebook group	• Share success stories or advice to improve diet & PA	✗
			• Find a colleague to exercise before/after shifts or actively commute to work.	✗
			• Self-nomination of nurse leaders willing to organise PA events or encourage healthy snacks during shifts.	✗
			• Posts with motivational and inspirational quotes to be active/healthy (*see* Appendix II)	✓
			• Participants are encouraged to post recipes/tips	✓
		App	• Participants set diet goals	✓
			• Participants set PA goals	✗
			• Participants use app to share goals and/or support others	✗
		Pedometer	• Participants check daily steps – goal of at least 10,000/day	✓
			• Compare and share their steps with other participants	✗

***PA**: physical activity; ✗: Not implemented as planned; ✓: Implemented as planned.*

Table 7.4 - Participants' feedback on intervention materials

Statement	Agree (%)
" The app helped me keep track of/set my goals"	78.9
"The information shared on Facebook helped me set my goals"	63.2
" The Facebook group motivated me to improve my diet and/or physical activity"	73.7
" The tools did not motivate me to change my diet and/or physical activity"	63.2
" I found it easy to set my own goals"	31.6
" I would prefer a more specific program to follow"	52.6

Participants' feedback

Participants who attended the 3-month follow-up session provided feedback on the most and least helpful aspects of the intervention. Pedometers and Facebook content were considered a good motivation, while completing the food frequency questionnaire or just being enrolled in the intervention increased participants' awareness of their own health and diet habits. Almost a third of participants reported that they were not regular Facebook users and therefore this was not a useful tool for them. Similarly, most people did not find the app useful or reported that they used it only for a short time at the beginning of the intervention. Participants suggested that future interventions should have more a specific program, such as having a meal plan or more contact sessions to receive feedback on their progress. Further, their comments implied that they would prefer less technology and apps and more personal contact.

The one-on-one interviews provided the researchers with a better understanding of the observed intervention effects, in particular for the improvements on diet but reduced physical activity. Most of the participants (60%) felt that this intervention study increased awareness of their current health status, diet and physical activity behaviours by *"just being enrolled and being part of it" (N42); " being accountable to someone (researcher leading the study)" (N35),* and *"knowing that there are other people doing it too" (N24)*. Completing the food frequency questionnaire helped participants see that they were *"eating too much junk food and having irregular meal patterns"(N21Mar) and "having bad diet habits" (N24).* The pedometer and the accelerometer were useful reminders because *"it's there (on the waist) and it's reminding you to be active"*.

Most participants focused on implementing dietary changes only instead of physical activity or both behaviours at the same time, as "it *is too hard to change both*" (N35). Others found it more feasible to change their diet instead of both behaviours as *"it's easier to start with diet, I'm walking at work anyway everyday" (n42)*. This quote also reflected some participants' perception of walking at work being enough physical activity, although data showed that average daily steps never reached 10,000 steps/day at any time-point. The strategies participants adopted to improve their diet included "*doing healthier options when buying food", "recipes and tips on how to make the best out of food helped me, it made me click and be more mindful", "I try to eat more veggies now".* Those participants who improved physical activity reported that this was due to other factors such as *"my friends do marathons and they got me started on running again"(N21) " I noticed I was putting on weight and decided to start running"(N16) " I try to do more walking, I walk the dogs"(N01)*

Participants who dropped out from the study were asked about potential improvements to the intervention that might lead to better participant retention. They reported that *"having a more frequent contact, someone that calls you and checks on your progress, someone to talk to";" enrolling with other people that work with you, I was the only one that enrolled in my ward".* We also asked participants how to increase the reach of the intervention if we were to implement it again. Some of the suggestions included becoming more involved in staff meetings, so nurses get to know the leading researcher. Another suggestion was to enrol groups of people from the same ward. However, the latter was described as a challenging task as people working on the same ward often do not have sufficient rapport with each other, *"it can be awkward to tell an overweight/obese colleague that they should join because you don't know them that much" (N31).* Participants also comment on providing healthier options at the hospital food outlets or for free on staff rooms, as the latter "*is full of cookies and biscuits, that's all you eat when you are hungry and they are there*" (N31).

7.4.4 Maintenance

We re-assessed diet and physical activity at 6-months. The percentage of time spent in sedentary time decreased further from 3 to 6-months and the time spent in MVPA and daily steps increased. Light intensity physical activity increases from baseline to 3 months, were maintained at 6 months.

Diet changes from baseline to 3 months were maintained or improved at 6 months. Discretionary foods in particular were lower at 6 months than at baseline and 3-months. Energy intake from fruit and vegetables slightly decreased from 3-month time point, but remained higher than it was at baseline. The changes in diet and physical activity were not significant.

Table 7.5 – Maintenance of intervention effects at 6-month follow-up

Participants attending 6-month follow-up session (n=12)					
	B	**3-m**	**6-m**	**F**	**p-value**
Physical Activity#					
Sedentary Activity	59.3±8.4	58.0±8.0	56.9±6.1	0.374	0.62
Light Activity	38.0±7.6	40.7±8.1	40.7±6.6	0.563	0.53
MVPA	**2.8±1.6**	**1.6±0.8**	**2.8±2.1**	**3.642**	**0.05**
Average Steps	8591±2991	7663±1856	8184±2046	1.093	0.35
Diet behaviour##					
Energy intake	7826.6±2694.5	8183.3±2804.4	7572.5±2798.3	0.520	0.57
ARF score (quality)	32.5±14.1	32.8±10.1	33.1±12.7	0.036	0.95
%E Fruit & Vegetables	14.8±7.4	19.1±7.0	16.9±8.5	1.809	0.19
%E Discretionary food	29.4±15.3	27.6±13.3	25.2±12.0	1.797	0.19

***#:** Physical activity as average % of total daily time, **MVPA:** Moderate-to-Vigorous Activity; **##:** Food/nutrient groups as percentage (%E) of total daily energy intake; **Discretionary food**: category including chocolate, pastries, cake, candy and soft-drinks (energy dense nutrient poor foods); **a:** Pearson Chi-square*

Organisational changes following the intervention

Data from the one-on-one interviews showed that, at an organisational level, the intervention study rose awareness about the importance of employees' health. Two months after the intervention was finished, one of the study settings started a Weight Watchers program for nurses. However, this was limited to NUMs, as they have a more regular and similar shifts that allow them to attend weekly meetings for this program. Two of the participants in our study enrolled in the Weight Watchers program and reported that it was working for them because the program made them feel as they are part of a group "*Having a group in weight watchers was good and motivating"; "you are part of a group, you are accountable to them and don't want to let them down"; "we have weekly meeting, they provide you with strategies on how to cope with social events, or stress. We also had weekly monitoring (weight)".* While both participants lost weight and improved their diet in this program, they reported no changes in or doing less physical activity because they do not feel the need ("*I'm losing weight anyway)*.

7.5 DISCUSSION

We used the RE-AIM framework to evaluate a 3-month intervention with 6-month follow-up which aimed to improve diet and physical activity behaviours in a group of working nurses. The process evaluation showed that intervention reach and efficacy were low. Diet improved with significant changes in fruit and vegetable intake, but moderate-to-vigorous activity (MVPA) decreased significantly. Most changes were maintained at 6-month, with some showing further improvements. The intervention was implemented and partially adopted as planned, with key objectives aimed to promote social-support not being met. Although consultations with the target group informed the selection of intervention materials and methods, almost half of the participants used materials with feedback suggesting these were not always useful. Participants reported that more frequent support and specific goals should be included in future workplace interventions.

Needs Assessment (Chapter 4) clearly showed that nurses valued social-support as a desirable aspect in an intervention, which could motivate behaviour change in this group. Participants referred to situations that could motivate them to improve their diet and physical activity, including success stories from fellow nurses and having a colleague to exercise with. Yet, our process evaluation showed that participants did not implement such behavioural outcomes, or used the materials provided to promote social-support. Previous studies in this population successfully promoted social support by having a nurse-champion who led the intervention.[218] Although this strategy showed small improvements in daily average steps at 3-month, these further improved at 6-month (+1700 steps/day). This, together with participants' feedback of more personal contact needed, may suggest that Facebook or other technological tools may not be adequate to promote social support in nurses.

Participants referred to having regular contact with the researcher as a way to remind them to be on track and achieve changes in their diet and physical activity behaviours. Previous workplace interventions provided regular face-to-face sessions to facilitate goal-setting of diet and physical activity goals. [294] However, this approach showed similar results for the implementation and adoption of intervention materials compared to our intervention study.[294] Viester *et al.* [294] included ~150 construction workers in the intervention group, of which 50% regularly used the pedometers provided, and only 23% used the information material. Another study showed higher participation and engagement

when providing on-site exercise sessions, in addition to face-to-face goal-setting.[295] In this 6-month workplace intervention with n=367 academic hospital older employees (>45 years old), the participation to the onsite exercise sessions raged from 44.5-63.2%. This approach resulted in increased minutes of weekly physical activity (sports participation), and higher intake of fruit and vegetable in those participants with higher compliance.[295]

Comparisons with previous studies suggest that having frequent personal contact with participants and including an environmental component could have increased the uptake and effects of our intervention. A multilevel approach can facilitate behaviour change by targeting both individual and work environment determinants. [157] For example, participants attending the feedback sessions and some of those attending the focus groups (Chapter 4) indicated that providing free fruit or providing healthier choices at the canteen could have facilitated improving dietary behaviour.

Although we conducted a thorough process evaluation following a sound and validated framework (RE-AIM), some limitations to our study remain. Having a convenience sample in the intervention group and a large loss at follow-up could have led to selection bias, and thus affected the observed intervention effects and feedback results. Adoption and implementation was measured at the end of the intervention in a retrospective way. This limited available data on the frequency of materials used throughout the intervention period, and how many and which specific goals were set/met by each participant each week.

The results of this process evaluation suggest several recommendations for future diet and physical activity workplace interventions targeting nurses. Intervention strategies should ensure the promotion and fostering of social-support among colleagues, which can be warranted with strategies such as nurse champions. For this purpose, key staff members, and hospitals' and nurse managers should be active stakeholders during the design and implementation of future interventions. Stakeholder's involvement and endorsement is also crucial for maximising reach, recruitment, and retention.

