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Breakfast intake and practices in Pacific Island women in New Zealand

A thesis presented in partial fulfilment of the requirements for the degree of

Masters of Science

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Abstract

Background/aim: Pacific people living in New Zealand have disproportionately high rates of obesity, leading to increased adverse health outcomes. A tendency to skip breakfast has been reported within this group. Skipping breakfast is linked to dietary deficiencies such as calcium and fibre, and an increased appetite later in the day. The aim of this study was to explore recorded and observed breakfast intake and practices in Pacific Island women aged 18-45 years of different body compositions in New Zealand. This included an extensive literature review on breakfast habits and the relationship with body composition and food groups.

Methods: In this cross-sectional study, Pacific women (18-45 years) completed a 5-day food record (FR) (n=146) and a videoed breakfast buffet (BB) (n=142). Body mass index (kg/m^2) was measured using the bioelectrical impedance analysis, categorising women in obese, overweight or normal weight BMI groups. Associations between body composition, nutrient intake, food choice and eating behaviours were investigated.

Results: From a nutrient perspective, all BMI groups had habitual intakes at the FR high in saturated fat, and low in dietary fibre and calcium. All BMI groups had significantly higher intakes at the BB compared with FR for energy, PUFA (g), carbohydrate (g), sugars, dietary fibre, riboflavin, vitamin B6 and calcium, and significantly lower intakes of cholesterol and protein (%). For food groups, servings of 'breads, cereals and grains', 'milk, dairy and alternatives', and 'discretionary foods' were all higher at the BB compared with the FR. Investigation into breakfast skipping found a significant difference in calcium intake between breakfast eating behaviour groups, with only breakfast eaters meeting breakfast recommendations (25% of NRV's).

Conclusion: The findings of this study provide valuable insight into Pacific women's breakfast eating habits. Nutrients and food choice differed significantly between BB and FR, which may indicate influential factors such as food availability and social influence. While the results did not suggest a significantly different intake of food groups or nutrients between BMI groups, this may provide future research opportunities to explore whether nutrients consumed and food choice at breakfast in Pacific women influence food intake later in the day, and whether there is an association with body composition. This study does highlight the role of public health intervention in emphasizing the importance of consuming breakfast high in whole

grains and dairy products to improve intakes of dietary fibre and calcium, and a lower saturated fat content of the meal for overall health benefits.

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Thank you to the Promise study team, in particular those who I had close involvement with; Niamh Brennan, Nikki Renall, Jo Slater and Elizabeth Cullen. It was great to work alongside such talented and motivated individuals.

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Abbreviation List

AMDR	Acceptable Macronutrient Distribution Range
ANOVA	Analysis of Variance
BB	Breakfast Buffet
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
cm	Centimetres
EAR	Estimated Energy Requirements
FFQ	Food Frequency Questionnaire
FR	Food record
g	Grams
kg	Kilograms
kJ	Kilojoules
m	Metres
µg	Micrograms
mg	Milligrams
MUFA	Mono-unsaturated fatty acids
Normal	Normal BMI group (BMI 18.5-24.9)
NNS	2008/09 New Zealand Adult National Nutrition Survey
NRVs	Nutrient Reference Values
Obese	Obese BMI group (BMI ≥30)
OECD	Organisation for Economic Cooperation and Development
Overweight	Overweight BMI group (BMI 25.0-29.9)
PROMISE study	Predictors linking Obesity and gut MIcrobiomE
PUFA	Poly-unsaturated fatty acids
RDI	Recommended Daily Intake
SD	Standard deviation
WHO	World Health Organisation
%E	Percentage energy intake

Chapter 1 Introduction

1.1 Background

Pacific people living in New Zealand have disproportionately high rates of obesity with 66% of Pacific adults obese (Ministry of Health, 2016), leading to adverse health outcomes. There is a tendency to skip breakfast in this group, which is a behaviour that has been linked to increased body weight in literature (Horikawa et al., 2011) amongst other dietary deficiencies.

There is growing scientific evidence to support that breakfast is an important meal. It is widely reported as the most important meal of the day due to it's role in meeting nutritional requirements (International Food Information Council, 2008) and achieving a healthy body weight (Cho, Dietrich, Brown, Clark, & Block, 2003). Breakfast has been defined in literature as the first meal of the day eaten within 2 hours of waking, typically no later than 10am, consisting of 20-35% of total daily energy needs" (Moshfegh, Goldman, & Cleveland, 2005). The Ministry of Health promotes having three healthy meals a day including breakfast (Ministry of Health, 2015a), due to the wide range of health benefits found in observational studies. A balanced breakfast meal including protein, fibre and calcium is recommended to provide energy throughout the morning and have positive effects on health, wellbeing and cognitive performance (Spence, 2017). Having a breakfast meal, compared to skipping breakfast, can have positive effects on signals controlling food intake regulation such as appetite, hormonal and neural signals (Leidy, Ortinau, Douglas, & Hoertel, 2013). A good quality breakfast, alongside overall diet quality, should be recommended due to the positive effects on body weight and health (Kant, Andon, Angelopoulos, & Rippe, 2008).

The literature shows Pacific people have a range of social, cultural and economic factors that result in different eating habits compared to New Zealand European women. Cultural factors and historical issues regarding food availability in the Pacific culture may contribute to a tendency of overconsumption of energy dense food, with a social emphasis on providing an abundance of food. This has resulted in an overall positive attitude towards a larger body size, particularly for women (Fitzgerald, 1980). Pacific people in New Zealand also have a larger burden of food insecurity than other cultures, due to lower income, education, and socioeconomic status on average (Rush & Rusk, 2009), all of which are associated with higher prevalence of obesity (Caprio et al., 2008). There are additional negative food-related trends

within this group: increased frequency of skipping breakfast; a significantly higher energy intake; lower intake of calcium; as well as being less likely to meet recommendations of fruit and more likely to choose white bread over wholegrain (Ministry of Health, 2012). There has been longstanding controversy in the relationship between breakfast consumption and body composition. A 2011 meta-analysis by Horikawa et al. found that a positive relationship exists between skipping breakfast and obesity in Pacific people.

Globally, there is an association between skipping breakfast and obesity (Deshmukh-Taskar et al., 2010; Horikawa et al., 2011; Leidy et al., 2013), however studies are primarily observational and cannot conclude a cause-and-effect relationship. On the contrary, some studies have found no associations between breakfast patterns and weight loss (Dhurandhar et al., 2014; Hermengildo et al., 2016; Wyatt et al., 2002), with some suggesting that the reduction in energy intake from skipping breakfast can lead to weight loss in some adults (Geliebter, Astbury, Aviram-Friedman, Yahav, & Hashim, 2014). Therefore it is important to explore this controversial topic in a range of settings to determine consistent guidelines around the consumption of this meal. While it appears that breakfast skipping itself is not the cause of increased body weight, literature frequently demonstrates a relationship between consuming breakfast and a reduced appetite later in the day, less overeating at later meals, less energy dense meals consumed, and an ability to be physically active later in the day (Sjöberg, Hallberg, Höglund, & Hulthén, 2003; Wyatt et al., 2002).

1.2 Purpose of the Study

The purpose of this sub-study was to analyse existing literature on breakfast habits and the relationship with body composition and food groups. This study then investigated nutrient intake, skipping breakfast, and food group choice at the breakfast meal in Pacific Island females, and associations with body composition. It is important to identify whether there may be factors that play a role in disproportionately higher numbers of obesity in the Pacific females in New Zealand, as this leads to increased adverse health outcomes.

This study provides significant insight into breakfast intake in Pacific Island women in New Zealand, which has not specifically been studied despite associations in literature between skipping breakfast and obesity. There is also an increased frequency of breakfast skipping in Pacific females, and disproportionately higher numbers of obesity. Research in this area may assist in improving the understanding of dietary trends of Pacific Island females at the

breakfast meal, and whether there are certain nutrients or food groups that do not meet recommendations, or tendencies that can be seen between different body composition groups.

This study is part of the wider cross-sectional PRedictors linking Obesity and gut MIcrobiomE (PROMISE) study at Massey University, Albany, Auckland. The dietary and anthropometric data components of the Promise study for Pacific women exclusively were investigated for this sub-study. This sub-study did not investigate any findings from New Zealand European woman.

1.2.1 Aim

The study then aimed to explore recorded and observed breakfast intake and practices in Pacific Island women aged 18-45 years of different body compositions in New Zealand. This included summarising existing literature on breakfast habits and the relationship with body composition and food groups.

1.2.2 Objectives

1. To assess and compare food and nutrient intakes from reported (5-day food record (FR)) and observed (videoed breakfast buffet (BB)) breakfast meals of Pacific Island women in different BMI groups.
2. To determine associations between skipping breakfast and dietary intake of different BMI groups at the recorded breakfast.
3. To explore and compare food groups chosen by Pacific Island women in different BMI groups at reported and observed breakfast occasions.

1.2.3 Hypothesis

We predict that the breakfast habits of Pacific women will show dietary trends low in fruit, whole grain and dairy products at this meal, resulting in not meeting a range of vitamin and mineral requirements and being linked to an increased body weight.

1.3 Thesis Structure

This thesis has been written in article format and separated into four chapters. Chapter one introduces the research topic and study, and outlines the importance of the study. Chapter two is a review of the literature on the importance of breakfast, Pacific dietary intake, food choice and eating behaviours at the breakfast meal. Chapter three consists of the research manuscript, presenting the findings including abstract, introduction, methods, results, discussion and conclusion. Chapter four gives an overview of conclusions and recommendations, incorporating strengths, limitations, and research impact.

1.4 Researcher's Contributions

Table 1 Researchers' Contributions to the Study

Researchers	Contributions to the study
Bronte Anscombe	Author of thesis Co-ordinated research assistants at videoed breakfast observation and data entry for videoed observation for the breakfast specific study. Data entry of 5-day food records, cross-checking data for videoed breakfast observation, used for wider Promise study. Statistical analysis of data and interpretation of results for this stub-study.
Dr. Marilize Richter	Main academic supervisor, advisor on the breakfast study, supervised the data entry and analysis, guidance on statistical analysis and interpretation of results. Thesis revision and approval.
A/Prof Rozanne Kruger	Academic co-supervisor. Concept and research design of the PROMISE study, ethical application. Designed and conceptualised the breakfast study, supervised the execution of the breakfast study, data entry and analysis, thesis revision.

Jo Slater, Nikki Renall	Coordination of participant recruitment, screening, testing. Analysis of 5-day food records
Elizabeth Cullen	Supervised participant testing, cross-checking of 5-day food records
Wider PROMISE study contributions *Not all data used in this thesis*	
Prof Bernhard Breier	Lead investigator, study concept and research design
Promise recruitment, screening: Niamh Brennan, Moana Manuki	Recruitment and screening throughout Auckland for NZ European and Pacific women
Promise testing: Niamh Brennan, Nikki Renall, Jo Slater, Sophie Kindleysides	Visit 1: anthropometric measurements (BIA, stadiometer and Lufkin tape), blood testing, demographic questionnaires, taste sensory testing Visit 2: anthropometric measurements (DEXA), dietary questionnaires
Ashleigh Jackson, Shivon Singh, Amelia Franklin, Alexandra Thomson, Anishka Ram, Sunna Jacoben, Beatrice Drury, Laura Mickleson	Data entry: food record, BIA, sleep, video observation, assistance with breakfast study implementation

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Horikawa, C., Kodama, S., Yachi, Y., Heianza, Y., Hirasawa, R., Ibe, Y., . . . Sone, H. (2011). Skipping breakfast and prevalence of overweight and obesity in Asian and Pacific regions: A meta-analysis. *Preventive medicine, 53*(4), 260-267.

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Chapter 2 Literature Review

This manuscript is formatted for submission to the Journal of the Academy of Nutrition and Dietetics (Author guidelines in **Appendix 1**). The referencing style for the research manuscript has been changed from the guidelines to be consistent between thesis chapters and to accommodate the ease of reading.

Breakfast intake and eating habits of Pacific Island women

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2.1 Abstract

Pacific people living in New Zealand have disproportionately high rates of obesity with 66% of Pacific adults obese (Ministry of Health, 2012), leading to increased adverse health outcomes. There is a tendency to skip breakfast in this group, which is a behaviour that has been linked to increased body weight in literature (Horikawa et al., 2011), amongst other dietary deficiencies. This narrative review explores breakfast trends both globally and locally, the relationship between breakfast intake and body composition, and nutrients and food groups chosen at breakfast in Pacific cultures.

Pacific people have a range of social, cultural and economic factors that result in different eating habits compared to New Zealand European women, such as an increased frequency of skipping breakfast, a significantly higher energy intake, and a lower intake of calcium (Ministry of Health, 2012). There has been longstanding controversy in the relationship between breakfast consumption and body composition. While it appears breakfast skipping itself is not the cause of increased body weight, literature frequently demonstrates a relationship between consuming breakfast and a reduced appetite later in the day, less overeating at later meals, less energy dense meals consumed, and an ability to be physically active later in the day (Sjöberg et al., 2003; Wyatt et al., 2002).

Research on breakfast intake in Pacific Island women has not specifically been studied, and may assist in improving the understanding of intakes and choices at this meal, or trends within different body composition groups, in an attempt to improve health outcomes for Pacific people.

2.2 Introduction

The Pacific population in New Zealand have disproportionately higher rates of obesity when compared to the general population (Chansavang et al., 2015), with 66% of Pacific adults obese in New Zealand (Ministry of Health, 2016).

Pacific people in New Zealand tend to have irregular eating habits such as skipping breakfast (Ministry of Health, 2003, Ministry of Health, 2012). Associations between skipping breakfast and obesity have been found in the literature (Timlin and Pereira, 2007, Cho et al., 2003), and this association has been confirmed in the Pacific culture in Asian and Pacific regions (Horikawa et al., 2011). Studies on this topic, however, are primarily observational and therefore do not conclude a cause-and-effect relationship. Breakfast consumption is often recommended due reported positive effects on body weight, meeting nutritional requirements and health (Ministry of Health, 2015a, Kant et al., 2008), however some studies found no associations between breakfast patterns and weight loss (Dhurandhar et al., 2014, Hermengildo et al., 2016, Wyatt et al., 2002). A study by Geliebter et al. (2014) even suggests that the reduction in energy intake from skipping breakfast can lead to weight loss in some adults. Therefore it is important to explore this controversial topic in a range of settings to determine consistent guidelines around the consumption of this meal.