In terms of intervention strategies, our results convey two major considerations for future intervention strategies. First, Needs Assessment suggestion should be weighed against the motivation level of the participants that will potentially enrol. We observed a discrepancy between what nurses say they wanted in an intervention, and what they were

prepared to do. The Trans-Theoretical model explains behaviour change in individuals, as a progression from different stages based on their readiness to change.[296] These range from individuals not intending to change who avoid thinking about their health risk, to think about and consider change, to finally being able to take action and maintain changes.[296] Measuring baseline motivation or readiness to change could inform whether intervention strategies are suitable, or if these need to be re-adapted to match participants' baseline motivation/readiness to change levels. Interventions that are matched to the participants' stage have shown to be effective because they improve participants' engagement.[297] Secondly, while multicomponent strategies are described in the literature as effective and synergetic (Chapter 2) the intervention effects showed that this approach might not be "ideal" for nurses. In nurses and similar populations, high stress, fatigue, and lack of time may undermine their ability to change two major behaviours at the same time. Finally, the discrepancy between our needs assessment's information on useful materials but then low engagement with these, rises a flag on the limitations of this approach. This indicates the need for future studies to test usefulness of and participant's engagement with materials in a pilot or feasibility study, before implementing a large-scale intervention.

7.6 CONCLUSION

When selecting intervention materials, future studies should consider target group's preferences in the context of their readiness to change and motivation to use the preferred materials. Future interventions should also monitor the use of intervention materials throughout the intervention period to understand whether intervention uptake is constant, or whether it is reduced after a specific time. This would provide valuable information about uptake changes in time, which can help better understand intervention effects and effectiveness of materials. Proper monitoring could also inform the real time commitment for participants, which is often a concern for management. Knowing the actual time commitment associated with the intervention is also useful for cost-effectiveness analysis, which can provide information on cost-benefits of running such interventions. Having a cost-effective intervention with a clear time commitment could increase hospital managers' interest to promote and implement future interventions.

CHAPTER 8
ECONOMIC EVALUATION

This chapter describes the economic evaluation of the intervention designed, implemented and evaluated in the previous chapters (Chapter 4, 5 and 6).

8.1 INTRODUCTION

Previous chapters have provided an overview of the intervention's effects, with a process evaluation showing how the intervention contributed to these effects and which aspects did not work as planned. While such information contributed to understanding whether the intervention was effective or not, it partially showed implementation barriers. Other barriers include the costs associated with the intervention's implementation, and the willingness of stakeholders to pay for these. These are important aspects both for the scalability and sustainability of workplace interventions.

Employees with poor lifestyle behaviours and those with NCD's are likely to incur greater health-care expenditure to both themselves and their workplace.[281] Employers' costs include disability, increased sick leave, and loss of or reduced productivity and increased staff turnover.[292, 298, 299] Consequently, workplace health promotion interventions are becoming increasing important for employers, as their employees' health has a direct impact on productivity and other direct and indirectly associated costs.

The healthcare industry is the biggest employer in Australia and nursing represents the largest workforce, with approximately 300.000 registered nurses. Nurses are insufficiently physically active and have an unhealthy diet (*see* Chapter 2), and as a result 60% of Australian nurses are overweight or obese.[27] Furthermore, 23% of Australian nurses are 55 years or older, which is another risk factor for NCD.[26] Improving dietary behaviours, physical activity and consequently health status could have a positive impact on productivity, absenteeism, and healthcare care expenditure.[300]

Improving nurses' health through the implementation of workplace health promotion interventions could reduce costs and the burden on the health care system.[13] However, there is insufficient evidence on the cost-effectiveness of such interventions for nurses. Because the Australian total expenditure on health care is already high, A$104.8 billion in 2013-14 equating to 9.8% of GDP, cost-effective interventions could play a role in reducing these costs.[55, 56] Chapter 2 found a small number of interventions in nurses, and none of them reported information on the costs associated with the intervention. Therefore, there is the need to explore the costs benefit associated with implementing an intervention for nurses. In a cost-effectiveness analysis, intervention's costs are plotted

with intervention health effects to produce several indicators such as the Incremental cost-effectiveness ratio (ICER). ICER can provide information on the investment needed to see an improvement on intervention effects, and thus health outcomes. This information could help decision-makers decide on whether investing in a workplace intervention is worth it or not. Consequently, the aim of this paper was to describe and analyse the costs and potential health gains associated with a diet and physical activity workplace intervention for nurses.

8.2 AIM

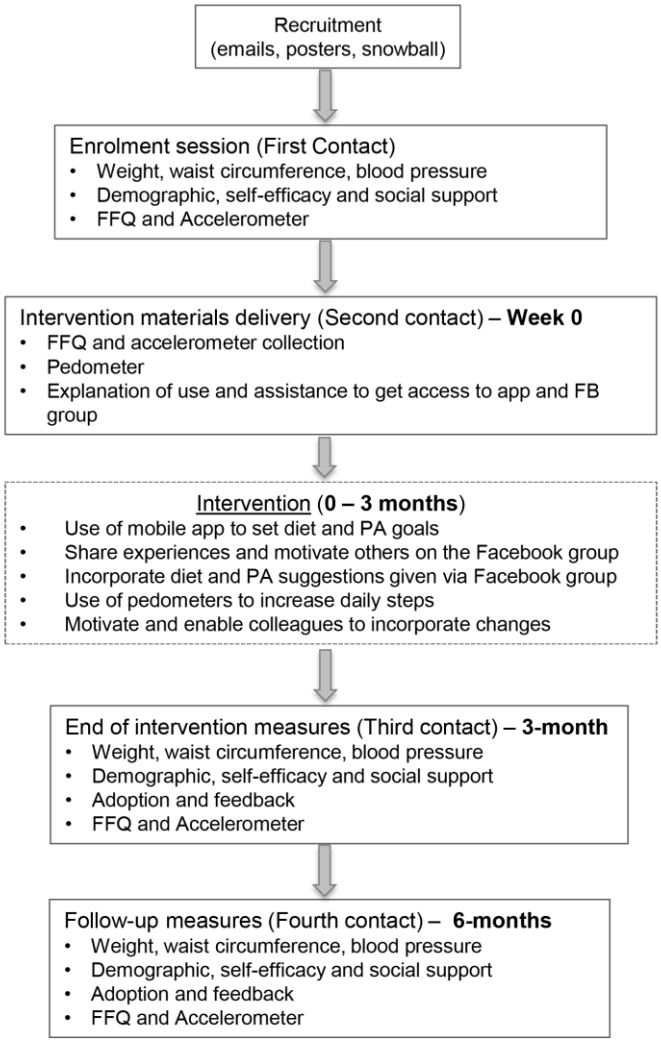
The aim of this chapter is to describe and analyse the costs and potential health gains associated with a diet and physical activity workplace intervention for nurses.

8.3 METHODS

8.3.1 Intervention design

Intervention development, methods and implementation have been described in Chapter 5 and 6. Briefly, the workplace intervention was a 3-month intervention study with a pre-post test design. The intervention was developed to improve dietary behaviours, such as reducing energy dense nutrient poor snacks and improving overall diet quality. The second aim of the intervention was to increase habitual levels of physical activity (Chapter 5). Self-monitoring, goal-setting and social-support were used as behaviour change strategies. Participants were asked to use a pedometer to encourage physical activity (self-monitoring), and mobile app to set diet and physical activity goals (goal-setting, self-monitoring). In addition, participants could join a closed Facebook group to share their progress and ideas, and encourage other participants to implement changes (social-support). The intervention design, outcome measurements and time-points for data collection are described in Figure 8.1. Data were collected for frequency and use of intervention materials, time spent engaging with these, and outcome measurements at each time-point. As this information was necessary to estimate costs, only participants that finished the intervention and had these data were included in this economic evaluation. Thus, 20 participants were included out of 26 that finished the intervention (*see* Chapter 7 for participants' characteristics).

Figure 8.1 – Intervention design and implementation flowchart



8.3.2 Cost-effectiveness analysis

In medical research, the cost-effectiveness analysis (CEA) is used to compare the costs and effects associated with two treatments or conditions [301]. In order to present the results of this analysis and inform decision-makers on whether an intervention has the better ratio between costs and effectiveness, the Incremental Cost-Effectiveness Ratio (ICER) was calculated as follows:

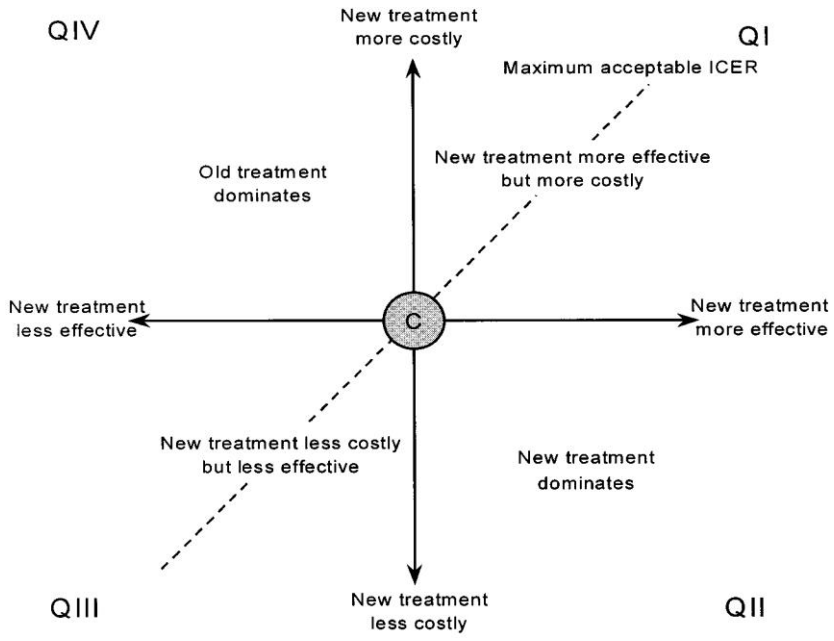
$$ICER = (\mu_{C1} - \mu_{C0}) / (\mu_{E1} - \mu_{E0})$$

From Stinnett and Mullahy [302]

The ICER equation describes the incremental cost and effectiveness of an intervention in relation to a comparator group, where μ_{ci} represents the mean cost and μ_{ei} the mean health effect of a given intervention (T_i). In this Chapter, the ICER is described as the incremental cost and effectiveness of the intervention in relation to pre-post changes, calculated using the mean costs and the mean health effects changes. For this analysis, diet and physical activity outcomes were used, and included discretionary foods intake, fruit and vegetable intake, and time spent in moderate-to-vigorous physical activity.