Breakfast trends in Pacific females in New Zealand have not been explored, therefore could provide insight for further public health interventions to reduce obesity and negative health outcomes in Pacific adults.

2.2.1 Objectives

1 To summarise existing literature on breakfast intake and habits globally, in New Zealand, and specifically in Pacific cultures

2 To report what is known in the literature regarding the relationship between breakfast intake and body composition

3 To report what is known in the literature regarding nutrient intake and food groups chosen at breakfast in Pacific Island cultures

2.3 Methods

Where possible, the most recent literature was used in this narrative review (2008-2018), however research from 1980 onwards was included if findings were still relevant and undisputed. A range of study designs were incorporated, such as longitudinal population based studies, randomised crossover trials and randomised controlled trials, however the most common research study design for this topic was cross-sectional studies. Where available, New Zealand based studies were included in this narrative review, however due to limited research on this topic a wide range of international studies were also included.

The following key words were used in the search on Google Scholar: methods of dietary analysis (3,900,000 results) breakfast intake, breakfast and obesity, skipping breakfast (344,200 results), Pacific diet (1,450,000 results), obesity (2,470,000 results), calcium, fibre, protein, B-vitamins and breakfast (295,500 results), environmental effects on food choice (713,000). Of these results, the following studies met criteria and were included in this literature review: methods of dietary analysis (n= 4), breakfast intake (n= 14), Pacific diet (n= 10), skipping breakfast (n= 11), breakfast and obesity (n= 9), obesity (n= 16), calcium and breakfast (n= 26), fibre and breakfast (n= 8), protein and breakfast (n= 7), B-vitamins and breakfast (5), environmental effects on food choice (n= 11). These studies were included in the literature review as these topics met the criteria and were significant in relation to the study. References from large meta-analysis studies on the topic of breakfast were also used as a tool to identify key studies on the topic.

2.4 Methods of Dietary Analysis

There are a variety of ways to collect dietary intake data and these have different benefits depending on the setting in which they are used. Food frequency questionnaires (FFQ) are often used in large-scale epidemiological studies, as these are inexpensive to administer and give long-term insight into dietary intake (Yang et al., 2010), rather than intake from a number of days. However there are limitations, such as weak associations with certain dietary biomarkers and a lack of consistency (Kristal, Peters, & Potter, 2005). Food records are another common dietary analysis method used. Participants are required to record all food and beverages consumed over a certain period of time, usually between three and nine days. This

method is often used as a gold standard and as a reference standard for other dietary analysis methods, due to not having to rely on participant memory, having a higher validity and more significant associations with dietary biomarkers (Yang et al., 2010). However this method does require participants to be highly motivated in order to complete the food record correctly. In recent years, researchers have shown an increasing interest in the social-cultural context, using video recording as a method to analyse dietary intake (Dufon, 2002). This gives exact data on what is eaten and reduces participant error. The limitation of this method is theoretical and methodological issues relating to video recording, secondary data input and only observing an isolated situation.

2.5 Nutrients in breakfast

The nutrients most frequently consumed at breakfast have been widely studied, as well as the effect of skipping breakfast on the nutritional adequacy of the diet. Eating breakfast is associated with an increased likelihood of meeting daily nutrient recommendations, due to consuming more vitamins and minerals (International Food Information Council, 2008), therefore making it an important meal.

The 1995 National Nutrition Survey in Australia showed a typical breakfast was high in carbohydrates, low in fat, and a good source of B vitamins and calcium (Williams, 2007). Breakfast consumption has to a higher intake of these nutrients, in particular carbohydrates, fibre, micronutrients and calcium (Kerver et al., 2006; Reeves, Halsey, McMeel, & Huber, 2013; Ruxton & Kirk, 1997), and is suggested to assist in achieving a healthy body weight (Cho et al., 2003). Dietary inadequacies can occur in breakfast skippers as nutrients are not always replaced later in the day (Nicklas, O'neil, & Myers, 2004), with female breakfast skippers found to have lower intakes of calcium, iron and vitamin D, and higher serum cholesterol compared to those who eat breakfast (Croezen et al., 2009).

2.5.1 Macronutrients

Macronutrients, such as carbohydrates, protein and fat, provide energy and allow for functions within the body such as growth, muscular activity, metabolic processes and physiological functions (Ministry of Health, 2012). The National Health Medical Research Council (2005) outlines the Nutrient Reference Values (NRVs) for Australia and New Zealand, and recommends acceptable macronutrient distribution ranges (ADMR) to reduce the risk of chronic disease. The ranges are: 45-65% total energy from carbohydrates; 20-35% total energy

from fat; <10% total energy from saturated fat; and 15-25% total energy from protein. The estimated average requirements (EAR), recommended daily intake (RDI), adequate intake (AI) and upper limit (UL) are guidelines to meet nutritional needs and prevent deficiencies (National Health Medical Research Council, 2005).

2.5.1.1 Fat

Fats can be categorised into saturated, monounsaturated and polyunsaturated fatty acids as the three main types of fats, equally 90% of total fat intake (Ministry of Health, 2015a). It is recommended to consume the majority of the ADMR (20-35%) from poly-unsaturated and mono-unsaturated sources for optimal health benefits, and <10% of total daily energy intake from saturated fats, which are found in foods such as animal and coconut products (Ministry of Health, 2015a). High intakes of saturated and trans fats have been linked to increased total and low-density lipoprotein (LDL) cholesterol (Mann J. & Truswell A., 2007). For New Zealand females, the median intake of total fat from the NNS (Ministry of Health, 2011) was 67g and 33.8%E, and saturated fat intakes of 25.8g and 13.1%E. These saturated fat intakes were slightly higher for Pacific females (13.5%). Research has found that total fat intake increases with body fat (W. Miller, Lindeman, Wallace, & Niederpruem, 1990), and that the environment also play a role on intake. This includes multiple studies showing fat intake increasing in social environments compared with eating alone (Hermstad, Swan, Kegler, Barnette, & Glanz, 2010; Patel & Schlundt, 2001; Story et al., 2002; Viskaal-van Dongen, de Graaf, Siebelink, & Kok, 2009). This may relate to the physiological components of fats, as mouth feel and taste can lead to passive overconsumption, due to a lack of sensory signals in accordance with the nutrient density (Blundell, 1996; Viskaal-van Dongen et al., 2009). Specific to breakfast, a recent randomised controlled trial by McFarlin et al. (2017) analysed the effect of a high-fat breakfast meal on cardiovascular biomarkers in 8 women. Their study speculated that cardiovascular disease risk might increase from cumulative effects of eating a high-fat diet on a regular basis.

2.5.1.2 Protein

Protein is a macronutrient with many beneficial properties such increasing thermogenesis and satiety (Journel et al., 2012). The mechanisms of protein-induced satiety are based on hormonal responses, such as high GLP-1 and PYY release (Smeets, Soenen, Luscombe-Marsh, Ueland, & Westerterp-Plantenga, 2008), with these functions suggesting protein may play an important role in weight loss. The recommended daily intake of protein for women aged 19-70

is 46g/day or 15-25% of total energy (Ministry of Health, 2015a). Pacific females in New Zealand consume an average of 16.9% of energy from protein (Ministry of Health, 2012), therefore at the lower end of recommendations. There is strong evidence to suggest that a breakfast rich in protein may be useful in increasing satiety and improving the overall diet quality (Leidy et al., 2013). Research has shown a higher protein breakfast meal reduces subsequent energy intake later in the day (Blom et al., 2006). A variety of small controlled trials (n=13-20) have compared isocaloric breakfast meals, either high-carbohydrate or high-protein, and the effect these meals have on hunger, appetite, food preferences and hormones (Blom et al., 2006; Burley, Leeds, & Blundell, 1987; Hill & Blundell, 1986; Hoertel, Will, & Leidy, 2014; Holt et al., 1999; Leidy et al., 2013). Findings included high protein breakfast eaters having stronger feelings of fullness and lower desire to eat (Hill & Blundell, 1986), decreased post-prandial ghrelin secretion and increased glucagon, CCK and gastric emptying rate (Blom et al., 2006), reduced evening snacking of high fat foods (Leidy et al., 2013), and reduced food cravings (Hoertel et al., 2014). These outcomes are important factors in maintaining a healthy body weight, and could reduce risk of obesity.

2.5.1.3 Carbohydrates

Carbohydrates are a diverse macronutrient group, made up of starches, sugars and fibre. Metabolism of carbohydrates provide the most efficient source of energy for the cells, with glucose being the primary source of fuel for the body, particularly the muscles and brain (Mann J. & Truswell A., 2007). The ADMR for carbohydrates is 45-65% of total energy (Ministry of Health, 2015a), with the NNS finding females in New Zealand to have a mean contribution of 47.1%. Pacific females were found to have similar intakes, with 48.1% of energy from carbohydrates (Ministry of Health, 2012). The foods that contribute most to carbohydrate intake in New Zealand is bread (17%), followed by grains and pasta, fruit and non-alcoholic beverages (all 9%) (Ministry of Health, 2011). Literature has shown benefits to consuming a breakfast rich in carbohydrates, such as wholegrain bread and cereals, with Holt et al. (1999) finding a high carbohydrate breakfast results in lower total energy intake throughout the day compared to a high fat breakfast.

2.5.1.4 Dietary fibre

Dietary fibre is supplied by plant foods, with a high fibre diet often associated with lower risk of obesity, coronary heart disease and high blood pressure, and assisting with weight loss (Birketvedt, Shimshi, Thom, & Florholmen, 2005; Keenan, Pins, Frazel, Moran, & Turnquist,

2002; Lairon et al., 2005; Liu et al., 1999). The adequate intake of fibre is 25g for women aged 19-50 years (Ministry of Health, 2015a). The median intake of fibre for Pacific females in New Zealand is below recommendations (17.5g), however this does not significantly differ for non-Pacific females (Ministry of Health, 2012). Low fibre intake in women is seen worldwide, with females having intakes below recommendations in the UK and USA (Bingham, Cummings, & McNeil, 1979; Howarth, Saltzman, & Roberts, 2001; Slavin & Green, 2007). Research has found that a high fibre breakfast results in lower hunger and food intake throughout the morning (Delargy, O'sullivan, Fletcher, & Blundell, 1997; Holt et al., 1999), as well as lower intakes of total fat and cholesterol (Stanton Jr. & Keast, 1989). Breakfast cereals are a strong contributor to daily fibre intake, and are unlikely to be consumed outside of the breakfast meal, therefore skipping breakfast can reduce overall fibre intake (Deshmukh-Taskar et al., 2010).

2.5.2 Micronutrients

2.5.2.1 Calcium

Calcium plays an important role in regulating energy metabolism and bone health, and therefore has been widely researched. Calcium insufficiency is more prevalent in certain populations, specifically older adults, women of childbearing age and people living in low socio-economic areas, and this can increase risk of chronic disease. In New Zealand, the NNS (Ministry of Health, 2011) found most females in New Zealand did not meet calcium recommendations of 1000mg, with a median intake of 745mg. Calcium deficiencies are more prevalent in the Pacific group, with an estimated 92.3% of Pacific females having an inadequate intake of calcium, and a mean daily intake of 604mg (Ministry of Health, 2012). An FFQ of 5523 New Zealand workers in 1988-1990 found Pacific Island women consume less calcium than European women (Metcalf, Scragg, Tukuitonga, & Dryson, 1998). There has been a wide range of literature investigating the relationship between calcium and dairy products and body weight, outlined in **Table 4**.

Table 2 Summary of studies investigating associations between calcium and/or dairy products and weight

First author (year)	Country and study design	Population sample	Aspect of diet examined	Diet measure	Dietary components	Key findings
Azadbakht (2005)	Iran, population-based cross-sectional	357 men, 470 women, 18-74 years	Relation between dairy consumption and metabolic syndrome	FFQ	Dairy	Dairy consumption inversely associated with risk of metabolic syndrome. Subjects in highest quartile of dairy consumption had lower odds of having enlarged waist circumference, hypertension and metabolic syndrome
Barba (2005)	Cross-sectional	1087 children	Association between dietary calcium from dairy sources and body weight in children	Questionnaire	Milk	Milk was inversely and significantly associated with BMI
Bowen (2005)	Australia, randomised-paralleled study	50 overweight adults	Compare effects of 2 high-protein diets that differ in dietary calcium and protein source on weight loss, body composition	1) High calcium (2400mg) 2) Moderate calcium (500mg)	Calcium, protein	Increased dietary calcium/dairy foods in an energy-restricted, high-protein diet does not affect weight loss or body composition.
Drapeau (2004)	Canada, cohort	248	Verify whether changes in dietary patterns over a 6-year follow up would be associated with weight changes	FFQ, 3-day food record	Food groups	Increases in consumption of skimmed milk and partly skimmed milk were negatively correlated with changes of each body-weight indicator
Gunther (2005)	USA, experiment	155 normal weight women, 18-30 years	Determine whether long-term increases in consumption of dairy calcium alter body weight and fat mass in young, healthy women	1) Control 2) Medium (1000-1100mg/d) 3) High 1300-1400mg/d	Dairy calcium	Increased intake of dairy products does not alter body weight or fat mass in young, healthy women over 1 year
Harvey-Berino (2005)	USA, experiment	54 overweight/ obese adults, 18-60 years	Compare weight and body fat loss on a calorie-restricted, low-dairy vs. high-dairy diet	1) 3-4 servings dairy, 1200-1400mg calcium 2) 1 serving dairy, 400-500mg calcium	Dairy products, calcium	High-dairy calcium diet does not substantially improve weight loss beyond what can be achieved in a behavioural intention

Jacqmain (2003)	Canada, cross-sectional	235 men, 235 women, 20-65 years	Association between daily calcium intake, body composition and plasma lipoprotein-lipid concentrations	1) <600mg calcium 2) 600-1000mg calcium 3) >1000mg calcium	Calcium	Low daily calcium intake associated with greater adiposity, particularly in women. In both sexes high calcium intake associated with a plasma-lipoprotein lipid profile predictive of lower risk of coronary heart disease risk compared with a low calcium intake
Liu (2005)	USA, cross-sectional	10,066 women, >45 years	Whether and to what extent intakes of calcium and vitamin D are related to metabolic syndrome in middle-aged or older women	FFQ	Calcium, vitamin D	In age and calorie adjusted analysis, higher intakes of total, dietary and supplemental calcium were significantly and inversely associated with prevalence of metabolic syndrome
Loos (2004)	USA, cross-sectional	362 men, 462 women, 17-65 years	Association between calcium intake abdominal obesity	FFQ	Calcium	Black men in high calcium intake group were leaner than those in the low calcium intake group. For white women, there were significant inverse associations between calcium intake and BMI
Marques-Vidal (2006)	Portugal, cross-sectional	17,771 men, 19,742 women, >18 years	Assess relationship between milk intake and BMI	Questionnaire	Milk	Increased calcium intake is slightly but significantly negatively related to BMI in men and pre-menopausal women
Ortega (1998)	Spain, cross-sectional	200 children, 9-13 years	Breakfast intake of calcium and milk products to determine whether these correlate with total intake of calcium and milk products	7-day food record	Calcium, milk products	Intake of milk and calcium at breakfast correlates with consumption of these foods in the whole diet. Subjects with the greatest intake at breakfast also showed greater intakes over the rest of the day
O'Sullivan (2015)	Australia, cross-sectional	1613 adolescents, 14 years	Associations between dairy intake, energy density and nutrient density, and relationships with obesity in adolescents	FFQ	Dairy intake	Higher dairy intakes associated with higher nutrient density, but not with obesity

O'Sullivan, 2016	Australia, cross-sectional	860 adolescents, 14-17 years	Associations between regular vs. reduced fat dairy products and cardiometabolic risk factors in adolescents	FFQ	Regular fat and reduced fat dairy	Regular fat dairy associated with slightly better cholesterol profile in boys Intake of regular fat and reduced fat dairy associated with similar cardiometabolic profiles in adolescents
Pereira (2002)	USA, cohort	3157 adults, 18-30 years	Associations between dairy intake and incidence of insulin resistance	CARDIA diet history – usual dietary practices and food frequency over past 28 days	Dairy products	Increased dairy consumption has a strong inverse association with insulin resistance among overweight adults, and may reduce risk of type 2 diabetes and CVD
Thompson (2005)	USA, experiment	72 obese subjects, 25-70 years	Effect of a high-dairy diet vs. high dairy, fibre and low GI diet on weight loss and body fat	1) 2 servings dairy 2) 4 servings dairy, 2 being milk 3) Same as #2 but increased fibre and reduced GI	Dairy, fibre, GI	No evidence that diets higher than 800mg calcium or higher in fibre and lower in GI enhance weight reduction beyond what is seen in calorie restriction alone
Zemel (2004)	USA, randomised trial	32 obese adults	Effect of increasing dietary calcium in the face of caloric restriction	1) Standard (400-500mg) 2) High calcium (800mg supplement) 3) High dairy (1200-1300mg)	Calcium, dairy	Increasing dietary calcium significantly augmented weight and fat loss secondary to caloric restriction and increased the percentage of fat lost from the trunk region, whereas dairy products exerted a substantially greater effort
Zemel (2005)	USA, randomised trial	34 obese African Americans, 29 healthy African Americans, 26-55 years	Effect of dairy consumption on adiposity and body composition in obese African Americans	<u>Phase 1:</u> 1) Control (low dairy) 2) High dairy – 3 servings per day including one of fluid milk <u>Phase 2:</u> 1) 500kcal deficit, 0-1 servings dairy	Low fat dairy products	Substitution of calcium-rich foods in isocaloric diets reduced adiposity and improved metabolic profiles in obese African Americans without energy restriction or weight loss and augmented weight and fat loss secondary to energy restriction

				2) 500kcal deficit, 3 servings dairy		

A cross-sectional study by Jacqmain, Doucet, Després, Bouchard, and Tremblay (2003) found high calcium intake was associated with a plasma lipoprotein-lipid profile predictive of lower coronary heart disease, compared to those with a low calcium intake. Zemel et al. (2004) have extensively studied the relationship between dietary calcium and obesity. Their research has found that a diet high in calcium-rich foods enhances weight loss in situations of calorie restriction due to increased lipolysis and maintained thermogenesis. Specifically, a randomised placebo-controlled trial by Zemel et al. (2004) in 32 obese adults found a standard 500kcal deficit diet lost 6.4 ± 2.5% body weight, which increased by 26% for 'high calcium' (500kcal deficit diet combined with an 800mg calcium supplement), and by 70% for 'high dairy' (500kcal deficit diet combined with 1200-1300 calcium from dietary sources). The 'high calcium' diet in this study also showed a reduced adipocyte accumulation and weight gain even in energy overconsumption (Zemel, 2003), and similarly Jacqmain et al. (2003) found low calcium was associated with greater adiposity.

Calcium is of interest at breakfast due to the contribution this meal has on overall calcium intake, and the effect that this nutrient has on weight management. Milk and milk products are commonly consumed at breakfast and contribute significantly to the daily intake of calcium in many individuals (International Food Information Council, 2008; Ortega et al., 1998), whereas skipping breakfast is likely to decrease the overall intake of calcium throughout the day (Croezen et al., 2009). Dairy sources of calcium have the greatest effect on preventing obesity out of all calcium foods, possibly due to bioactive compounds such as angiotensin-converting inhibitors and branched chain amino acids (Zemel, 2003).

2.5.2.2 B Vitamins

The B vitamin group is made up of nine vitamins, with cofactors folate, vitamin B6 and B12 involved in the metabolism of homocysteine, all of which have positive associations with cognition (Riggs, Spiro, Tucker, & Rush, 1996). Homocysteine is an amino acid that has been associated with cognitive defects and dementia, with the assumption that higher plasma levels of homocysteine are neurotoxic (Budge, De Jager, Hogervorst, & Smith, 2002; J. W. Miller et al., 2003; Schafer et al., 2005). Adequate consumption of B vitamins are therefore very important, with sufficient vitamin B6 required for folate metabolism and homocysteine concentrations (Tucker et al., 2004). The role of folate in cell growth and development makes it a particular nutrient of importance for pre-menopausal women, due to the relationship between folate deficiency in pregnancy and neural tubal defects (Mann J. & Truswell A., 2007).

Large population based studies found breakfast eaters were more likely to meet the recommended daily intake (RDI) of B vitamins (Nicklas, Bao, Webber, & Berenson, 1993), with other studies finding one cup of fortified cereal daily was effective in increasing B vitamins and decreasing homocysteine concentrations (Tucker et al., 2004). Mandatory fortification of B vitamins, particularly folate, into the food supply has been introduced in certain countries worldwide to improve health outcomes. In Canada, mandatory folate fortification has been successful in decreasing rates of neural tube defects by 46% (De Wals et al., 2007). Since 1996 in New Zealand there has been voluntary folic acid fortification of foods such as breakfast cereals, flour and bread. A standard for the mandatory fortification of bread was to be introduced in 2009 however was deferred, therefore fortification with folic acid in bread remains on a voluntary basis (Ministry of Health, 2011).

2.6 Breakfast and Health

The most common definition for breakfast used in literature is "the first meal of the day eaten within 2 hours of waking, typically no later than 10am, consisting of 20-35% of total daily energy needs" (Moshfegh, Goldman, & Cleveland, 2005). There is a wide variety in the food consumed at breakfast, therefore if this meal is missed certain nutrients may lack from overall daily intake. In dietary pattern research it has become increasingly difficult to distinguish between set meals of breakfast, lunch and dinner, as skipping meals, snacking and shift work is becoming more common. Research has indicated that consuming breakfast leads to metabolic alterations that control appetite and food intake regulation, which may assist in weight management (Leidy et al., 2013). While breakfast consumption has been linked to a lower body weight, other weight-related factors also contribute to this relationship, such as smoking, sugar intake and physical activity levels (Wyatt et al., 2002, Moy et al., 2009, Benton et al., 2001, Sjöberg et al., 2003). The following table (**Table 2**) outlines the literature on the contribution of the breakfast meal to nutrient intake and/or body composition. There is a variety in the definition of breakfast used within literature, as outlined in **Table 2.** This is a limitation when investigating the topic of breakfast intake, and subsequent relationships with nutrient intakes and weight, as literature cannot be directly compared due to inconsistent definitions.

Table 3 Summary of studies that have investigated the contribution of the breakfast meal to nutrient intakes and/or weight

First author (year)	Country and study design	Population sample	Aspect of breakfast examined	Diet measure	Breakfast definition	Dietary components	Key findings
Affenito (2005)	USA, longitudinal (9 years)	1,166 white girls, 1,213 African American girls 9-10 years at baseline	Frequency of breakfast consumption	3 day food records	0500-1000 weekdays, 0500-1100 weekends	Calcium, fibre	Frequency of breakfast consumption declined with increasing age; White girls had greater frequency of breakfast consumption than African American girls; More days eating breakfast was associated with higher calcium and fibre intake, and lower BMI
Cho (2003)	USA, population based study	16,452 adults >18 years	Food groups consumed at breakfast and breakfast categories	24-hour dietary recall	Self-reported Subjects that had no food or beverage, excluding water, were named as breakfast skippers	Food categories – e.g. “skippers”, “dairy”, “meat and eggs”, “ready-to-eat cereals”	Eating cereal (ready-to-eat or cooked) for breakfast was associated with a significantly lower BMI compared to skipping breakfast or eating meat/eggs
Farschi (2005)	UK, randomised crossover trial	10 women, 19-38 years	Effect of eating or omitting breakfast on energy intake, energy expenditure, circulating insulin, glucose and lipids	Two 14-day interventions with 2 week crossover in between	Milk before 0800, cookie between 1030-1100	Skipping breakfast	Omitting breakfast impairs fasting lipids and post-prandial insulin sensitivity and could lead to weight gain if the observed higher energy intake was sustained
Hoertel (2014)	USA, randomised crossover pilot study	16 women, 13-20 years, overweight/obese and “breakfast skippers”	Whether normal or high protein breakfast alters food cravings and homovanillic acid	3 breakfast patterns – normal & high protein, breakfast skipping	0700-0930	Protein	Breakfast reduces post-meal food cravings and increase homovanillic acid concentrations, wither higher protein versions eliciting greater responses
Kerver (2006)	USA, cross-sectional study	15,978 adults >20 years	Effect of specific meal patterns (breakfast) and nutrient intakes	24-hour dietary recall	Self-reported	Macronutrient distribution, cholesterol, vitamin B6, folic acid, vitamin C, calcium,	Breakfast skippers had the lowest intakes of micronutrients examined except sodium

						magnesium, iron, sodium, potassium, fibre	
McFarlin (2015)	USA, randomised controlled trial	8 women 18-30 years	Effect of high-fat, high-calorie diet on consecutive days on CVD biomarkers	2 consecutive days of high fat breakfast	High fat breakfast meal (70% daily calories, 100% daily fat)	Fat	Chronic CVD risk may result from the cumulative effect associated with eating high-fat foods on a habitual basis
Nicklas (2004)	USA, cross-sectional study	504 adults, 19-28 years	Impact of breakfast consumption on nutritional wellbeing	24-hour dietary recall	Self-reported	Macronutrients, micronutrients	Omission of breakfast contributes to dietary inadequacies, and 2/3 do not meet RDA for numerous vitamins and minerals Children's breakfast consumption relates inversely to CVD risk factors (serum cholesterol, obesity) which persist into adulthood
Ortega (1998)	Spain, cross-sectional study	200 children, 9-13 years	Evaluate breakfast intake of calcium and milk products and determine whether this correlates with total intake of calcium and milk products	7-day food record	Intake before school	Calcium	Intake of milk products and calcium at breakfast correlates with consumption of these foods in the whole diet Subjects with the greatest intake at breakfast also had greater intakes throughout the day
Pereira (2011)	USA, pilot experimental study	Study 1: 9 adults, 20-40 years, overweight Study 2: 28 children, 14 boys, 14 girls 9-13 years	Effect of breakfast skipping and composition on blood glucose and appetite	Study 1: 1 of 5 breakfast categories Study 2: 2 weeks of each breakfast category with 1 day washout	Study 1: High CHO, high GI; High CHO, low GI; Low CHO, high GI; Low CHO, low GI; Water only Study 2: Balanced – wholegrain, milk, fruit; Refined CHO; Water	Fibre, glycemic index, macronutrients	Breakfast frequency and quality may be related in causal ways to appetite controls and blood sugar control; Supports hypothesis breakfast meal and quality may have important causal implications for the risk of obesity and type 2 diabetes
Sjoberg (2003)	Sweden, cross-sectional study	611 boys, 634 girls 15-16 years	Relate meal patterns to food choice, nutrient intake and other lifestyle factors	Diet history questionnaire	Intake before school	Macronutrients, micronutrients	Meal pattern with omission of breakfast related to a clustering of less healthy lifestyle factors and food choice leading to a poorer nutrient intake

Smith (2010)	Australia, longitudinal	2184 participants 26-36 years	Examine longitudinal associations of breakfast skipping in childhood and adulthood with cardiometabolic risk factors	Meal patterns chart, FFQ, food-habits questionnaire	0600-0900	Food groups – breads and cereals, fruit, dairy, lean meat and alternatives, takeout foods	Skipping breakfast over a long period may have detrimental effects on cardiometabolic health Participants who skipped breakfast in childhood and adulthood had larger waist circumference, higher fasting insulin, total cholesterol and LDL cholesterol than those who ate breakfast
Song (2005)	USA, cross-sectional	4,218 adults, >19 years	Test hypothesis that breakfast consumption was associated with weight status	Dietary recall	Self-reported	Energy, fibre, fat, CHO, protein	Breakfast consumers more likely to be older, female white, non-smokers, regular exercisers, and trying to control their weight For women, daily energy intake was higher among breakfast consumers Energy intake from fat was lower in RTEC breakfast consumers and energy intake from CHO was higher BMI lower for breakfast consumers and RTEC consumers
Wyatt (2002)	USA, cross-sectional	2959 subjects, 2350 women, 607 men, in National Weight Control Registry, >18 years	Examine breakfast consumption in subjects maintaining weight loss	FFQ, questionnaire for frequency of breakfast consumption	Self-reported breakfast consumption	Breakfast consumption, frequency of hot or cold breakfast cereal, frequency of fruit	Eating breakfast is a characteristic common to successful weight loss maintainers and may be a factor in their success

2.6.1 Eating behaviours and breakfast consumption

Eating behaviour is described as a function resulting from both internal and external influences. These influences on eating behaviour can be split into four key categories: individual (e.g. biological); social (e.g. family and friends); physical (e.g. school); and societal (e.g. marketing and social norms) (Story, Neumark-Sztainer, & French, 2002). Skipping breakfast is an eating behaviour that has increased in the past 40 years (Kant & Graubard, 2015). In New Zealand, the 2008/09 Adult Nutrition Survey found that 66.9% of the population over 15 years ate breakfast daily, a further 18.8% ate breakfast between three and six times a week, and 6.0% did not consume breakfast (Health Promotion Agency Research and Evaluation Unit, 2014; Ministry of Health, 2011). The Adult Nutrition Survey found that factors such as age, socioeconomic status and gender are linked to breakfast consumption in New Zealand. Less than half of Pacific females (48.1%) eat breakfast daily, with 18.8% eating breakfast zero to two times a week (Ministry of Health, 2012), and eating breakfast daily was found to be significantly lower compared to non-Pacific females.