The ICER has no dimension, and as such cannot be properly interpreted without the separate effectiveness and cost outcomes. When both difference in effects and in costs are >0, the ICER represents the additional cost of obtaining one more unit of health by the new treatment T_i. On the other hand, if the effect difference is >0 and the cost difference is ≤0, T_i is preferred (dominant) [302]. The health outcomes and costs for each individual receiving T_i can be plotted in the Cost-Effectiveness (CE) plane [301]. This plane is shown in Figure 8.2, and is divided into four quadrants namely I (North-East), II (South-East), III (South-West) and IV (North-West). Each of these represents four possible scenarios related to additional costs and additional health outcomes (effects) of one intervention or condition compared to another one. The dashed line represents the maximum or "ceiling" value of ICER. Such limit is necessary for decision-making, as values to the right of this line are cost-effective, while those to the left are not cost-effective [301].

Figure 8.2 - The CE plane



From Briggs and Fenn [301]

However, because the cost and effect means used in the ICER equation are estimations, uncertainty remains around the true value of the ICER. [302, 303] In order to analyse the uncertainty around ICER, we can estimate its Confidence Intervals (CI) by calculating the Net Health Benefits (NHB). This means assessing the health gains obtained in intervention I_i compared to another one using the following formula:

$$NHB = (\mu_{E1} - \mu_{E0}) - (\mu_{C1} - \mu_{C0}) / \lambda$$

From Stinnett and Mullahy [302]

In which, $\boldsymbol{\mu_{E1}}$ are the mean effects of intervention (I_1) and μ_{C1} are the mean costs of intervention, in this case they refer to the post-intervention condition. In general, $\boldsymbol{\mu_{E0}}$ and $\boldsymbol{\mu_{C0}}$ would represent the sample from a different intervention or control group, but in this analysis they represent the mean effects and costs at baseline, respectively. In this formula, $\boldsymbol{(\mu_{E1} - \mu_{E0}) - (\mu_{C1} - \mu_{C0})}$ represents the difference between the mean effects and the mean costs at baseline (I_0) and after intervention (I_1). NHB represents the incremental difference between health effects of the intervention (I_1) compared to baseline (I_0). In this analysis, NHB represent the expected health gains if we invest on this workplace intervention instead of a marginally cost-effective intervention (baseline, usual care).[302] This investment is defined as **λ,** and represents society's or employer's willingness-to-pay for an incremental health gain. Because the threshold or real value of **λ** is unknown, a range of values for λ was calculated, and then used the NHB as function of **λ**.[302]

8.3.3 Parameters used for CEA in this study

The intervention costs included in this analysis were the time involved for recruitment, for intervention materials utilisation, time-off work and invested leisure time. Materials and staff required to conduct this intervention were also included. To calculate changes in health benefits, we used dietary behaviours (e.g. improvement in diet quality through a reduction of Discretionary foods) and physical activity behaviours as intervention outcomes. For this CEA, the time period represented the duration of the intervention (3-month). Because there was no health-promoting intervention before our study, the comparison group was represented by baseline values (i.e. absence of intervention = usual care).

Intervention costs

Costs were divided in “fixed” and “for intervention use”. The former included the costs associated with the enrolment and participation in the study, regardless of the engagement, use of materials and changes in diet and physical activity at follow-up. These costs considered the time participants used during work to meet the researchers for baseline and follow-up measurements, and for collection of intervention materials and accelerometers. Here, we also considered the time spent by the researcher to arrange these meetings and meet participants. The cost of a working hour for a nurse was calculated using the latest hourly rates in Queensland, [304] calculating an average value based on the level and tenure of the participants included in the analysis. The average hourly rate was A$41. We estimated the hourly rate for a Research Assistant using an average of the weekly salary for PhD student and a casual research assistant (A$25/h, http://www.uq.edu.au/current-staff/current-pay-schedules). Finally, we added materials costs such as printing of forms (A$0.10 each, estimated), Food Frequency Questionnaire for diet measurements (A$17.50/each, http://www.newcastleinnovationhealth.com.au), and pedometers for each participant (A$16, http://pedometersaustralia.com.au). Fixed costs for the enrolment of one participant were calculated and are presented on Table 8.1.

“For intervention use” costs included those that depended on the engagement with the intervention, use of materials, and changes in physical activity. These costs are variable as they are different for each participant. We considered changes in physical activity behaviour as a cost to leisure activity by assuming that, because of our intervention, participants are using their free time on physical activity instead of other activities. Based on the “opportunity cost method”, [305] we calculated the cost of leisure time as 1/3 of the cost of a weekly working hour (A$41=A$13.66). Such approach was applied in previous Australian population studies to estimate the cost of leisure time [306, 307]. We used this approach to calculate the costs at baseline, using participants usual MVPA in the absence of our intervention (accelerometer baseline data).

Table 8.1 - Fixed costs associated with the intervention for one participant

	Enrolment session *(20min)*	**Materials session** *(10min)*	**Follow-up session** *(20min)*	**Collection session** *(5min)*	**Participant management** *(10min/each)*
Participant					
Work time (A$41/h)	A$13.66	A$6.83	A$13.66	A$3.42	
Leisure time (A$13.66/h)	A$6.6*		A$6.6*		
Intervention resources					
Research Assistant (A$25/h)	A$8.33	A$4.16	A$8.33	A$4.16	$16.64 (x4 sessions)
Printing (A$0.10/page)	A$0.80		A$0.80		
Pedometer (A$16/ea.)		A$16			
FFQ (A$17.50/ea.)	A$17.50		A$17.50		
				Total fixed cost	**A$138.40**

***:** *Participant to fill-up the FFQ (20min) outside working hours.*

Diet behaviour outcome

Diet behaviour was assessed with a Food Frequency Questionnaire (Australian Eating Survey – AES) [108] at baseline and at post-test (3-months). The intervention aimed to improve diet quality. In line with the Australian Dietary Guidelines [264] and the AES improvements in diet quality included an increase in diet quality score, increased vegetable and fruit intake, and decreased intake in energy dense-nutrient poor foods. The latter category is described by the guidelines as “Discretionary foods” and includes foods such as pastries, cakes, chips, chocolate, candy, etc. We used changes in percentage of total energy intake from “Discretionary foods” and fruit and vegetable intakes as separate outcomes for the CEA. In terms of intervention effects, negative changes in “Discretionary foods” are desirable, as they represent a reduced intake from this group of foods.

Physical activity outcome

Physical activity was measured objectively with accelerometers at baseline and at 3-months after the intervention. During the intervention, participants were encouraged to increase their moderate intensity physical activity by increasing their daily steps, taking the stairs instead of the lift, actively commuting to work and similar strategies (Chapter 5 and 6). For this reason, we considered changes in Moderate-to-Vigorous physical activity (MVPA) as the outcome for the CEA. This outcome is a better index of significant changes in physical activity, as increased MVPA is associated with health benefits.[33] Thus, in this analysis increased MVPA was the desirable intervention effect.

8.3.4 Statistical analysis

Analysis was run in Microsoft Excel 14.06 (Microsoft Office®) using a macros function for non-parametric bootstrap. This was used to calculate differences between groups accounting for the skewed cost distributions.[308] Bootstrap was performed with 1000 replications to compare costs between groups, baseline versus post-intervention. Likewise, 1000 replications bootstrap was performed with cost-effect pairs to calculate cost-effectiveness and plot results in the CE plane.

8.4 RESULTS

8.4.1 Intervention costs

Total costs for the intervention were calculated for each participant, summing costs for intervention use and fixed costs. There was a great variability within costs per intervention use, with an average of A$37.36±42.30) and a range 0-122.94. Such variability reflects the differences among participants use of intervention materials and time spent engaging with the intervention. Total fixed costs were A$138.40 per participant, which was independent of intervention use and outcomes. The average total costs for this intervention was A$175.76±42.30 per participant.

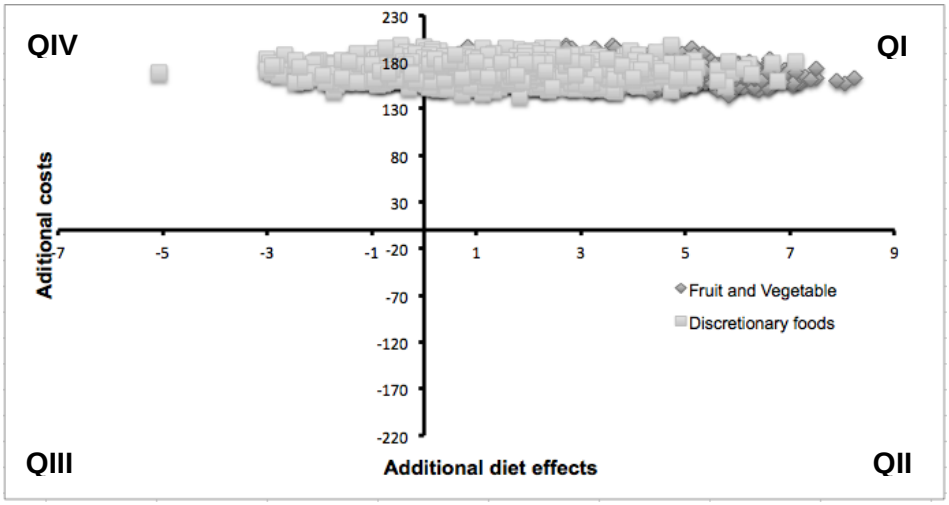
8.4.2 Cost-effectiveness plane

Diet behaviour outcome

The analysis showed positive effects for diet outcomes, including less percentage of total energy coming from discretionary foods and increased in percentage of fruit and vegetable intake. The distribution of the effects on “Discretionary foods” in the CE plane was 78% in the QI and 22% in the QIV quadrant. For this particular outcome, positive effects were considered a reduced intake and thus the direction on the CE plane had to be reversed (*see* Figure 8.3). Fruit and vegetable intake was distributed in the CE plane with 99% of cases being on the Q1 and 1% in QIV. The quadrant QI implicated that we obtain more health gains, because of increased intake from fruit and vegetables and decreased intake from discretionary foods, when we invest more in the intervention compared to usual care. Health outcomes related to increased intake of fruit and vegetables were

discussed in Chapter 2, and it is mainly associated with a decreased risk of mortality and NCDs morbidity. The distribution of dietary outcomes and their cost-effectiveness are presented in Figure 8.3.

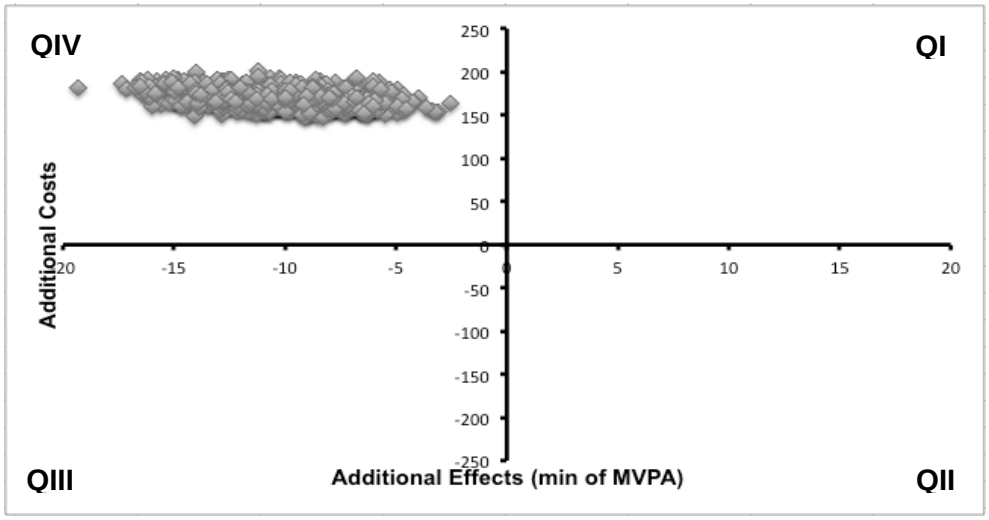
Figure 8.3 – CE plane distribution of the cost-effectiveness of dietary outcomes



Physical activity outcomes

The analysis showed a negative result for physical activity, with a decrease in average minutes of MVPA as the intervention effect. In the CE plane, 99% of the effects was on the QIV quadrant, meaning that the intervention was not cost-effective for physical activity. QIV quadrant shows that the more we invest in this intervention, the less health gains obtained due to reduced physical activity time. This is shown in Figure 8.4.

Figure 8.4 – Distribution of effects on Moderate-to-Vigorous Physical Activity (MVPA) and costs in the CE plane



8.4.3 Incremental Cost-Effectiveness (ICER).

For dietary outcomes, the average cost at baseline was A$5.60 per participant, while it was A$170.03 at the end of the intervention. There was a mean decrease of 1.4% energy intake from discretionary foods, with an incremental cost-effectiveness of A$170.15 and an ICER of A$118.40. For fruit and vegetables outcome, there was a 3.89% increase in energy intake from fruit and vegetables. Incremental cost-effectiveness for this outcome was A$164.43 and an ICER A$42.28. ICER described how much one is to invest per participant to observe a 1% decrease of total energy in discretionary foods, or for 1% increase of total energy from fruit and vegetables. Acceptability curves for ICER were calculated for dietary outcomes, leading to a λ of A$2500. This represented society's or employer's willingness to pay for a probability of 77% and 99% that the intervention is cost-effective for discretionary or fruit and vegetable intake, respectively.

Physical activity showed similar incremental cost to dietary outcomes (A$170.15), but a negative intervention effect with a decrease in MVPA minutes of -10.15. This generated a negative ICER (-A$16.76), implying an investment that leads to negative outcomes. For this reason, acceptability curves were not calculated for this outcome. Physical activity and diet outcomes cost and effects are presented on Table 8.2.

Table 8.2 – Distribution of costs and effects for diet and physical activity outcomes

Group	Costs	ICER	Difference Effectiveness	Distribution CE plane			
Diet				QI	QII	QIII	QIV
Baseline	5.60 (4.18 –7.25)		0				
Post-intervention							
Discretionary	170.03 (153.66 – 189.48)	$118.40	-1.39 (-1.88 – 4.88)	78%	0%	0%	22%
Fruit & vegetable	170.03 (153.66 – 189.48)	$42.28	3.89 (0.67 – 6.89)	99%	0%	0%	1%
Physical activity							
Baseline	5.60 (4.18 –7.25)		0				
Post-intervention	175.76 (161.05–198.33)	-$16.76	-10.15 (-14.89 – -5.20)	1%	0%	0%	99%

8.5 DISCUSSION

A cost-effectiveness analysis was conducted for both diet and physical activity outcomes for a 3-month workplace intervention. For diet, the intervention appeared to be cost-effective, as the majority of the effects were displayed in the QI plane (more investments for more health gains). Although the changes in diet included a modest decrease in energy intake from discretionary foods, and an increase in fruit and vegetable intake, these changes were not big enough to be clinically significant. On the other hand, physical activity decreased after the intervention. The analysis showed that, compared to baseline, we invested more resources to obtain less minutes of Moderate-to-Vigorous activity, and thus less health gains. Because of the mixed results in both outcomes the intervention in its current format is not cost-effective.

However, similar results were observed in a workplace intervention which aimed to promote physical activity through self-monitoring and work team challenges, with employees from 44 different worksites comprising hospitals, university and government agencies.[309] Physical activity did not increase and the CEA showed a negative investment (-£103.02 for incremental net benefit). However, a potential bias could have been present in McEchan *et al.*'s study [309], as the outcome measures were obtained via self-report and not objectively measured physical activity. Outcome measures for the CEA in workplace intervention promoting diet and physical activity are widely variable in the literature.[310] Allen and colleagues [311] used pedometers to improve employees' physical activity, their fixed costs were similar to our study ($136.27≈A$184). Their main outcome for the economic evaluation was decreased Coronary heart disease risk based on the Framingham Risk Score. Using this outcome, their incremental cost-effectiveness was $454.23 per point reduction in risk. Although this looked like a promising investment, the impact on physical activity in this intervention was small. Participants increased their steps from baseline by almost 2000 steps at 6-month (5.253±1644 vs 7149±1648), with no further improvements at 12-months (6878±1645), and without reaching the 10,000 steps/day guideline for health benefits at any of the time-points. [286]

Another workplace intervention promoting diet and physical activity simultaneously, used weight reduction as the outcome for the economic evaluation.[312] Here, delivering lifestyle counselling was effective on reducing employees' body weight but the intervention

was not cost-effective (€1337 /Quality of life year, QALY, using internet-based approach). A recent systematic review supports the cost-effectiveness of diet and physical activity intervention studies,[313] in which authors calculated an ICER of $13 761/QALY, supporting group-based intervention (median $1819/QALY) over individual intervention (median ICER $15 846/QALY). It is important to highlight that this review included studies targeting at-risk individuals, which are often more effective, indicating that interventions are more cost-effective if targeted to at risk sub-groups (i.e. only inactive, or overweight and obese nurses). Because our study was not targeted to high-risk individuals, it could explain why the intervention was not cost-effective.

Although small, our CEA results for diet were positive with and ICER of A$42.28 and A$118.40 for a unit of change in fruit and vegetable, and discretionary foods intake, respectively. These values are smaller than those reported for similar outcomes by a systematic review, in which ICER ranged from A$12 to A$7500.[314] The most recent Australian dietary guidelines highlight the importance of reducing energy intake from discretionary foods.[95] Foods from this group should be consumed sparingly, as high intake is linked to increased overweight/obesity rates and poorer dietary patterns**.** [95] In addition, results from the Needs Assessment for this target group highlighted changes needed, such as reducing energy dense nutrient poor snacks, improving diet quality (*see* Chapter 4). In this context, our intervention showed relevant effects by reducing 1.4% in total energy intake from discretionary foods while increasing 3.9% intake from fruit and vegetable. From a general point of view, these results remain important, as currently Australians obtain one third of their energy intake from discretionary foods, with less than 50% and 10% of the population consuming the recommended amount of fruit and vegetables, respectively. [285] While the results of our intervention and CEA are promising, uncertainty remains around the investment required with an estimated willingness-to-pay (**λ**) of A$2500 per unit of health benefit.

The change in one behavioural outcome (diet) and the parallel decrease in the other (physical activity) reflect the current theories of “compensatory behaviour”.[315] This theory suggests that an increase in energy expenditure could result in increased energy intake, and vice versa, thereby maintaining energy balance. Therefore, the “compensatory behaviour” aims to explain the unsuccessful changes in both diet and physical activity behaviours, or why people decrease their activity levels when they restrict their calorie intake. This also explains why people who increased their physical activity, might also

increase their caloric intake. [316] In line with this theory, our study results showed that participants focused more on dietary behaviours than on physical activity. These results suggest that costs and use of resources could be optimised if future intervention in nurses should target one behaviour at the time.

Our analysis presented a few limitations. The available data regarding intervention usage and adoption was limited, leading to a final sample of n=20 for each outcome analysis. There was a large variability of the sample, with outliers skewing the results. Although we performed bootstrap analysis in both outcomes to limit outliers' effects, this limitation should be considered when interpreting the results. Further, we only considered direct costs of intervention in this analysis. Efforts were made to access data retrospectively to calculate indirect costs, such as absenteeism, productivity, sick days, and health care claims. However, the employer refused to provide this information as this would involve the researcher having access to employers' confidential reports, or managers accessing employees' confidential data. Thus, future studies should consider gathering these through self-report from participants, ensuring the privacy and confidentiality of the information provided.

Another limitation included the lack of information on costs for increased intake of fruit and vegetables. Given the higher price of this group of foods compared to discretionary food,[317] an increased intake on the former would have implicated that participants spend more money than before because of the intervention. It was not possible to calculate such costs as the data on dietary behaviour included frequency of intake and energy intake from fruit and vegetables. Thus, there was no information available on pieces of fruit and vegetables, which could have been used to estimate their average cost. A different tool or a modified FFQ should be considered in future studies in order to provide a more comprehensive analysis. Although, the study's positive results for diet outcomes represent a valuable first step for the scalability of this intervention, more and better-designed diet and physical activity intervention for nurses are needed. Even if the effects of the intervention were small (diet) or negative (diet), this analysis provided an estimation of costs regarding the implementation of a workplace intervention for nurses. This included employee's time commitment and costs of intervention materials and staff, which are common concerns of stakeholder and policy makers (HREC committee and nurse managers in Chapter 5 and [318]). Having such information could facilitate management openness to support future workplace interventions.