2.6.2 Benefits of breakfast

Literature has often emphasised the importance of eating breakfast to meet daily nutrient intake, particularly for dietary fibre and calcium, with requirements being less likely to be met if not consumed at this meal (Affenito et al., 2005; Croezen, Visscher, Ter Bogt, Veling, & Haveman-Nies, 2009; Kerver, Yang, Obayashi, Bianchi, & Song, 2006). The Ministry of promotes eating three healthy meals a day including breakfast (Ministry of Health, 2015a), with the nutritional composition of breakfast influencing the energy density of foods consumed later in the day (Holt, Delargy, Lawton, & Blundell, 1999; Levitsky & Pacanowski, 2013).

In multiple studies, breakfast consumption has been found in to be associated with a lower body weight (Deshmukh-Taskar et al., 2010; Huang, Hu, Fan, Liao, & Tsai, 2010; Niemeier, Raynor, Lloyd-Richardson, Rogers, & Wing, 2006; Ruxton & Kirk, 1997), with research finding that breakfast eaters are less likely to be obese, have metabolic syndrome, high blood pressure or type 2 diabetes (Pereira et al., 2005). A balanced breakfast meal can also have positive health effects on wellbeing, cognitive performance, food intake regulation, appetite, and hormonal and neural signals (Leidy et al., 2013), however this crossover study was

specifically focused on overweight adolescent girls, so results cannot necessarily be extrapolated to the wider population. The timing of this meal is also important, as according to Gardner, Wansink, Kim, and Park (2014) healthier food choices are made when people are in a more positive mood, which rises in the early morning. Breakfast consumption has also been found to reduce appetite later in the day, less overeating at later meals, less energy dense meals consumed, and an ability to be physically active later in the day (Wyatt et al., 2002).

2.6.3 Health consequences of poor breakfast

Literature has indicated that skipping breakfast may be the most important risk factor for being overweight and obese (Croezen et al., 2009), and this behaviour of skipping breakfast was seen to increase in all age groups in the last 25 years in a cross-sectional study (Nicklas et al., 2004). It must be noted that the dietary measurement methods in this study were self-reported. Multiple studies have found breakfast skipping to be associated with a larger waist circumference, higher fasting insulin, higher total cholesterol, and higher LDL-cholesterol, therefore having negative effects on cardiovascular health (Smith et al., 2010, Farshchi et al., 2005, Pereira et al., 2011). Breakfast skippers have been found to have the lowest intakes of all micronutrients except sodium (Kerver et al., 2006). Both breakfast frequency and breakfast quality can affect appetite control and blood sugars, which can increase type 2 diabetes risk (Pereira et al., 2011). A crossover study by Farshchi, Taylor, and Macdonald (2005) found that when participants omitted breakfast, the period of time the meal would normally be consumed showed a lower peak postprandial insulin response and higher circulating levels of insulin caused by being in a fasted state. This was thought to affect increasing fat storage and subsequent weight gain, indicating the possibility that skipping breakfast affects energy metabolism.

The trend of declining breakfast consumption in adults has correlated with increasing obesity prevalence. Observational studies support that children and adolescent breakfast skippers have higher BMIs (Deshmukh-Taskar et al., 2010), with other studies finding skipping breakfast is not an effective strategy for weight loss (Cho et al., 2003; St-Onge et al., 2017) and that eating breakfast may be important for a healthy body weight and maintaining weight loss. Very few successful weight loss maintainers (<5%) report never eating breakfast (Wyatt et al., 2002).

Skipping breakfast appears to alter subsequent eating behaviour in the day, due to feelings of hunger and a lack of satiety (Benton, Slater, & Donohoe, 2001), often leading to an increased total energy intake (Sjöberg et al., 2003, Williams, 2007). Furthermore, behaviours associated with skipping breakfast, such as an increased prevalence of smoking, consuming more alcohol, and exercising less (Keski-Rahkonen, Kaprio, Rissanen, Virkkunen, & Rose, 2003; Li et al., 2011; Mekary et al., 2013; Moy et al., 2009) all contribute to the development of obesity. One specific study of over 1200 Swedish adolescents (Sjöberg et al., 2003) showed skipping breakfast was associated with negative health factors such as smoking and irregular meal patterns throughout the day, with a higher percentage of energy from snack foods and higher intakes of sucrose and alcohol compared to regular breakfast consumers. It may not be the act of skipping breakfast as such that is linked to body weight, rather the associated behaviours that predispose breakfast skippers to a higher body weight.

2.7 Obesity

2.7.1 Definition & measure of obesity

Obesity is defined by the World Health Organization (2000) as “abnormal or excessive fat that results in a risk to health”. While many factors contribute to the development of obesity, diet always plays a crucial role. One of the many areas researched in relation to obesity are meal patterns, including the relationship between the breakfast meal and obesity risk factors. Obesity and poor nutrition are strong risk factors for chronic diseases, such as type 2 diabetes, ischemic heart disease, ischemic stroke and some cancers (Chansavang et al., 2015), resulting in a reduced life expectancy of 8-10 years for the extremely obese (Ministry of Health, 2015b).

2.7.2 Obesity worldwide & NZ

According to the latest statistics from World Health Organization (2016), in 2014 1.9 billion adults worldwide were overweight and 600 million obese. Obesity prevalence has doubled in over 70 countries since 1980 (The GBD 2015 Obesity Collaborators, 2017). Four million deaths worldwide are attributed to a high BMI, with 70% of these deaths occurring due to cardiovascular disease (The GBD 2015 Obesity Collaborators, 2017). New Zealand has the third highest adult obesity rate out of fifteen countries in the Organisation for Economic Co-operation and Development (OECD) (Ministry of Health, 2016), and this is the leading modifiable risk factor for health loss in the country. Almost one in three adults are obese (32%), with an additional 35% of adults overweight but not obese (Ministry of Health, 2016).

Despite ongoing public healthcare campaigns aimed at combating obesity through reducing dietary fat intake and increasing physical activity, the rates of obesity are still increasing (Swinburn et al., 1997). There are significant ethnic disparities with regards to BMI-related diseases in New Zealand, as there are disproportionately higher numbers of obesity in Pacific Island adults when compared to the general population (Chansavang et al., 2015) with 66% of Pacific adults obese (Ministry of Health, 2016). This higher prevalence of obesity increases risk factors for chronic disease, and leads to significantly poor outcomes in Pacific adults (Chansavang et al., 2015). This include a higher risk of developing obesity related illnesses such as coronary heart disease, hypertension and diabetes, compared to New Zealand European adults (Scragg, Baker, Metcalf, & Dryson, 1991, 1993; Tukuitonga, Stewart, & Beaglehole, 1990).

As well as obesity resulting in comorbidities and an increased risk for adverse health outcomes, it is also a large cost to the economy. This is due to direct healthcare costs of associated diseases, such as cardiovascular disease (CVD) and diabetes, combined with indirect costs from reduced productivity, absentees, recruitment of staff and premature death (Swinburn et al., 1997). Specifically in New Zealand, it has been estimated that overweight and obesity costs the country between $722 million and $849 million per year (Lal, Moodie, Ashton, Siahpush, & Swinburn, 2012). This cost has increased significantly since the previously estimated cost of $135 million in 1991, as obesity has increased more than 10% since this stage (Lal et al., 2012). These estimated costs do not include other expenses of obesity, such as the effect of foregone taxes, disability, and reduced quality of life.

2.7.3 Obesity in women

Worldwide, a higher percentage of women are obese (15%) compared to men (11%) (World Health Organization, 2016), and women are also more likely to experience obesity-related complications (Chan & Woo, 2010). Increased prevalence can be partially attributed to differences in fat free mass, with women having an approximately 20% lower metabolic rate than men (Arciero, Goran, & Poehlman, 1993). Obesity in women has also been found to be associated with socioeconomic status, such as food-related values of health consciousness, perceived high cost of eating, and lack of time due to work commitments (Inglis, Ball, & Crawford, 2005). Gender differences of food choice and eating behaviour have been widely researched, with women more likely to avoid high-fat foods, eat fruit and fibre and limit salt

than men (Wardle et al., 2004), however women are more influenced by social pressures to eat perceived unhealthy foods.

Obesity can lead to adverse health outcomes in any person. Women in particular experience adverse health outcomes from obesity at all life stages, from psychosocial health at a young age to reproductive health, with effects such as infertility, polycystic ovary syndrome (PCOS) and menstrual irregularity (Rich-Edwards et al., 1994; Wang, Davies, & Norman, 2000). A focus on obesity in women of a reproductive age is important due to the effect of a mother's metabolic status during pregnancy (Wang et al., 2000). Not only do obese women have lower fertility, but this group also has an increased risk of serious pregnancy complications such as congenital defects and miscarriages (Roman et al., 2011). This is a considerable concern due to pre-pregnancy obesity for women of a reproductive age increasing worldwide.

2.7.4 Causes of obesity

The global increase in obesity has occurred alongside changes in the food environment. The major shift is towards an 'obesogenic environment', characterised by dietary patterns of overconsumption of energy dense foods and a reduction in physical activity. This has resulted in an increase in obesity, from factors such as increased accessibility, affordability and availability of unhealthy food choices, as well as an environment that discourages physical activity.

Sociocultural factors also contribute to energy intake and obesity, such as nutrition knowledge, culture, traditions, income, education, food availability and the food environment. Living in a lower-socioeconomic area, even after controlling for education, occupation and income, is associated with a higher prevalence of obesity (Krieger, Chen, Waterman, Rehkopf, & Subramanian, 2003), with availability of low-cost energy dense foods with limited nutritional value, such as fast foods and soft drinks, that further promote weight gain (Andrieu, Darmon, & Drewnowski, 2006). Time poverty is another factor associated with increased risk of obesity, particularly when both parents are working or shift work is involved, and family-eating time is reduced and fast food consumption increases. In New Zealand, Pacific people have a significantly larger burden of food insecurity than other cultures, due to lower income, education, and socioeconomic status on average (Marriott and Sim, 2015), therefore contributing to increased obesity prevalence. A study by Metcalf et. al (2000) found that household income, tertiary education and socioeconomic status were lower in Pacific Island people compared to Europeans, with the overall literacy and numeracy of Pacific adults to be

lower than other ethnic groups. Interestingly, this study also found that there was an increased weight gain in low education and low socioeconomic groups between the ages of 20 and 40, suggesting a relationship between these factors.

While dietary intake is not the only factor predisposing Pacific Island people to obesity, it does play a fundamental role. Historically, environmental conditions in the islands influenced this food supply, with periods of food shortage leading to famine. This created a mentality prioritising the importance of an abundant food supply that symbolises wealth and prosperity (Fitzgerald, 1980). There is a symbolic importance of food within Pacific culture, with social occasions and celebrations often focused around both offering and consuming foods in the form of generous feasts. These feasts are to compensate for famine periods, and enhance individual and community wellbeing through connection, elevated group identity and social status. This social emphasis on providing an abundance of food has resulted in a positive attitude towards a larger body size, being indicative of a higher status, nurturance and higher level of beauty (McCabe, Waqa, Dev, Cama, & Swinburn, 2013). In New Zealand, Pacific females have a significantly higher energy intake compared to non-Pacific females (Ministry of Health, 2012), which again may contribute to the significant difference in obesity between the two groups. However, health equity and the concept of a European ethno-centric healthcare system in New Zealand is a factor beyond dietary intake that may negatively influence the health of Pacific people in New Zealand (Sheridan et. al, 2011). While equity for Maori is included in policy, this is not always the same for the Pacific culture and could result in underserving the healthcare needs for this group.

2.8 Food Choice

Historically, food choice was dictated by the biological need for food, yet this has changed in the nineteenth and twentieth centuries due to cultural and social factors resulting in an increase in fat and sugar in the diet. Such foods are now widely consumed due to their palatability, despite the limited nutritional value. An individual's food choice can be affected by factors such as resources, the context of food, and social and personal factors, all of which inform value negotiations and behavioural strategies. The complex social and physical environment is often under-emphasised in relation to obesity, with a stronger emphasis placed on individual health behaviours, despite New Zealand's high regional inequalities (Pearce & Dorling, 2006). Geographical inequalities in deprived areas can strongly effect food choice and

subsequent health outcomes, such as the placement and number of fast food and liquor stores, as well as the availability of fresh produce.