8.6 CONCLUSION

Further research is needed in this field to better inform changes to our intervention, as it is not cost-effective in its current shape. Our results suggest that a single-component intervention (diet) could be more cost-effective than the current multi-component design. Future studies could explore whether tailoring this intervention to specific at risk subgroups (i.e. inactive or obese nurses), or modifying intervention materials and theories could have bigger effects. Strategies to improve intervention effects limiting “compensatory behaviours” and reducing overall costs are necessary to translate this intervention into practice in a sustainable way.

CHAPTER 9
SUMMARY, CONCLUSION & FUTURE DIRECTIONS

Diet and physical activity have been promoted through different channels ranging from mass media campaigns, community programs, or school education programs. Health promoters, such as nurses, are often involved in the enrolment and implementation of such initiatives. Nurses are the largest group of health professionals, but arguably the least healthy (see Chapter 2). The literature describes this profession as stressful, demanding, and with irregular shift patterns. These, together with the tense environment where nurses work, lead to nurses being worn out, fatigued and prone to emotional eating. The Literature Review and Needs Assessment (Chapter 2 and 4) showed that nurses have unhealthy dietary behaviours, with irregular meal patterns, overeating after shifts, and frequent snacking on energy-dense nutrient poor foods. Because of lack of time, fatigue and irregular shift work, it is hard for nurses to maintain an active lifestyle with the majority not meeting the physical activity recommendations (150-300min/week).[34] The behaviours described in the literature match those observed in the baseline characteristics of the intervention study, with only 45.2% meeting the physical activity guidelines, 33.3/75 average diet quality score (>40 considered “good”), and 66% being overweight or obese.

Current health promotion literature describes the use of the workplace as an ideal setting to promote healthy behaviours in the adult population.[319] It has a potential large reach given that the majority of the adult population is in the workforce, and people spend most of their waking hours at work.[16] Given nurses’ lifestyle behaviours and work characteristics, one would expect that this group is the most popular target for workplace health promotion interventions. However, the systematic review showed that only nine studies aimed to promote diet and physical activity in this group (Chapter 3). In addition, the rational and the methodology of the most of these studies was unclear providing inconclusive evidence on the effectiveness of diet and physical activity interventions. Some of the included studies suggested feasible strategies for this group, such as pedometers (Chapter 3). The findings highlighted a clear gap in the literature and the need for better-designed studies to promote diet and physical activity in nurses.

To better understand how to design a study that suits the characteristics of nurses, we conducted a Need Assessment with our target population (Chapter 4). This study also provided a comprehensive view of the behavioural determinants specific to the group we were catering for. Conclusions drawn from this study indicated that dietary behaviours were challenged by a cycle of lack of breaks during long shifts, feeling hungry, and subsequently overeating energy dense foods. Physical activity on the other hand, was hindered by fatigue and lack of time. The participants in this study also expressed their desire for a simple intervention with tools that allowed them to monitor their behaviour and also set goals. Social support from colleagues was seen as a strong motivation towards behaviours change and maintenance.

The intervention study was then developed following Needs Assessments information, nurses' characteristics and suggestions (Chapter 4). However, nurses working at the organisation where this study was implemented showed little interest in participating. The challenged implementation of the intervention may partially explain the limited number of similar studies found in the systematic review (Chapter 3). The lack of nurses' engagement with an initiative that is focused on their health was already observed during the recruitment for the focus group study (Needs Assessment, Chapter 4). Even if offered an onsite complementary afternoon or morning tea at suitable times (before, during or after their shifts) the number of nurses interested in taking part was very low (Chapter 4).

A lack of interest and engagement led to a very difficult recruitment and follow-up for the intervention study (Chapter 6). This intervention was original, as it combined novel effective strategies previously used separately, such as pedometers, smartphone app and social media. We observed small intervention effects and contradictory results, with physical activity decreasing and only some dietary aspects improving after the intervention. Findings from this study combined with those of the process evaluation suggest that changing two major behaviours was too difficult for this group (Chapter 6 and 7). Nurses felt it was easier to start with dietary changes, as this does not require as much effort as increasing physical activity after work for example. Fatigue and irregular shifts were and are major physical activity barriers that cannot be changed by nurses. These findings could be generalised to other workforces with long and rotational shifts such as doctors, police officers, and truck drivers. Shift workers commonly have altered sleep patterns and a demanding schedule, which impact their ability to engage in healthy

lifestyle behaviours.[320] Therefore, changing diet and physical activity behaviours at the same time might also not be feasible in these populations.

From the process evaluation (Chapter 7) it also emerged that the intervention did not successfully promote social support among colleagues. This was a key factor to motivate behaviour change and engagement, which was identified during the Needs Assessment, one-on-one interviews, and feedback questionnaires (Chapter 4 and 7). Findings indicated that although materials selection was informed by participants' suggestions, they did not engage with these as much as expected. Very few used the app, and the rest used the pedometer and Facebook sporadically with some participants not using this platform at all. Although it would have made the intervention time consuming and not "simple", participants said that having more frequent contact and meetings would have helped them change. Having this external support monitoring them was seen as necessary to motivate them and "keep them on track". These remarks confirm nurses' lack of internal motivation and interest for their own health, as observed in other studies that found poor lifestyle behaviours despite nurses' health knowledge and role as health promoters.[209]

There are many lessons learned from this thesis, and valuable insights and considerations for future research in this group. A significant issue that limits the application of the findings in this thesis was the extreme difficultly recruiting nurses to participate in the intervention study. This led to small sample size and a study design without a control group. Having a control group and larger numbers could have made the intervention's effects clearer and statistically more powerful. In addition, we did not include a multilevel strategy that targeted environmental factors at work, which need to be included in future studies. Unfortunately, for the purpose of this PhD thesis the inclusion of environmental changes were not feasible. Being an external person to the organisation and having a small and limited research budget, made it difficult to include such changes in the research design. In addition, environmental changes, such as changing shift patterns or changing what food is offered to employees, involves complex processes that go above and beyond the scope of a PhD project.

Nevertheless, the economic evaluation included in this thesis provides a good first step towards making a business case for hospital managers to consider environmental changes. Even if small, the observed cost-effectiveness of promoting fruit and vegetable intake (Chapter 8) provides a case for supporting strategies such as their free provision at

the workplace. Investing in such initiatives has shown to have a positive Return on Investment (ROI), with $3.30 generated for every $1 invested in a local community intervention that provided free fruit and vegetables.[321] A recent systematic review on financial return of diet and physical activity workplace interventions described a mean ROI of 42%, indicating a 42% profit for each dollar invested.[300] They also found 14 out of 21 interventions had a positive ROI, showing the positive economic outcomes of investing in employees' health.

Translating intervention investment into financial return and employees reduced costs is an attractive approach for hospital managers. Managers should have a long-term approach for investments, considering not only the economic return, but also the improved company's social capital as an outcome.[322] Managers that invest in their employees' health promote a working culture where employees feel valuable and cared for.[39] Several studies show that such characteristics are directly correlated to increased productivity, reduced absenteeism, and reduced "job leave".[323] Such work culture can foster employees' interest for their own and their colleagues' health, promoting social-support among them. This aspect was very valuable for nurses, but it also applies across all workplaces [322] (*see* also Chapter 4).

Based on the sample calculation performed in Chapter 6, to ensure appropriate statistical power future studies should aim to have at least n=119 nurses completing the intervention per group. Considering the high drop-out rate (40%) and low reach (~5%) in this population, in total at least n= 398 nurses should be recruited and n= 7960 nurses should be contacted, respectively. The latter figure highlights the need to improve reach in this group; so future interventions can be implemented with enough participant numbers. Based on our participants' feedback and other studies suggestions, environmental changes should include better shift patterns and scheduled breaks to allow for participation and better meal patterns, provision of free healthy food or cheaper healthy options at the onsite food outlets, or free onsite gyms or discounted gym memberships,[209] (*see* also Chapter 7 and 8). Finally, future studies should include a clear economic analysis to allow for comparison with other studies or current employees' health status and costs. Having cost-effectiveness interventions is the key to ensure intervention's scalability and acceptability from hospital managements.

The findings of this thesis reflect the challenges for promoting healthy diet and physical activity in the general population. Using educational campaigns and focusing on individuals taking action has not produced significant changes at population level so far, and nurses are a clear example of this. Nurses know and see the consequences of unhealthy lifestyle behaviours on their everyday work, and yet this is not enough to motivate them to implement healthy diet and physical activity behaviours. Even though the intervention aimed to motivate them and facilitate change, very few of them were sufficiently interested and engaged to improve both behaviours.

Nurses represent an example on how the work environment and lack of opportunities negatively influence diet and physical activity even when information is available. At the same time, participants' feedback showed how environmental changes at work could promote individuals' behaviours if manipulated properly. Examples of these include facilitating healthy food choices with increased availability and accessibility, and providing opportunities for leisure physical activity by improving shift work patterns. For future studies to be effective, such environmental changes should be included in addition to stronger individual support to promote behaviour change. For this purpose, strong and collaborative relationships should be fostered with key stakeholders in the organisations where the interventions will be implemented. Diet and physical activity can be effectively promoted if targeted by a multilevel approach that enables such behaviours. However, their adoption, both at the workplace and population level, can be warranted only if fostered by a culture that values the social, mental and physical health benefits of such behaviours.

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APPENDIX I

MATERIALS FOR FOCUS GROUP STUDY

AI.1 INVITATION LETTER TO PARTICIPATE IN THE FOCUS GROUP INTERVIEWS

----------FACSIMILE EMAIL----------

From: ******@mater.org.au
Sent: Day, nr May 2014 time
To: "Nursing staff"
Subject: External student research project

Please find below a letter from an external PhD student, wishing to run focus group interviews with some of you.

DISCLAIMER: I am not involved in this research nor have access to data or information about staff participation. This research is completely external to Mater Health Services and Queensland Health.