Recommendations for healthy food choices are outlined in the Eating and Activity Guidelines for New Zealand adults (Ministry of Health, 2015a) including choosing unsaturated fats over saturated fats, foods low in salt, little or no added sugar and minimally processed foods. Some food groups such as fruits and vegetables will provide protective factors against chronic diseases, whereas other highly processed foods high in saturated fat sodium and energy can increase risk factors for such conditions (Ministry of Health, 2012).

Foods typically consumed at the breakfast meal, such as wholegrains, low fat milk and milk products and fruit, fall into a category of foods that are "encouraged" by public health organisations (International Food Information Council, 2008) as they help to meet daily nutritional requirements and assist in the prevention of chronic disease. The foods chosen at breakfast can influence satiety throughout the day, thought to be a factor in the relationship between consuming breakfast and having a healthy body weight (Song et al., 2005). For example, a breakfast that contains protein, fibre and fat may reduce overall daily energy intake, due to feelings of satiety (Burley et al., 1987, Holt et al., 1999). Eating a varied breakfast may indicate a healthy breakfast habit, with a study by Ortega et al. (1996) finding participants of a normal weight consumed breakfasts that were more varied, involved more foods and food groups, and contained a higher percentage of their daily energy intake.

2.8.1 Food choice in Pacific culture

Cultural traditions, norms and beliefs often underpin food intake and influence food choices, beyond biological factors requiring foods for physiological roles within the body. The results from the 2008/09 Adult Nutrition Survey in New Zealand (Ministry of Health, 2011) found a significant difference in food choice depending on neighbourhood deprivation, socioeconomic status, gender and ethnicity. The following table (**Table 3**) outlines studies that have investigated nutrient intake or food choice in Pacific Island people.

Table 4 Summary of studies investigating nutrient intake of food choice in Pacific Island people

First author (year)	Country and study design	Population sample	Aspect of diet examined	Diet measure	Dietary components	Key findings
Dewes (2013)	NZ, cross-sectional survey	2495 Pacific Island adolescents, 13-18 years	Risk and preventative factors for obesity in Pacific Island adolescents	Questionnaire	Food and nutrition behaviours	Higher weight associated with less healthy breakfast and lunch sources
Fitzgerald (1980)	NZ, cross-sectional	62 households	Dietary patterns of Cook Islanders, and how food habits are influenced by economic, social and cultural conditions	Questionnaire	Consumption patterns, food preferences,	Economic and social conditions affect availability and use of food, and therefore nutritional status and disease patterns For Cook Islanders in NZ, diet has shown trends of an increase in fat, decrease in starchy foods (root vegetables) and an increase in sugar and refined CHO
McCabe (2013)	Australia, cross-sectional	628 Fijian, 463 Indo-Fijian, 598 Tongan, 534 Australian adolescents	Cultural values related to eating practice	Cultural Values Scale and Likert Scale	Body size, eating behaviours	Fijian and Tongan adolescents were more likely to value a large body Religious influences was associated with eating practices for Fijians, Indo-Fijians and Tongans
Metcalf (2014)	NZ, cross-sectional	954 Pacific, 1,745 NZ European adults, 35-74 years	Dietary intake, food servings, and cooking practices of Pacific ethnic groups with NZ Europeans	FFQ – food intake in past 3 months	Energy, alcohol, calcium, protein, cholesterol, Food groups	Pacific men and women had lower calcium intakes then NZE adults Pacific adults ate more servings of fish, chicken and bread, and fewer servings of cheese and breakfast cereals
Sluyter (2010)	NZ, cross-sectional	1,422 male, 1,127 female high school students, 14-21 years	Comparing dietary intake of European, Maori, Pacific Island and Asian adolescents	FFQ	Food groups Energy, CHO, starch, fibre, sucrose, protein, fat, SFA, PUFA, MUFA, cholesterol, alcohol, calcium	Pacific consumed more energy per day than European Pacific Islanders consumed larger portion sizes for nearly every food item compared to European

Food plays a significant role in Pacific culture, with the food produced on the islands affecting communal sense of wellbeing, inclusive of health, economic opportunity, and the overall food security for the people. The traditional Pacific diet in the islands was generally low in energy and fat, however adjusting to the Western cultures such as New Zealand has altered the diet and resulted in adverse health outcomes. While it has been argued that genetics may play a role in food-related disease in the Pacific cultures, this does not explain why these illnesses occur at lower rates in traditional Pacific settings, compared to Western settings (Ringrose & Zimmet, 1979). In modern Western contexts, food is readily available and often high in energy, fat and sugar; therefore the Pacific tradition of feasting can result in overeating and an energy imbalance (Fitzgerald, 1980).

Pacific adults generally make different food choices compared to New Zealand European adults, with a focus on consuming an abundance of food. Pacific adults were less likely to make healthy food choices than non-Pacific adults, having lower intakes milk, cereals and vegetables, as well as having larger portion sizes and more frequent consumption of takeaways (Ministry of Health, 2013; Sluyter, Schaaf, Metcalf, & Scragg, 2010).

2.8.2 Specific food choices at breakfast

Breads and cereals are frequently incorporated into the breakfast meal through food choices such as wholegrain bread, ready to eat cereals and oats (International Food Information Council, 2008). Wholegrains are high in fibre, vitamins and minerals, and have inverse associations with cardiovascular disease, type 2 diabetes, weight gain and some cancers (Ministry of Health, 2015a). The latest New Zealand NNS (Ministry of Health, 2012) found that wholegrain bread was chosen most often by 63.3% of the population, more likely for females in the least deprived areas (76.9%) than the most deprived areas (53.4%). However it found that only 43.4% of Pacific females chose wholegrain bread, with Pacific adults being almost twice as likely to choose white bread compared to non-Pacific adults (Ministry of Health, 2012). Ready-to-eat cereals (RTC) are a common food consumed at breakfast. These are often fortified and can be higher in micronutrients and lower in fat than other breakfast choices (International Food Information Council, 2008). Research has found that those who ate RTC had a significantly lower intake of fat, a higher intake of carbohydrates, and a lower BMI (Song et al., 2005), similarly reflected in study by (Galvin, Kiely, & Flynn, 2003) to find even a small amount of breakfast cereal makes an important contribution to daily carbohydrate and fibre

intake. Literature has also found that young adults were 31% less likely to be overweight or obese, and 39% less likely to have abdominal obesity when comparing RTC consumption with breakfast skippers (Deshmukh-Taskar et al., 2010). While it has been argued that many breakfast cereals contain added sugars, and contribute to the overall sugar intake throughout the day, studies have found that in fact breakfast skippers consume more added sugars later in the day (Cho et al., 2003).

Reduced or low fat milk and milk products are another nutritious food group to encourage at breakfast due to a range of vitamins and minerals, in particular high levels of protein and calcium (International Food Information Council, 2008). Research has found low fat dairy to play a role in facilitating weight loss due to the role of protein in satiation (Journel, Chaumontet, Darcel, Fromentin, & Tomé, 2012). Dairy products also contain bioactive compounds that may further diminish weight gain, suggesting an important role of dairy products in combination with calorie restriction in treating obesity (Zemel, 2003). Ortega et al. (1998) found that calcium intakes fell below recommended levels when the breakfast meal provided less than 20% of total energy intake in children, and the intake of milk at breakfast also correlated with the overall dietary calcium intake (Ortega et al., 1998). The NNS (Ministry of Health, 2012) found that almost half of the New Zealand population (48.4%) chose reduced fat or trim milk, and this was more likely to be chosen by women of least deprived areas (56.5%) compared to those living in the most deprived areas (40.5%). It was also found that Pacific adults were more likely to choose standard milk than non-Pacific adults (Ministry of Health, 2012).

Fruit and vegetables are a frequently promoted food group, providing an abundance of vitamins, minerals and dietary fibre, with recommended servings of at least two fruit and three vegetables per day (Ministry of Health, 2015a). They play a role in the prevention of weight gain and obesity, as they are generally low in energy and high in fibre, as well as playing a protective role against heart disease, stroke, some cancers and other non-communicable diseases (Boeing et al., 2012). A study by Lazzeri et al. (2013) found associations with breakfast intake, specifically that irregular breakfast consumption is associated with lower fruit and vegetable intake. In the NNS (Ministry of Health, 2012), under half Pacific females met recommendations for three servings of vegetables per day (48.9%), whereas more than half met recommendations for two servings of fruit (62.4%). However Pacific female fruit intake was significantly lower than non-Pacific female (-2.7%, $P<0.05$).

Discretionary foods are a food group high in saturated fat and sugar. These foods can be highly palatable leading to high consumption, however are often energy dense without providing sufficient nutrients. 'Cakes and muffins' are one of the main sources of saturated fat intake in New Zealanders' diet (5%) (Ministry of Health, 2011), and are one of the food groups that fall within this discretionary food category. The Eating and Activity Guidelines (Ministry of Health, 2015a) recommends consuming less of these foods, and instead choosing foods low in saturated fats, and with little or no sugar. Reducing foods high in saturated fats has been associated with a lower cardiovascular disease (Hooper, Martin, Abdelhamid, & Davey Smith, 2015). Examples of these foods are high-fat takeaways and highly processed convenience foods e.g. muesli bars, potato chips, cookies. Discretionary foods also include high sugar foods, and consuming a diet high in refined sugars has been linked to higher body weight and tooth decay (WHO, 2015), and sugars increased the energy density of foods without adding additional useful nutrients. New Zealanders consume free sugars from foods such as fizzy drinks, sweets, and baked goods such as cakes and biscuits (Ministry of Health, 2015a). Swapping these discretionary foods high in saturated fats and sugar for healthier alternatives is likely to result in positive health outcomes.

2.9 Conclusion

Obesity is continuing to increase both worldwide and in New Zealand, leading to increased adverse health outcomes and disease risk. This is particularly prevalent in the Pacific Island population group from what appears to be due to a range of social, cultural and economic factors. Pacific Islanders have disproportionately higher rates of obesity, and different eating habits to NZ European, such as an increased frequency of skipping breakfast, a significantly higher energy intake, and a lower intake of calcium (Ministry of Health, 2012).

There has been longstanding controversy in the relationship between breakfast consumption and body composition. The nutritional quality of this meal is important, as this can affect subsequent food eaten throughout the day. While it appears breakfast skipping itself is not the cause of increased body weight, literature frequently demonstrates a relationship between the two due to other related factors such as appetite later in the day, prevalence of smoking, alcohol and exercising less. Evidence suggests that the nutritional quality of the meal is strongly influenced by the environment food is consumed in. The individual, social, physical and societal influences are all contributing factors to both food intake and eating behaviours, both positively and negatively.

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Chapter 3 Research Manuscript

This manuscript is formatted for submission to the Journal of the Academy of Nutrition and Dietetics (Author guidelines in **Appendix 2**). The referencing style for the research manuscript has been changed from the guidelines to be consistent between thesis chapters and to accommodate the ease of reading.

Recorded and Observed Breakfast Intake and Eating Habits in Pacific Island Women

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3.1 Abstract

Background/aim: There are disproportionately higher numbers of obesity in the Pacific population group in New Zealand, leading to increased adverse health outcomes. A tendency to skip breakfast has been reported within this group. Skipping breakfast is linked to dietary deficiencies such as calcium and fibre, and an increased appetite later in the day. The aim of this study was to explore recorded and observed breakfast intake and practices in Pacific Island women aged 18-45 years of different body compositions in New Zealand, analysing nutrient intake, food choice, and effects of breakfast skipping.

Methods: In this cross-sectional study, Pacific women (18-45 years) completed a 5-day food record (FR) (n=146) and a videoed breakfast buffet (BB) (n=142). Associations between body composition, nutrient intake, food choice and eating behaviours were investigated. Body mass index (kg/m^2) was measured using the bioelectrical impedance analysis, categorising women in obese, overweight or normal weight BMI groups.

Results: From a nutrient perspective, all BMI groups had habitual intakes at the FR high in saturated fat, and low in dietary fibre and calcium. All BMI groups had significantly higher intakes at the BB compared with FR for energy, PUFA (g), carbohydrate (g), sugars, dietary

fibre, riboflavin, vitamin B6 and calcium, and significantly lower intakes of cholesterol and protein (%). For food groups, servings of 'breads, cereals and grains', 'milk, dairy and alternatives', and 'discretionary foods' were all higher at the BB compared with the FR. Investigation into breakfast skipping found a significant difference in calcium intake between breakfast eating behaviour groups, with only breakfast eaters meeting recommendations.

Conclusion: The findings of this study provide valuable insight into Pacific women's breakfast eating habits. Nutrients and food choice differed significantly between BB and FR, which may indicate influential factors such as food availability and social influence. While the results did not suggest a significantly different intake of food groups or nutrients between BMI groups, this may provide future research opportunities to explore whether nutrients consumed and food choice at breakfast in Pacific women influence food intake later in the day, and whether there is an association with body composition. This study does highlight the role of public health intervention in emphasizing the importance of consuming breakfast high in whole grains and dairy products to improve intakes of dietary fibre and calcium, and a lower saturated fat content of the meal for overall health benefits.

Key words: Breakfast, food choice, eating behaviour

3.2 Introduction

Positive dietary habits and eating patterns, such as eating breakfast, are associated with a healthy dietary intake, nutritional status and health (Ministry of Health, 2012). Breakfast is often reported as the most important meal of the day due to roles in meeting nutrient requirements (International Food Information Council, 2008) and achieving a healthy body weight (Cho et al., 2003). Having a breakfast meal, compared to skipping breakfast, leads to beneficial effects on signals controlling food intake regulation, such as appetite, hormonal and neural signals (Leidy et al., 2013). Without these regulatory signals, overall food intake may increase thus leading to poor weight control, weight gain and even obesity in individuals.

New Zealand has the third highest adult obesity rate out of fifteen countries in the Organisation for Economic Cooperation and Development (OECD) (Ministry of Health, 2016), and this is the leading modifiable risk factor for health loss in the country. Pacific people have disproportionately higher rates of obesity when compared to the general population (Chansavang et al., 2015), with 66% of Pacific adults obese (Ministry of Health, 2016). There is an association between skipping breakfast and obesity (Smith et al., 2010). It has been reported that the Pacific culture skip breakfast more frequently (Ministry of Health, 2003, Ministry of Health, 2012). Research has found a positive association between skipping breakfast and obesity (Horikawa et al., 2011). Cultural factors and historical matters regarding food availability in the Pacific culture also contribute to a tendency of overconsumption of energy dense food, with a social emphasis on both offering and consuming foods in the form of generous feasts (Tamasese et al., 2012).

Food choice differs for Pacific adults in New Zealand compared to New Zealand European adults, such as being less likely to meet fruit and vegetable recommendations, more likely to choose white bread over wholegrain, and the majority having an inadequate intake of calcium (Ministry of Health, 2012). The breakfast meal is traditionally one that significantly contributes to the intake of these foods groups and nutrients, and appropriate intakes may not be reached if not consumed at the breakfast meal.

The aim of this study was to explore recorded and observed breakfast intake and practices in Pacific Island women aged 18-45 years of different body compositions in New Zealand, analysing nutrient intake, food choice, and effects of breakfast skipping.

3.3 Methods

3.3.1 PROMISE Study Design

This sub-study is a cross-sectional study investigating the recorded and observed breakfast meals of Pacific women. The larger PROMISE (PRedictors linking Obesity and gut MIcrobiomE) is a cross-sectional study conducted by Massey University, investigating associations between diet, physical activity, sleep, taste and gut bacteria and body weight of New Zealand European and Pacific women. This sub-study only used the dietary data and anthropometric data from the PROMISE study. Nutrient intake, food choice and eating habits at breakfast were analysed using a combination of a 5-day food record (recorded intake) and video recorded breakfast buffet meal (observed intake).

3.3.2 Ethical approval

Ethical approval was obtained for the PROMISE study by the Southern Health and Disability Ethics Committee (HDEC), reference 16/STH/32. Prior to the study, all participants completed consent forms and were provided with information on the procedures for the study, the inclusion and exclusion criteria, and their role as a participant. Cultural safety was ensured throughout the research process, including the development of a study that may provide results that would be of benefit to Pacific people in New Zealand. A Pacific public Health Organisation 'The Fono' were involved to ensure the cultural safety and sensitivity throughout the research process.

3.3.3 Study population

Figure 1 outlines the process for selecting participants for this sub-study describing the participants included from each BMI group in each section of the study; the breakfast buffet (BB) and the food record (FR). Fewer participants' BB data were available for processing due to technological error with video recording.

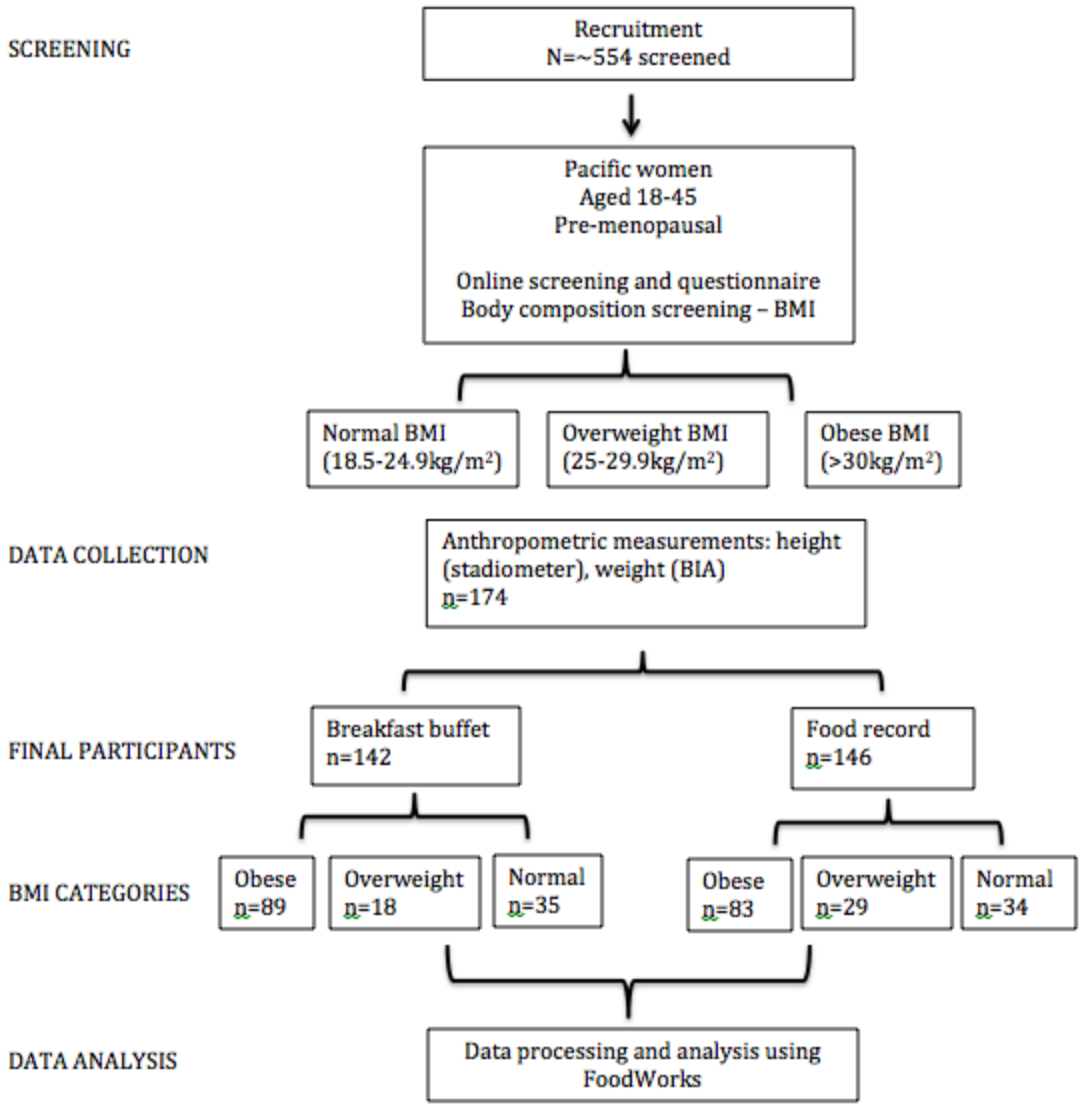

Figure 1 Process for screening, selecting, and data collection for the Pacific participants in the sub-study

Participants

The Promise study aimed to recruit 272 women who met the inclusion criteria of being healthy pre-menopausal women of NZ European and Pasifika ethnicity, aged between 18 to 45 years falling into either a normal or obese BMI category. This sub-study solely focuses on the Pacific Island women, and included recruited women of obese, overweight and normal BMI.

Recruitment

Recruitment for the Promise study occurred alongside data collection, from June 2016 to September 2017. Pacific Island participants were targeted throughout Auckland using pamphlets, posters, word of mouth, emailing lists and social media. Those interested in the study were sent an information sheet and an online screening questionnaire. A limitation of this method of recruitment is the reliance on literacy. Pacific people who have on average

lower health literacy than European people in New Zealand (Hefford et. al, 2005), which may have been a limiting factor for recruitment in this study.

A total of 174 Pasifika women for the Promise study met the inclusion criteria for this sub-study. This criterion was healthy Pacific women aged 18-45 years, falling into normal BMI (≥18.5 - <25), overweight BMI (≥25 - <30) or obese BMI (≥30) categories (see **figure 1**).

If the participant met the inclusion criteria, they were then invited to schedule an appointment for visit 1 and 2 at the Human Nutrition Research Unit at Massey University, Albany. While transport was offered from South Auckland for participants, the distance required to travel to North Auckland may have limited recruitment. Participants were excluded if they were pregnant or lactating in the past six months, diagnosed with a chronic disease or illness (e.g. Diabetes Mellitus), had a food allergy or severe dietary restriction, were taking medications affecting the immune system, or had undergone bariatric surgery.

Anthropometric Measurements

On visit 1, anthropometric measurements were taken. Height was measured using a stadiometer and waist and hip circumference using a Lufkin tape, based on protocol from the International Society for the Advancement of Kinanthropometry (ISAK) (Marfell-Jones, Stewart, & De Ridder, 2012). Body composition profiles were derived from a Bioelectrical Impedance Analysis (BIA) (InBody 230, Biospace Co. Ltd, Seoul) (Ling et al., 2011). Body Mass Index (BMI) was calculated (weight (kg)/height (cm) squared) and participants were categorised according to BMI for this sub-study (obese (BMI≥30); overweight (BMI 25-29.9); normal body weight (BMI 18.5-24.9). Waist to hip ratio was calculated by weight circumference (cm) divided by hip circumference (cm).

5-day Food Record

After training on how to complete a food record, participants were required to complete a food record on five non-consecutive days (including one weekend day) in the two-week period in between visits. The completed food record was collected and then reviewed by New Zealand registered dietitians together with the participants themselves at the beginning of visit two. The food record is referred to as 'FR' throughout the study. A total of 146 participants were included in food record analysis, having either all 5 days completed, or partially completed with 3 or 4 days. There were 27 Pacific women excluded due to either not completing enough days of their food record or dropping out from the study.

Videoed Breakfast Observation

The participants arrived fasted to visit 1 and were provided a small breakfast buffet following their blood sample collection and taste testing. They had free choice of all food and beverages offered in a communal dining setting, and were instructed by a research assistant that they must consume all food sitting in a designated table in the room. Foods provided were selected based on the categories outlined in the Eating and Activity Guidelines (Ministry of Health, 2015a) falling into both 'healthy' and 'unhealthy' categories, as well as 'discretionary foods' high in saturated fat or sugar. A full list of the foods available at the breakfast buffet within the different food groups is outlined in **Appendix 4**. These foods were selected based on a typical Western breakfast to align with other breakfast literature, including bread, cereal, fruit, milk and dairy products, as well as tea, coffee and juice. Options such as breakfast crackers were also included, being a popular Pacific breakfast option. Video surveillance recorded both selection and consumption of the meal, with discrete observation by researchers of selection and plate waste. The breakfast buffet is referred to as 'BB' throughout the study. There were 32 Pacific women excluded, as they did not have a video analysis at their breakfast buffet due to technology errors with the video camera, or research staff being unable to record foods chosen.

Breakfast Definition

The lack of a standard definition of breakfast within literature results in the definition of breakfast differing greatly among studies (Stanton Jr. & Keast, 1989). A common way of defining this meal is allowing participants to define the meal, which results in subjective variation (O'Neil et al., 2014). This study has chosen to follow the definition of a quantitatively adequate breakfast being defined as 25% of daily energy intake or more (O'Neil et al., 2014; Ortega et al., 1998; Sjöberg et al., 2003). Therefore the reference values of 25% of estimated energy requirements (EARs) and recommended daily intakes (RDIs) for both macronutrients and micronutrients were used for comparison to determine whether these intakes were met at the breakfast meal for the Pacific women involved in this study, and these are referred to as 'breakfast recommendations' throughout the study.

The participants were split into 'breakfast eating behaviour' groups to compare differences dietary intake depending on their breakfast eating patterns. These groups were: 'regular breakfast eaters', with zero days skipping breakfast; 'irregular breakfast eaters', with one or two days skipping breakfast; and 'breakfast skippers', with three, four or five days skipping

breakfast. Their mean nutrient intake was calculated based on dividing their total intake over five days by five, regardless of the number of days skipped.

Food Groups

Six food groups were developed based on the Ministry of Health Eating and Activity guidelines (Ministry of Health, 2015a): breads, cereals and grains; milk, dairy and alternatives; fruits and vegetables; protein foods; fats, nuts and seeds; and discretionary foods. A full list of the foods categorised into these groups can be seen in **Appendix 3 and 4**. It must be noted that there were only five food group categories for the breakfast buffet, as there were no warm protein foods provided that fell into the 'protein food' category.

The 'breads, cereals and grains' and 'milk, dairy and alternatives' food groups were further split into food categories, to explore specifically which items were selected within these food groups, and how this compared between FR and BB settings. This has been recorded as total frequency of food categories selected for all participants, either throughout five days in the FR or during the one-off breakfast at the BB.

3.3.5 Data management

Analysis of dietary data (recorded and observed intake)

Two Masters of Science in Dietetics students and one research intern entered the food record data into Foodworks 8 (2015, Xyris Software (Australia) Pty Ltd, Queensland, Australia). For cross-checking, 50% were checked by two New Zealand registered dietitians. Two human nutrition students entered the data from the breakfast buffet, which was then cross-checked. The database used in the initial data entry was from the New Zealand Food Composition Database (NZ FOODfiles 2014), however when not available Australian databases were used. For the secondary databases, NUTTAB 2010 (from Food Standards Australia New Zealand (FSANZ)) was preferably used, followed by AusFoods 2015 (from Xyris software, developed from AusNut 2013), and then AusBrands 2015 (data from nutrient packaging). The information from Foodworks provided an average of nutrients and food groups consumed over the five days, whereas the breakfast observation solely included the number of food groups chosen on the one occasion.

Table 5 describes the classification procedure for including foods from the 5-day food record in the breakfast analysis.

Table 2 Breakfast classification from food records

Step	Food entered in food diary	Classification
1	First meal consumed between 0600-1000	Breakfast
2	Snack/drink followed by breakfast meal all consumed between 06:00-10:00	All included as breakfast
3	Breakfast meal followed by snack/drink over 30 minutes later all consumed between 06:00-10:00	Only entered meal as breakfast, later snack not included
4	First meal of day consumed outside 06:00-10:00 but within 2 hours of waking	Breakfast

3.3.6 Statistical analysis

The data was analysed using SPSS 24 for Windows (SPPS Inc, Chicago, IL). Data within each BMI group was checked for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests with significance analysed visually (superimposed bell curve on the histogram, box-plot and Q-Q normality plot). Data that were not normally distributed were log transformed to improve normality. Normally distributed data was presented as mean ± standard deviation, non-normal data were log transformed and presented as geometric mean and 95% confidence interval. If normality was not achieved after log transformation, non-parametric statistics were applied and data were presented as median with 25th and 75th quartiles in cases where variables were unable to reach normality. Categorical data were presented as numbers, frequencies and percentages.