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Internet www.hms.uq.edu.au
CRICOS PROVIDER NUMBER 00025B

Dear Nurse,

I would like to invite you to participate in a group discussion about nutrition and physical activity. My name is Luciana Torquati, and this study is part of my PhD project, at The University of Queensland. The aim of this study you could assist us with, is the planning and development of a future worksite health promotion program. I am not an employee or health provider, and I am not connected in any way with the Mater Organization, its Governance or any other private/public agencies.

I would like to explore nurses' perceptions and opinions about nutrition, physical activity and how/if your occupation affects these. Therefore, your participation will provide information to help me design a tailored workplace program in the future, aimed to improve diet and physical activity behaviours.

The group discussion will take place during a complementary morning/afternoon tea, will last approximately one hour, and will include 6 to 8 other nurses. We will talk

about daily habits at work, lifestyle, and your opinion about physical activity, food, meals and nutrition. I will lead this meeting as a moderator, not an interviewer, so you are free to share your opinion/ideas or just enjoy a morning/afternoon tea with your colleagues.

To accurately capture all of your important ideas, the discussion will be audio-recorded and then transcribed into a written report. You participation in this meeting is entirely voluntary and your choice to participate will not affect your job or employment. You are free to leave the session anytime, if you decide to not participate any further.

Your involvement and the information you provide at the discussion group will be completely confidential. You as an individual will not be identified in the written report.

I am very excited about the opportunity to learn about your perspective on how to best provide a health promotion program for you. I hope that you will be able to join us for this very important meeting.

Interviews will be run during **August - September 2014**, **in the afternoon and early morning (preferably before/after shifts for your convenience)**. Times and dates will be agreed with those who decide to participate. For RSVP or for any further questions about this meeting, please contact Luciana Torquati (main researcher) at: l.torquati@uq.edu.au or 33654998, including:

- Best contact details
- Hospital and unit where you work
- Preferred days/time.

Thank you for considering this invitation. Your support is greatly appreciated.

Yours Sincerely,

Luciana Torquati, PhD candidate
The University of Queensland

AI.2 PARTICIPANT INFORMATION SHEET

THE UNIVERSITY OF QUEENSLAND
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PARTICIPANT INFORMATION SHEET

Researchers Luciana Torquati (School of Human Movement and Nutrition Sciences, UQ)
Dr. Michael Leveritt (School of Human Movement and Nutrition Sciences, UQ)
Dr. Toby Pavey (School of Human Movement and Nutrition Sciences, UQ)
Christina Persson (School of Human Movement and Nutrition Sciences, UQ)

"Workplace health promotion intervention in nursing population: Focus Group interviews"

Aims of the Research

This study aims to explore nurses' perceptions and opinions about healthy diet and physical activity behaviours. This will help us to better understand this population's needs in relation to these factors, and be able to design a workplace intervention in the future, targeted to improve diet and physical activity levels.

You will benefit by participation, by contributing to new knowledge on how to develop effective nutrition and physical activity programs. Please note, that there is no reimbursement for participation.

Please inform us if any aspects of the study cause you concern because of your cultural, religious or traditional customs or beliefs.

The Study

We will run a Focus Group interview of 6-8 nurses, with discussions about diet and physical activity. These group discussions will take place during a morning or afternoon tea offered to you, outside your working hours, in times matching before or after shifts, for your convenience.

However, further times/dates can be organised via email/phone/text communication. The aim will be to hold interviews at your workplace.

The main researcher will lead the group interview, acting as a moderator of discussion between participants, through open questions about nutrition and physical activity. Some examples of these are:

1. What does physical activity means to you?
2. Which leisure time activities do you enjoy doing?
3. What is a healthy diet to you? How would you rate your current diet based on your definition?
4. Is there anything you would like to change about your diet/physical activity levels? Is there anything stopping you?
5. What do you think we should consider or add to a nutrition and physical activity programme to make it more interesting for you and the rest of your colleagues?

A second researcher will be taking notes during the interview. The whole interview will be audio-recorded, and transcribed for later analysis. However, **your involvement and the information you provide at the discussion group will be completely confidential. You as an individual, will not be identified in the written report.**

This will be a very casual meeting, where you could talk about your opinions and share your experience with other nurses similar to you. Group similarity is important for this type of study, therefore we will be asking for personal details such as years of experience, shifts you normally do, and basic demographics. You are free to speak whenever you feel like sharing your thoughts, contribute to discussion, or agree/disagree with other nurses' opinions or researcher questions. **You are free to not be involved in the discussion of any questions or leave anytime you feel uncomfortable or no longer wish to participate.**

At the end of the interview, the researcher will do a summary of what has been said to ensure we capture all relevant information. We will also ask you for any extra information or comments you would like to add at this stage, and provide feedback about the interview.

Safety and Risk

Each component of the study has been designed to maximise the safety of the people who volunteer as subjects.
You are completely free to withdraw from the interview, without any penalties or justification, at any time if you find any procedure uncomfortable, or for any other reason.

Confidentiality

Results from this experiment may be published. However, your individual results will be stored securely and published in such a way that it will be impossible to link any data to you personally.
All information gathered from the study will remain confidential. Your identity as a participant will not be disclosed to any unauthorized persons. Your identity and personal details will not be disclosed for any purpose or included in any database for disclosure to any other party.
Only the research study team will have access to the research materials, which will be kept in a secure room. Any references to your identity that would compromise your anonymity will be removed or disguised prior to the preparation of any research reports. Your last name will not be used in the written transcripts of any recordings.

Access to your Results

A summary report will be emailed to you, once the transcription and analysis is finished. No other person apart from the researchers will have access to this data, including your employer.

Ethical Clearance

The ethical aspects of this research project have been approved by the HREC of *Mater Health Services.* This project will be carried out according to the *National Statement on Ethical Conduct in Human Research (2007)*. This statement has been developed to protect the interests of people who agree to participate in human research studies. You are free to discuss your participation in this study with the main researcher (contactable on 07-33654998, Luciana Torquati). If you have any complaints about any aspect of the project, the way it is being conducted or any questions about being a research participant in general, then you may contact: **Mater Health Services Human Research Ethics Office (** research.ethics@mmri.mater.org.au or 07 3163 1585)

AI.3 PARTICIPANT CONSENT FORM

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RESEARCH PARTICIPATION CONSENT FORM

PROJECT TITLE: Workplace health promotion intervention in nursing population.

Researchers: Luciana Torquati (School of Human Movement and Nutrition Sciences, UQ)
Dr. Michael Leveritt (School of Human Movement and Nutrition Sciences, UQ)
Dr. Toby Pavey (School of Human Movement and Nutrition Sciences, UQ)
Christina Persson (School of Human Movement and Nutrition Sciences, UQ)

This study has been cleared in accordance with the ethical review guidelines and processes of the University of Queensland and Human Research Ethics Committee of Mater Health Services. This project will be carried out according to the *National Statement on Ethical Conduct in Human Research (2007)*. You are free to discuss your participation in this study with main researcher (contactable on 3365 4998, Luciana Torquati). If you have any complaints about any aspect of the project, the way it is being conducted or any questions about being a research participant in general, then you may contact: **Mater Health Services Human Research Ethics Office** research.ethics@mmri.mater.org.au or 07 3163 1585.

1. I, the undersigned..... hereby acknowledge that I have read the information document, and that the specific sections of the document that are relevant to the present experiment have been drawn to my attention. I have been provided with a description of the experiment, including the purposes, methods, demands, and possible risks and inconveniences involved.
2. I am aware that I may withdraw from this research project at any time without penalty (even after I have signed this statement of participation), and that I am entitled to a thorough explanation of any procedure employed in the study. I understand this group interview will be audio-recorded and that any information I provide will be treated confidentially, and that it I will not obtain any direct benefits from my participation other than what has been outlined in the participant information sheet.
3. I hereby consent to being a research participant in this study.

(Signed)..... Date: .....
Principal Investigator ..... Date: .....

APPENDIX II

MATERIALS FOR INTERVENTION STUDY

AII.1 PARTICIPANT INFORMATION SHEET

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PARTICIPANT INFORMATION SHEET

PROJECT TITLE: "Workplace intervention to improve diet and physical activity in nurses"

Researchers Ms Luciana Torquati (School of Human Movement and Nutrition Sciences, UQ)
Dr Michael Leveritt (School of Human Movement and Nutrition Sciences, UQ)
Dr Toby Pavey (School of Human Movement and Nutrition Sciences, UQ)
Dr Tracy Kolbe-Alexander (School of Human Movement and Nutrition Sciences, UQ)

Aims of the Research

Thank you for considering participation in this research study, which is part of a PhD student thesis (Ms Luciana Torquati)and aims to promote healthy diet and physical activity behaviours in nurses. The materials and methods have been developed based on nurses' feedback and suggestions. These were collected through Focus Group interviews held with Mater Health Service nurses during August - October 2014.

The Study

This study is a 12-week program that will assist you with changing those aspects of your diet and physical activity *that you want to change*. You will be able to do so by:

- Using a mobile app to set your goals
- Joining a dedicated Facebook group for peer-support
- Using program's complementary pedometer to check your steps and get motivated.

We will assess changes in diet, physical activity and other health outcomes before and after the program, and 6-month follow-up.

What should I know and do before I take part of this study?

1. Read this information document in each specific section, which gives a description of the experiment, including the purposes, methods, demands, and possible risks and inconveniences involved.
2. You are entitled to a thorough explanation of any procedure employed in the study by the researchers.
3. The information you provide will be treated confidentially.
4. You will not obtain any direct benefits from my participation other than what has been outlined in this participant information sheet.
5. You will not be able to participate if you are pregnant or have any other condition that limits any changes in your diet and physical activity.
6. You can withdraw from this research project at any time without penalty (even after you have signed the consent form).
7. I hereby consent to being a research participant in this study.

What should I do if I take part of this study?