A one-way ANOVA test was used to determine significant differences for nutrient intake between the BMI groups for parametric data, with Tukey post hoc tests used to find the difference between the groups. Because of the difference in age between the groups, the tests controlled for age. For determining differences between categorical data, chi-square tests were used, and Kruskal-Wallis for non-parametric data.

A paired sample T-test was used to compare intake at breakfast buffet with usual intake from the food record. This was used to determine if there was a significant difference for intake between BMI groups at the two different settings. A P-value of less than 0.05 was considered statistically significant throughout.

3.3.7 Financial support

The PROMISE study is funded by the Health Research Council, New Zealand, grant #15/273.

3.4 Results

3.4.1 Study population

There were 174 Pacific Island women who completed this study, 146 of the 174 completed the food record and 142 completed the videoed breakfast observation. These women were categorised into body composition groups based on their body mass index (BMI); obese, overweight and normal BMI (**Figure 1**).

3.4.2 Participant characteristics

The characteristics of the Pacific Island women in this study population are outlined in **table 6**.

Table 3 Characteristics of Pacific women in Promise study

Characteristics	Total (n=174)	Groups (n=174)			P-values
		Obese (n=90)	Overweight (n=41)	Normal (n=43)	
Age (years)	25.1 ± 6.4	25.7 ± 6.2	25.2 ± 7.0	23.7 ± 6.2	0.228
Height (m)	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1	0.424
Weight (kg)	89.2 ± 21.9	104.6 ± 18.5 [a, b]	79.2 ± 6.7 [a, c]	66.2 ± 7.3 [b, c]	<0.001*
Body Mass Index (BMI) (kg/m^2)	31.4 ± 7.4	37.0 ± 5.7 [a, b]	27.6 ± 1.5 [a, c]	23.1 ± 1.5 [b, c]	<0.001*
Body fat percentage (%)	37.6 ± 9.0	43.6 ± 6.7 [a, b]	33.9 ± 5.5 [a, c]	28.5 ± 5.7 [b, c]	<0.001*
Waist circumference (cm) *RR <88cm*	90.9 ± 15.3	101.6 ± 12.2 [a, b]	82.9 ± 4.4 [a, c]	74.2 ± 4.2 [b, c]	<0.001*
Hip circumference (cm)	115.0 ± 13.6	123.8 ± 11.6 [a, b]	109.0 ± 4.8 [a, c]	101.0 ± 5.7 [b, c]	<0.001*
Waist: Hip ratio *RR <0.85*	0.79 ± 0.1	0.8 ± 0.1 [a, b]	0.8 ± 0.0 [a]	0.7 ± 0.0 [b]	<0.001*

Mean ± standard deviation for comparability with other studies
**= Significant difference (P<0.05) using ANOVA, paired T-test, or Kruskal-Wallis (non-parametric)*

[a, b, c] = same symbol indicates significant difference (P<0.05) between BMI groups as shown in post hoc test
RR = reference range based on World Health Organisation value for predictors of health

The majority of participants in this study were obese (n=90). Lower numbers of participants were recruited for overweight (n=41) and normal BMI (n=43) groups. The participants' anthropometric characteristics increased by category from normal BMI, to overweight to obese groups. There was a significant difference in waist circumference between all three BMI groups *(P<0.001).* The normal BMI group had the lowest mean waist circumference (74.2cm), followed by overweight (82.9cm). Both of these values were below the recommended reference range from the World Health Organization (2011) of <88cm. The obese BMI group exceeded this recommendation with a mean waist circumference of 101.6cm.

3.4.3 Nutrient intake at breakfast

Differences between recorded (FR) and observed (BB) intake within each BMI group, as well as the differences between each BMI groups for both recorded and observed are outlined in **Table 7.**

Table 4 Nutrient intake at breakfast in FR and BB for obese, overweight and normal BMI groups

Nutrients	25% of NRV Recommendations	Breakfast setting	BMI groups			P-value
			Obese (n=90)	Overweight (n=41)	Normal (n=43)	
Energy (kJ)	2175	FR[d]	1374.1 ± 710.1	1286.7 ± 587.4	1186.6 ± 667.4	0.426
		BB[e]	2329.2 ± 1100.4	2148.5 ± 1118.7	1929.8 ± 680.5	0.339
		P-value	<0.001*	0.003*	<0.001*	
Protein (g)	9.3[2]	FR[d]	12.1 ± 7.2	13.1 ± 8.0	11.1 ± 7.5	0.624
		BB[d]	17.0 ± 8.5	16.7 ± 10.3	12.8 ± 7.4	0.075
		P-value	<0.001*	0.196	0.340	
Protein (%)	15-25[1]	FR[e]	14.9 ± 5.2[a]	19.0 ± 7.2 [a]	15.8 ± 6.0	0.051
		BB[e]	12.6 ± 4.0 [a]	14.8 ± 7.0 [a, b]	10.9 ± 4.4[b]	0.049*
		P-value	<0.001*	0.030*	<0.001*	
Total fat (g)		FR[f]	11.8 ± 8.3	12.1 ± 6.8	10.7 ± 7.5	0.756

Nutrients	25% of NRV Recommendations	Breakfast setting	BMI groups			P-value
			Obese (n=90)	Overweight (n=41)	Normal (n=43)	
		BB[d]	20.1 ± 12.1	17.1 ± 9.8	18.3 ± 10.4	0.475
		P-value	<0.001*	0.063	0.002*	
Total fat (%)	20-35[1]	FR[d]	30.7 ± 10.9	29.7 ± 10.2	31.3 ± 12.1	0.867
		BB[d]	31.2 ± 10.0	28.3 ± 11.7	32.7 ± 12.9	0.342
		P-value	0.750	0.624	0.646	
Saturated fat (g)		FR[f]	4.8 ± 3.7	4.6 ± 2.6	4.1 ± 3.0	0.639
		BB[e]	8.2 ± 4.8	6.2 ± 3.7	7.4 ± 4.1	0.268
		P-value	<0.001*	0.107	<0.001*	
Saturated fat (%)	<10[1]	FR[e]	12.8 ± 6.1	13.7 ± 8.2	11.7 ± 5.6	0.826
		BB[e]	13.7 ± 6.9	12.0 ± 7.2	13.4 ± 6.3	0.506
		P-value	0.342	0.438	0.176	

Nutrients	25% of NRV Recommendations	Breakfast setting	BMI groups			P-value
			Obese (n=90)	Overweight (n=41)	Normal (n=43)	
PUFA (g)		FR[e]	1.7 ± 1.7	1.8 ± 1.7	1.7 ± 1.7	0.825
		BB[e]	3.9 ± 3.0	3.6 ± 2.3	3.2 ± 2.1	0.638
		P-value	<0.001*	0.004*	0.003*	
MUFA (g)		FR[f]	4.0 ± 3.3	4.5 ± 3.1	3.7 ± 2.9	0.631
		BB[e]	5.8 ± 4.0	5.4 ± 3.7	5.9 ± 5.1	0.809
		P-value	0.006*	0.393	0.048*	
Cholesterol (mg)		FR[e]	53.0 ± 67.9	62.0 ± 57.3	63.3 ± 89.0	0.417
		BB[e]	28.1 ± 18.1	23.1 ± 14.3	24.4 ± 13.7	0.681
		P-value	0.002*	0.007*	0.022*	
Carbohydrate (g)		FR[e]	41.3 ± 22.7	34.6 ± 17.6	34.0 ± 19.1	0.262
		BB[e]	73.3 ± 35.0	69.4 ± 36.8	58.6 ± 19.0	0.178

Nutrients	25% of NRV Recommendations	Breakfast setting	BMI groups			P-value
			Obese (n=90)	Overweight (n=41)	Normal (n=43)	
		P-value	<0.001*	<0.001*	<0.001*	
Carbohydrate (%)	45-65[1]	FR[e]	50.9 ± 11.1	43.6 ± 13.9	49.4 ± 15.1	0.119
		BB[e]	52.1 ± 9.1	52.5 ± 12.6	52.5 ± 12.8	0.883
		P-value	0.472	0.023*	0.328	
Sugars (g)		FR[e]	17.4 ± 14.5	14.0 ± 9.4	15.7 ± 8.8	0.738
		BB[e]	43.3 ± 24.9	39.1 ± 19.8	32.1 ± 14.7	0.156
		P-value	<0.001*	<0.001*	<0.001*	
Dietary fibre (g)	6.25[4]	FR[e]	3.9 ± 2.7	3.4 ± 1.8	3.3 ± 2.7	0.455
		BB[d]	6.3 ± 3.1	6.8 ± 4.8	4.9 ± 2.5	0.073
		P-value	<0.001*	0.003*	0.008*	
Thiamin (mg)	0.3[3]	FR[e]	0.6 ± 0.6	0.6 ± 0.7	0.3 ± 0.4	0.118

Nutrients	25% of NRV Recommendations	Breakfast setting	BMI groups			P-value
			Obese (n=90)	Overweight (n=41)	Normal (n=43)	
		BB[e]	0.6 ± 0.6	0.5 ± 0.5	0.3 ± 0.3	0.038*
		P-value	0.810	0.777	0.935	
Riboflavin (mg)	0.3[3]	FR[e]	0.6 ± 0.7	0.5 ± 0.4	0.4 ± 0.3	0.623
		BB[e]	1.2 ± 0.9 [a]	1.0 ± 0.9	0.7 ± 0.5 [a]	0.011*
		P-value	<0.001*	0.020*	0.026*	
Niacin (mg)	2.8[2]	FR[e]	3.1 ± 2.5	3.1 ± 2.0	2.8 ± 2.5	0.617
		BB[e]	5.1 ± 3.8	3.8 ± 3.0	3.8 ± 2.9	0.177
		P-value	<0.001*	0.321	0.169	
Vitamin C (mg)	7.5[2]	FR[e]	15.4 ± 68.8	7.9 ± 9.5	13.8 ± 19.4	0.662
		BB[e]	9.9 ± 13.2	9.0 ± 12.5	6.6 ± 12.4	0.164
		P-value	0.486	0.751	0.111	

Nutrients	25% of NRV Recommendations	Breakfast setting	BMI groups			P-value
			Obese (n=90)	Overweight (n=41)	Normal (n=43)	
Vitamin B6 (mg)	0.3[2]	FR[e]	0.4 ± 0.4	0.4 ± 0.3	0.4 ± 0.4	0.573
		BB[e]	1.3 ± 1.0 [a]	0.9 ± 0.8	0.8 ± 0.6[a]	0.033*
		P-value	<0.001*	0.003*	0.003*	
Vitamin B12 (µg)	0.5[2]	FR[f]	0.6 ± 0.5	0.9 ± 1.3	0.6 ± 0.5	0.223
		BB[e]	1.2 ± 1.0 [a]	1.0 ± 0.9	0.6 ± 0.7 [a]	0.007*
		P-value	<0.001*	0.701	0.667	
Total folate (µg)	80[2]	FR[e]	73.2 ± 55.0	68.3 ± 45.8	68.2 ± 76.7	0.473
		BB[e]	133.7 ± 106.6 [a]	102.9 ± 92.3	72.7 ± 72.8 [a]	0.012*
		P-value	<0.001*	0.118	0.804	
Calcium (mg)	210[2]	FR[e]	169.1 ± 105.2	182.0 ± 126.1	162.4 ± 113.9	0.834
		BB[e]	460.2 ± 316.1 [a]	416.2 ± 316.1	285.3 ± 211.5 [a]	0.014*
		P-value	<0.001*	0.005*	0.006*	

Mean ± standard deviation
NRV Recommendations based on 25% Nutrient Reference Values (National Health Medical Research Council, 2005) for average female 19-50 years
FR = Recorded intake (food record)
BB = Observed intake (breakfast buffet)
PUFA = Polyunsaturated fatty acids
MUFA = monounsaturated fatty acids
**= Significant difference (P<0.05) using ANOVA, paired T-test, or Kruskal-Wallis (non-parametric)*
[a, b, c] = same symbol indicates significant difference (P<0.05) between BMI groups as shown in post hoc test
[1] = Acceptable Macronutrient Distribution Range (AMDR)
[2] = Estimated Average Requirements (EAR)
[3]= Recommended Daily Intake (RDI)
[4]= Adequate Intake (AI)

Differences between BMI groups for recorded and observed nutrient intake

There was no significant difference between energy intakes between the three BMI groups for FR or BB. The percentage of energy from protein (%) for BB was significantly higher in the overweight BMI group (14.8%E), than both the obese BMI group (12.6%E) and the normal BMI group (10.9%E) (*P=0.049*). There was no significant difference in absolute intake of protein (g) between BMI groups at FR (*P=0.624)* or BB (*P=0.075)*. There were significantly higher intakes at BB of riboflavin *(P=0.011)*, vitamin B6 (*P=0.033*), vitamin B12 (*P=0.007*), total folate (*P=0.012*) and calcium (*P=0.014*), compared between the obese BMI group and the normal BMI group, but not the overweight BMI group.

Differences between recorded and observed intake within each BMI category

The obese BMI group had significantly higher intakes at BB compared with FR for the following nutrients: MUFA (g) *(P=0.006)*, and energy, protein (g), total fat (g), saturated fat (g), PUFA (g), carbohydrate (g), sugars, dietary fibre, riboflavin, niacin, vitamin B6, vitamin B12, total folate and calcium *(*all *P<0.001).*
However cholesterol *(P=0.002),* and protein (%) *(P<0.001)* were lower in the BB compared with the FR for the obese BMI group.

The overweight BMI group had significantly higher intakes at BB compared with FR for the following nutrients: energy *(P=0.003)*, PUFA (g) *(P=0.004)*, MUFA (g) *(P=0.006)*, carbohydrate (%)*(P=0.023)*, dietary fibre *(P=0.003)*, riboflavin *(P=0.020)*, vitamin B6 *(P=0.003)*, calcium *(P=0.005)*, and carbohydrate (g) and sugars *(*both *P<0.001).* However protein (%) *(P=0.030)* and cholesterol *(P=0.007)*, were lower in the BB compared with the FR for the overweight BMI group.