1. Liaise with Principal Investigator to set a date and time to meet. The PI will give you a throughout explanation of this study and take baseline measures. This will be done in a quiet and private room at you workplace.
2. **Enrolment: baseline measures session (20min**): we will ask you to provide demographic information (e.g. name, age, job, marital status, etc.) and to fill-up a Food Frequency Questionnaire and a Diet and Physical activity self-efficacy questionnaire. **We will measure your weight, waist circumference, and blood pressure.**
3. If this is taking is too long for you, you can decide to re-schedule another day to finish the measurements. You can also take the questionnaires with you and return it via email or next time we will meet.
4. At this point, you will be given an **accelerometer**. This is a small waist-worn device to monitor your physical activity. We will kindly ask you to **wear this for 1 week**. We will arrange collection time based on your availability.
5. **Start:** When we meet **for accelerometer collection** (**5 min**.), we will instruct you how to download the mobile app, set privacy settings for your Facebook account, and how to join the group. We will be happy to answer any questions at this time or anytime you need. If you do not have time to meet with us, you can leave your accelerometer at the nurses' station and we will collect it from there. Instructions and information about mobile app and Facebook group will be sent via email in this case.
6. **During the program:** For 12 weeks you will set and aim to reach your own goals. The objective is to improve some aspects from your diet and physical activity that you are interested on changing. During this time, you can use your pedometer for personal motivation (we advise you to track your steps, but not log and reporting is required). You can create your goals (e.g. food, steps, exercise, etc.), choose them from the app menu, or choose them from the Facebook group (from other participants). You can share your goals on FB if you whish to do so, to inspire other participants. They could use this information to set their own goals. **We encourage you to use this group for peer-support and encouragement, but you are not required in any way to comment, post or share if you do not feel like doing this.**
7. **Other:** we will post weekly motivational quotes for nutrition and physical activity, ideas about quick and healthy recipes. We will ask for your on-going feedback on things you would like use to post or remove. We will ask expression of interest of nurses willing to organise group

exercise sessions or events. We will assist you with Facebook settings if you ever would like to stop receiving notifications about this.

8. **After the program:** we will repeat the baseline measures two times: 1) Straight after the program, and 2) three months after end of program (6-month follow-up from baseline). Times and dates will always be arranged based on your availability, and hold at your workplace for your convenience.

What about my personal information?

All your information will be stored in a de-identifiable way. This means after you enrol, we will assign you a participant code and will refer to you using that code. Any files containing your real name will be stored straight after your enrolment, in a password-protected file in a password-protected computer. Hard-copies will be stored in a locked cabinet in a locked room at the University of Queensland. Only the researchers listed above will have access to you data and only for the research purposes listed here.

You are not required to "become friends" on Facebook with any participants or researchers, thus no one will have access to you Facebook profile and personal information, photos, wall, etc. We will offer support with your Facebook privacy settings if needed. We will instruct you how to ensure your settings are adequate to protect your personal information in this social platform. We can do this via email or face-to-face, based on your preference.

Safety and Risk

Each component of the study has been designed to maximise the safety of the people who volunteer as subjects. You are completely free to withdraw from the interview, without any penalties or justification, at any time if you find any procedure uncomfortable, or for any other reason.

Please inform us if any aspects of the study cause you concern because of your cultural, religious or traditional customs or beliefs.

Benefits

You will benefit from participation, by having access to a free and simple program that will help you improve your nutrition and physical activity. **Once you enrol, you will be rewarded with a pedometer as an appreciation gift for your time. You can keep this regardless of finishing the program or not.** Please note no reimbursement is provided.

Confidentiality

Results from this experiment may be published. However, your individual results will be stored securely and published in such a way that it will be impossible to link any data to you personally.
All information gathered from the study will remain confidential. Your identity as a participant will not be disclosed to any unauthorized persons. Your identity and personal details will not be disclosed for any purpose or included in any database for disclosure to any other party.

Only the research study team will have access to the research materials, which will be kept in a secure room. Any references to your identity that would compromise your anonymity will be removed or disguised prior to the preparation of any research reports.

Access to your Results

A summary report will be emailed to you, once the analysis is finished. No other person apart from the researchers will have access to this data, including your employer.

Ethical Clearance

The ethical aspects of this research project have been approved by the HREC of *Mater Health Services.* This project will be carried out according to the *National Statement on Ethical Conduct in Human Research (2007)*. This statement has been developed to protect the interests of people who agree to participate in human research studies. You are free to discuss your participation in this study with the main researcher (contactable on 07-33654998, Luciana Torquati).
If you have any complaints about any aspect of the project, the way it is being conducted or any questions about being a research participant in general, then you may contact: **Mater Health Services Human Research Ethics Office (**research.ethics@mmri.mater.org.au or 07 3163 1585)

AII.2 PARTICIPANT CONSENT FORM

School of Human Movement and Nutrition Sciences

The University of Queensland
Brisbane Qld 4072 Australia
Telephone (07) 33656240
International +61 7 33656240
Facsimile (07) 33656877
Email enquiries@hms.uq.edu.au
Internet www.hms.uq.edu.au
CRICOS PROVIDER NUMBER 00025B

RESEARCH PARTICIPATION CONSENT FORM

PROJECT TITLE: "Workplace intervention to improve diet and physical activity in nurses"

Researchers Ms Luciana Torquati (School of Human Movement and Nutrition Sciences, UQ)
Dr Michael Leveritt (School of Human Movement and Nutrition Sciences, UQ)
Dr Toby Pavey (School of Human Movement and Nutrition Sciences, UQ)
Dr Tracy Kolbe-Alexander (School of Human Movement and Nutrition Sciences, UQ)

Thank you for considering participation in this research study, which is part of Ms Luciana Torquati's PhD thesis. This study has been cleared in accordance with the ethical review guidelines and processes of the University of Queensland and Human Research Ethics Committee of Mater Health Services. This project will be carried out according to the *National Statement on Ethical Conduct in Human Research (2007)*. You are free to discuss your participation in this study with main researcher (contactable on 3365 4998, Luciana Torquati) or her supervisors/associated researchers (contactable at 3365 6877, Dr Leveritt; 3346 9898, Dr Pavey and Dr Kolbe-Alexander). If you have any complaints about any aspect of the project, the way it is being conducted or any questions about being a research participant in general, then you may contact: **Mater Health Services Human Research Ethics Office** research.ethics@mmri.mater.org.au or 07 3163 1585.

4. I, the undersigned..... hereby acknowledge that I have read the information document, and that the specific sections of the document that are relevant to the present experiment have been drawn to my attention. I have been provided with a description of the experiment, including the purposes, methods, demands, and possible risks and inconveniences involved.
5. I am entitled to a thorough explanation of any procedure employed in the study.
6. I understand any information I provide will be treated confidentially.
7. I will not obtain any direct benefits from my participation other than what has been outlined in the participant information sheet.
8. I am not pregnant or have any other condition that limits my participation.
9. I am aware that I may withdraw from this research project at any time without penalty (even after I have signed this statement of participation).
10. I hereby consent to being a research participant in this study.

(Signed)..... Date: .....
Principal Investigator ..... Date: .....

AII.3 ACCELEROMETER QUESTIONNAIRE

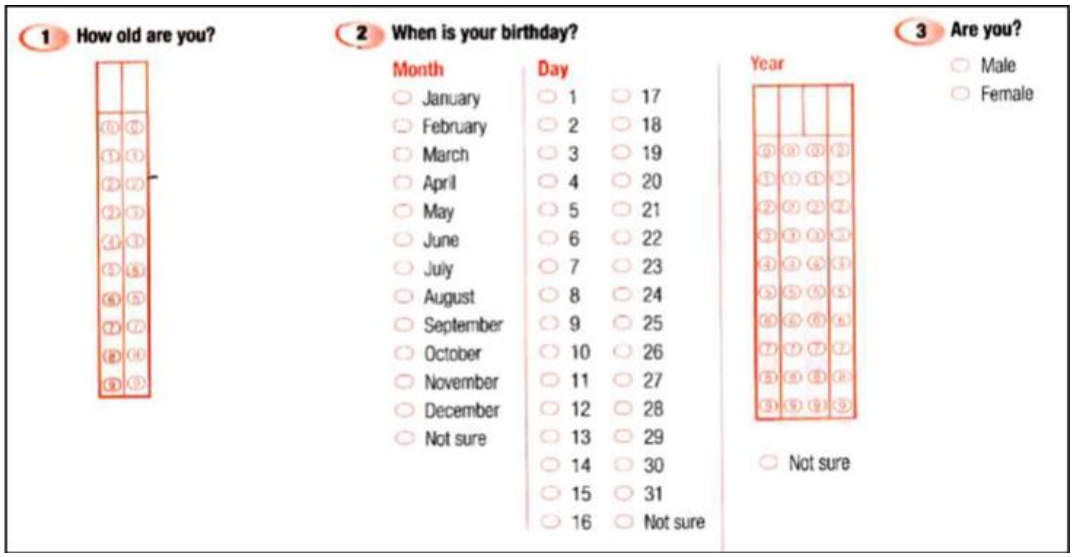
THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Accelerometer data

Name:			
Gender:			
Age:			
Hospital:			
Current shift:			
Your shifts in the next 10 days:	Day	From	To
	1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10		

Accelerometer nr	
Date and time given	
Preferred contact for collection	Phone/email ……
Date and time collected	

AII.4 FOOD FREQUENCY QUESTIONNAIRE (SAMPLE QUESTIONS)



From Newcastle Innovation User Manual

http://www.newcastleinnovationhealth.com.au/sites/default/files/content/aes_user_manual.pdf

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Diet and Physical Activity
Self-Efficacy and Social Support

Participant ID……..
Date ……

1) Please indicate how confident you feel about the following situations

"I'm confident that I'm able to exercise 20 min three or more times per week even if…

	Not at all confident	Somewhat confident	Moderately confident	Very confident	Completely confident
"… I am under a lot of stress"	☐	☐	☐	☐	☐
"… I feel I don't have the time"	☐	☐	☐	☐	☐
"… I have to exercise alone"	☐	☐	☐	☐	☐
"… I don't have access to exercise equipment"	☐	☐	☐	☐	☐
"… I am spending time with friends or family who do not exercise"	☐	☐	☐	☐	☐
"…It's raining or snowing"	☐	☐	☐	☐	☐
" … I am tired because of my shifts"	☐	☐	☐	☐	☐
"…I don't feel like because is my day-off?"	☐	☐	☐	☐	☐

"There are many things that can get in the way of choosing to eat healthy foods/snacks. HOW CONFIDENT are you that you can choose healthy foods/snacks in each situation?"

When others around you are eating unhealthy foods/snacks	☐	☐	☐	☐	☐
When you are craving unhealthy foods/snacks.	☐	☐	☐	☐	☐
When you are on your break.	☐	☐	☐	☐	☐
When you are upset or having a bad day.	☐	☐	☐	☐	☐
When you are at a social event.	☐	☐	☐	☐	☐
When you are out at a restaurant	☐	☐	☐	☐	☐

2) Please indicate the frequency of the following situations

"How often in the last 7 days have your colleagues or friends have done the following?

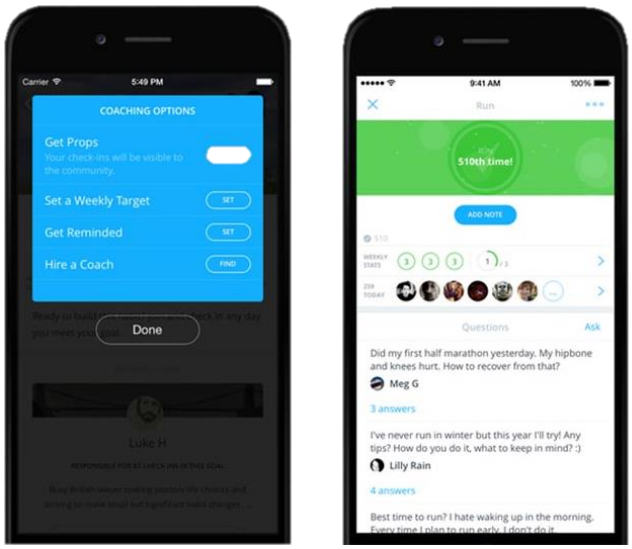
	Almost always	Often	Sometimes	Once in a while	Almost never
Encourage you to eat healthy foods	☐	☐	☐	☐	☐
Discuss the benefits of eating healthy foods	☐	☐	☐	☐	☐
Remind you to choose healthy foods	☐	☐	☐	☐	☐
Share ideas on healthy eating	☐	☐	☐	☐	☐
Eat healthy meals with you.	☐	☐	☐	☐	☐
Complain about eating healthy foods	☐	☐	☐	☐	☐

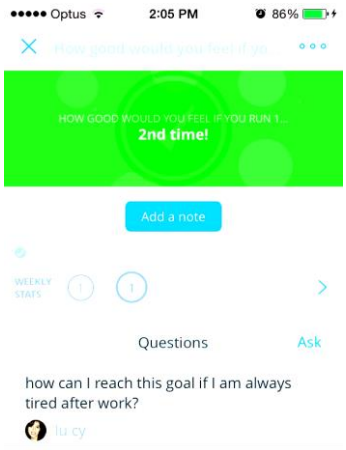
"How often in the last 7 days have your colleagues or friends have done the following?

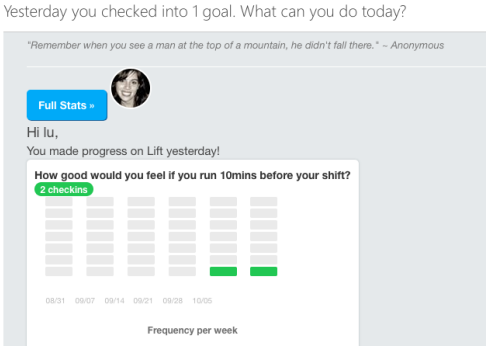
	Almost always	Often	Sometimes	Once in a while	Almost never
Exercised with me	☐	☐	☐	☐	☐
Offered to exercise with me	☐	☐	☐	☐	☐
Gave me helpful reminders to exercise ("Are you going to exercise tonight?")	☐	☐	☐	☐	☐
Gave me encouragement to stick with my exercise program	☐	☐	☐	☐	☐
Changed their schedule so we could exercise together	☐	☐	☐	☐	☐
Discussed exercise with me.	☐	☐	☐	☐	☐
Complained about the time I spend exercising	☐	☐	☐	☐	☐
Criticised me or made fun of me for exercising.	☐	☐	☐	☐	☐
Gave me rewards for exercising (bought me something or gave me something I like)	☐	☐	☐	☐	☐
Planned for exercise on recreational outings	☐	☐	☐	☐	☐
Helped plan activities around my exercise	☐	☐	☐	☐	☐
Asked me for ideas on how they can get more exercise.	☐	☐	☐	☐	☐
Talked about how much they like to exercise	☐	☐	☐	☐	☐

Thank you for your participation!

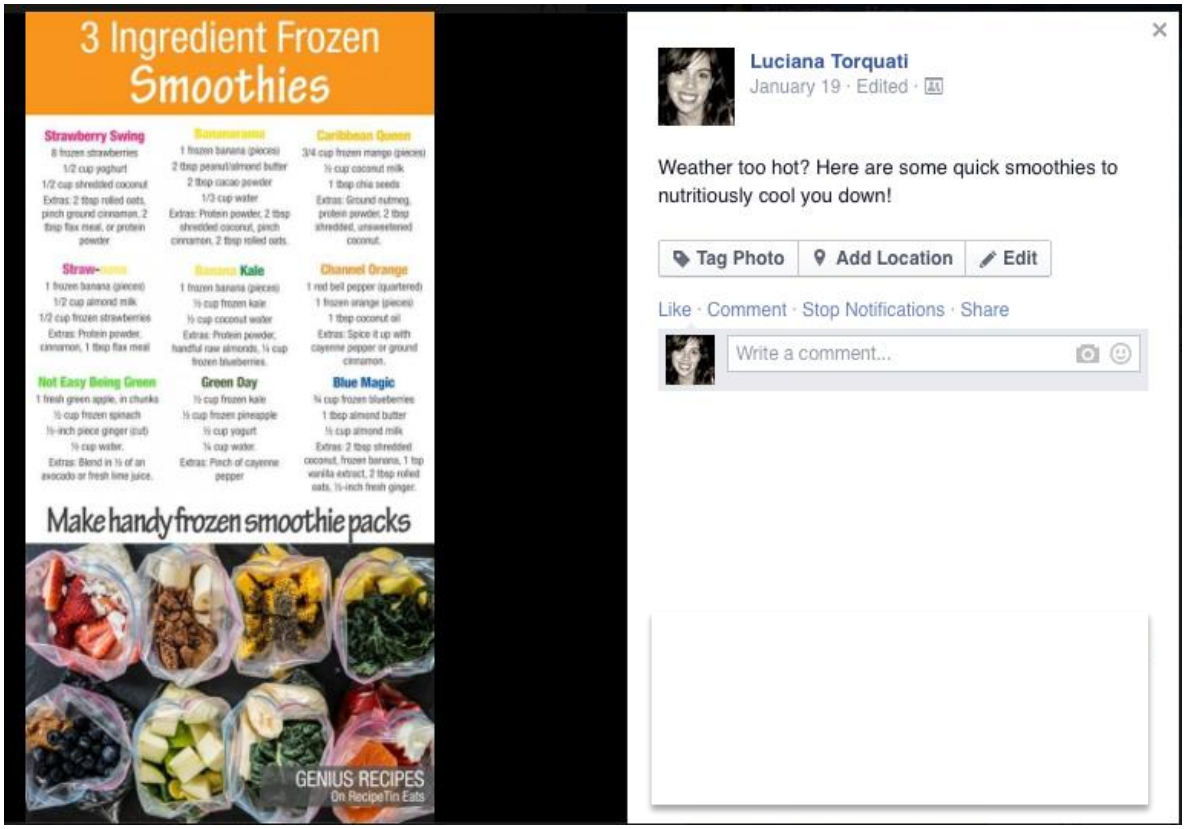
AII.6 COACH.ME APP AND PEDOMETER GS-2026







AII.7 FACEBOOK GROUP POSTS



Luciana Torquati
July 27, 2015 · Brisbane, QLD

You don't need a gym and you don't need much time... pick your favourite 2 songs and try this mini-workout 🙂 Even doing one or two exercises is a great start!

You can do it! 👍

7-Minute Bodyweight Workout

For this seven-minute workout, we tapped Brynn Putnam, founder of Refine Method studio in New York City to create a quickie routine that's also seriously effective at sculpting muscle and stripping...

BLOG.MYFITNESSPAL.COM

Luciana Torquati
August 10, 2015

Easy & tasty recipes are back! I tried this one over the weekend and was shocked by how simple, yummy and filling it is!

Quick Salmon Salad (it really takes 20min!) 🙂

Ingredients: (serves 2)

2 salmon fillets (approx 150g each)
half cabbage
one onion
Feta cheese, 100g
Baby spinach, 2 cups
Balsamic vinegar
Extra virgin olive oil
Lemon juice/salt/pepper or your favourite herbs

Instructions:

Pre-heat oven at 200 C
Rub the salmon with salt, pepper and lemon juice
Place it on aluminium foil, skin down
Bake it for 10-12min or until cooked
In the meantime, slice the onion and the cabbage. Combine onions, cabbage, and baby spinach on each plate. Add feta cheese cut in small cubes.
Once the salmon is cooked, place it on top of the salad and dress with one tsbp of olive oil and two tbsp of balsamic or lemon or lime juice.

Enjoy! 👍

APPENDIX III

MATERIALS FOR PROCESS EVALUATION

A III.1 ADOPTION AND FEEDBACK QUESTIONNAIRE

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Adoption and Feedback Questionnaire

Participant……..
Date……

Please indicate how often did you…

	Never	Once a month	Once a week	2-3 times/ week	>4 times/ week
"… use the Coach.me app"	☐	☐	☐	☐	☐
"… wear your pedometer"	☐	☐	☐	☐	☐
"…check the Facebook group"	☐	☐	☐	☐	☐
"… set new diet goals"	☐	☐	☐	☐	☐
"… set new exercise goals"	☐	☐	☐	☐	☐

Please indicate if you agree with the following statements

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
" Using the coach.me app helped me keep track of/set my goals"	☐	☐	☐	☐	☐
"The information shared on Facebook helped me set my goals"	☐	☐	☐	☐	☐
" The Facebook group motivated me to change my diet and/or physical activity levels"	☐	☐	☐	☐	☐
" I feel the tools given to me did not motivate me to change my diet/physical activity"	☐	☐	☐	☐	☐
" I found it easy to set my own goals"	☐	☐	☐	☐	☐
" I would prefer a more specific program to follow"	☐	☐	☐	☐	☐

Which components were more helpful and beneficial for you?

……..
……..
……
……
……

Which components were least helpful and beneficial for you?

……..
……..
……
……
……

What would you change/add to improve this program?

……..
……..
……
……
……