The normal BMI group had significantly higher intakes at BB compared with FR for the following nutrients: total fat (g) *(P=0.002)*, PUFA (g) *(P=0.003)*, MUFA (g) *(P=0.048)*, dietary fibre *(P=0.008)*, riboflavin *(P=0.026)*, vitamin B6 *(P=0.003)*, calcium *(P=0.006)*, and energy, saturated fat (g), carbohydrate (g) and sugars *(*all *P<0.001).* However cholesterol *(P=0.022),* and protein (%) *(P<0.001)* were lower in the BB compared with the FR for the obese BMI group. Therefore all three BMI groups had significantly higher intakes at BB compared to FR for energy, PUFA (g), carbohydrate (g), sugars, dietary fibre, riboflavin, vitamin B6 and calcium. Whereas all three BMI groups had a lower intake at the BB of cholesterol and protein (%) compared with the FR.

3.4.4 Skipping breakfast and recorded nutrient intake

Participants were categorised into three groups: 1) breakfast eaters, with zero days skipping breakfast; 2) inconsistent breakfast eaters, with one to two days skipped; 3) breakfast skippers, with ≥ three days skipped out of five.

Table 8 and **Figure 2** outlines the numbers of participants in each breakfast eating behaviour group, based on their BMI group.

Table 5 Breakfast skipping prevalence between BMI groups

Breakfast eating behaviour group	BMI group			Total
	Obese (n=83)	Overweight (n=30)	Normal (n=34)	
Regular breakfast eaters (n (%))	28 (34)	12 (40)	10 (30)	50 (34)
Inconsistent breakfast eaters (n (%))	37 (44)	11 (37)	15 (44)	63 (43)
Breakfast skippers (n (%))	18 (22)	7 (23)	9 (26)	34 (23)

Breakfast eaters= 0 days skipped breakfast
Inconsistent breakfast eaters = 1 or 2 days skipped breakfast
Breakfast skippers = 3, 4 or 5 days skipped breakfast

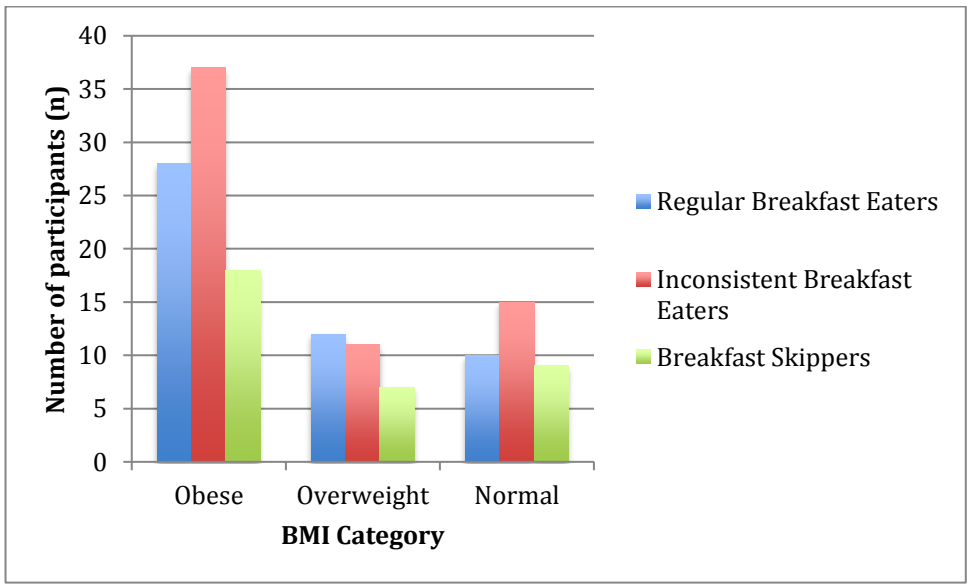

Figure 2 Breakfast eating behaviour prevalence between BMI groups

Pacific Island women in this study were most frequently in the category of inconsistent breakfast skippers (43%), followed by breakfast eaters (34%) and breakfast skippers (23%). This same pattern was seen for both the obese and normal BMI groups, whereas the overweight group had most breakfast eaters (40%).

Table 9 outlines the mean nutrient intake at breakfast from the recorded intake for each breakfast eating behaviour category. The mean has been recorded for comparability with the literature, and for consistency when comparing between the two breakfast settings.

Table 6 Nutrient intake between breakfast eating behaviour groups per 5 days

Nutrient ***Reference values (25%)***	**Breakfast eating behaviour group**						**P-value**
	Regular breakfast eaters (n=50)		**Inconsistent breakfast eaters (n=63)**		**Breakfast skippers (n=34)**		
	Mean intake	**% NRVs**	**Mean intake**	**% NRVs**	**Mean intake**	**% NRVs**	
Energy (kJ) *2175kJ*	1666.5 ± 646.7[a]	76.6	1432.9 ± 618.2[b]	65.9	867.1 ± 568.8[a, b]	39.9	<0.001*
Protein (g) *9.3g*	14.5 ± 6.6[a]	156	13.6 ± 7.2[b]	146	6.2 ± 3.4[a, b]	66.7	0.004*
Protein (%) *15-25%*	15.3 ± 3.9	102	16.5 ± 6.5	110	14.0 ± 5.7	93.3	0.954
Total fat (g)	15.2 ± 8.5[a]		13,6 ± 8.3[b]		7.1 ± 6.2[a, b]		0.001*
Total fat (%) *20-35%*	31.9 ± 9.0	156	32.4 ± 10.9	162	28.0 ± 9.3	140	0.792
Saturated fat (g)	6.1 ± 3.7[a]		5.8 ± 3.6[b]		3.4 ± 3.5[a, b]		0.006*
Saturated fat (%) *<10%*	13.1 ± 5.2	131	15.2 ± 7.0	152	12.2 ± 5.2	121	0.252
PUFA (g)	2.3 ± 2.0[a]		1.6 ± 1.4		0.7 ± 0.5[a]		0.001*
MUFA (g)	5.1 ± 3.2[a]		4.6 ± 3.5		2.1 ± 1.9[a]		0.007*

Cholesterol (mg)	76.8 ± 93.8		69.1 ± 63.6		30.8 ± 40.7		0.581
Carbohydrate (g)	48.3 ± 18.1 [a]		39.7 ± 17.9		28.0 ± 18.4 [a]		0.005*
Carbohydrate (%) *45-65%*	49.0 ± 9.5	109	46.0 ± 14.1	102	54.6 ± 11.3	121	0.299
Sugars (g)	21.2 ± 11.8 [a]		16.9 ± 9.6		12.0 ± 7.1 [a]		0.043*
Dietary fibre (g) *6.25g*	4.9 ± 2.5 [a]	78.4	3.4 ± 1.9	54.4	2.0 ± 1.5 [a]	32.0	<0.001*
Thiamin (mg) *0.3mg*	0.7 ± 0.7 [a]	233	0.5 ± 0.6	167	0.3 ± 0.4 [a]	100	0.018*
Riboflavin (mg) *0.3mg*	0.6 ± 0.3	200	0.5 ± 0.3	167	0.3 ± 0.3	100	0.467
Niacin (mg) *2.8mg*	3.9 ± 2.4	139	3.5 ± 2.6	125	1.8 ± 1.1	64.3	0.535
Vitamin C (mg) *7.5mg*	8.6 ± 10.8	115	10.3 ± 13.8	137	5.6 ± 12.3	74.7	0.247
Vitamin B6 (mg) *0.3mg*	0.5 ± 0.4 [a]	167	0.4 ± 0.4 [b]	133	0.1 ± 0.1 [a, b]	33.3	0.001*

Vitamin B12 (µg) *0.5µg*	0.7 ± 0.5	140	0.9 ± 1.0	180	0.3 ± 0.2	60.0	0.050
Total folate (µg) *80µg*	104.4 ± 54.1 [a]	131	64.3 ± 45.6	80.4	48.1 ± 42.8 [a]	60.1	<0.001*
Calcium (mg) *210mg*	228.5 ± 101.9 [b, c]	109	172.7 ± 96.6 [a, c]	82.2	105.8 ± 82.1 [a, b]	34.1	<0.001*

Mean ± standard deviation
Regular breakfast eaters = 0 days skipped breakfast
Inconsistent breakfast eaters = 1 or 2 days skipped breakfast
Breakfast skippers = 3, 4 or 5 days skipped
** = Significant difference between breakfast eating behaviour groups (P<0.05) using One-way ANOVA*
[a, b, c] = same symbol indicates significant difference (P<0.05) between breakfast eating behaviour groups as shown in post hoc test

The percentage energy from protein that is recommended (15-25%E) was met by breakfast eaters and irregular breakfast eaters, but not by breakfast skippers (12.2%E). All three breakfast eating behaviour groups exceeded saturated fat recommendations (<10%E). Calcium intake showed a significance difference between regular breakfast eaters, irregular breakfast eaters and breakfast skippers respectively (228.5mg, 172.7mg, 105.8mg, *P<0.001)*. Only breakfast eaters met the 25% recommendation of 210mg.

There was a significantly higher intake of nutrients for regular breakfast eaters compared to breakfast skippers for energy (*P<0.001)*, protein (g) (*P=0.004)*, total fat (g) (*P=0.00)*, saturated fat (g) (*P=0.006)*, PUFA (g) (*P=0.001),* MUFA (g) (*P=0.007),* carbohydrate (g) *(P=0.005),* sugars *(P=0.043),* dietary fibre *(P<0.001)*, vitamin B6 (*P=0.001),* thiamin *(P=0.018),* and total folate *(P<0.001).* Dietary fibre and total folate met breakfast recommendations of 6.25mg and 80 µg, which were met by regular breakfast eaters, but not by either irregular breakfast eaters or breakfast skippers. The breakfast skippers group also did not meet recommendations for either energy or vitamin B6.

The mean energy intake from protein per day (%E) did not differ significantly between regular breakfast eaters, inconsistent breakfast eaters and breakfast skippers respectively (15.0%, 15.3%, 15.1%), which meets recommendations of 15-25% energy. However there were significant differences (*P=0.004)* in the mean grams of protein consumed (14.5g, 13.6g, 6.2g).

Table 10 outlines the mean number of serves of each food group chosen per day between breakfast eating behaviour groups.

Table 7 Mean servings of food groups per day between breakfast eating behaviour groups

Food Group	Food record			P-value
	Regular breakfast eaters	Inconsistent breakfast eaters	Breakfast skippers	
Breads, cereals and grains	0.5 ± 0.3	0.5 ± 0.4	0.6 ± 0.3	0.780
Milk, dairy and alternatives	0.6 ± 0.3	0.6 ± 0.3	0.4 ± 0.4	0.129
Fruits and vegetables	1.0 ± 0.3	1.4 ± 1.4	0.4 ± 0.32	0.512
Protein foods	0.4 ± 0.2	0.3 ± 0.1	0.4 ± 0.1	0.757

Food Group	Food record			P-value
	Regular breakfast eaters	Inconsistent breakfast eaters	Breakfast skippers	
Fats, nuts and seeds	0.4 ± 0.2	0.7 ± 0.1	0.3 ± 0.2	0.644
Discretionary foods[1]	0.3 ± 0.2	0.7 ± 0.4	0.4 ± 0.2	0.994

Mean ± standard deviation
[1] *= Foods high in fat or sugar. See Appendix 3 and 4 for example list of foods.*
Significant difference between breakfast eating behaviour groups (P<0.05) using One-way ANOVA

The number of servings of food groups chosen did not significantly differ between breakfast eating behaviour groups (see **table 10**), with a one-way ANOVA test showing no food groups to have *P<0.005.*

3.4.5 Food groups chosen at breakfast

Table 11 outlines the mean number of serves of each food group chosen per day in both FR and BB settings, and between the BMI groups.

Table 8 Mean serves per day of food groups in FR and BB

Food Group	Food record			Breakfast buffet		
	Obese (n=83)	Overweight (n=29)	Normal (n=34)	Obese (n=89)	Overweight (n=18)	Normal (n=35)
Breads, cereals and grains	0.5 ± 0.3	0.5 ± 0.3	0.6 ± 0.3	1.2 ± 0.4	1.4 ± 0.5	1.1 ± 0.3
Milk, dairy and alternatives	0.4 ± 0.3	0.5 ± 0.2	0.6 ± 0.6	1.5 ± 0.5	1.9 ± 0.7	1.1 ± 0.3
Fruits and vegetables	0.5 ± 0.2	1.5 ± 1.0	0.8 ± 0.3	1.1 ± 0.3	1.0	1.0
Protein foods*	0.4 ± 0.2	0.5 ± 0.3	0.4 ± 0.3	/	/	/
Fats, nuts and seeds	0.3 ± 0.2	0.7 ± 0.1	0.3 ± 0.1	1.2 ± 0.5	1.0	1.1 ± 0.4
Discretionary foods[1]	0.4 ± 0.2	0.5 ± 0.4	0.4 ± 0.2	1.6 ± 0.8	1.4 ± 0.5	1.2 ± 0.4

**Cooked Protein foods were absent from breakfast buffet*

[1] = Foods high in fat or sugar. See Appendix 3 and 4 for example list of foods.

The servings consumed of all food groups was greater at BB compared to FR, with the one exception being 'fats, nuts and seeds' for the overweight group being higher at FR (1.5 serves) compared to BB (1.0 serves).

For the obese BMI group, the highest intake at FR was 'breads, grains and cereals' and 'fruits and vegetables' whereas at BB was 'discretionary foods'. In contrast the highest intakes for the overweight BMI group was 'fruits and vegetables' for FR, and 'milk, dairy and alternatives' for BB. The normal BMI group similarly had the highest intake of 'fruits and vegetables' at FR, but 'discretionary foods' at BB. Therefore all three BMI groups had 'fruits and vegetables' as one of their most frequently consumed food groups throughout the FR, but this was not reflected at the BB, where this was replaced with 'discretionary foods' for both obese and normal BMI groups.

For the food groups least frequently consumed, the obese BMI group had 'fats, nuts and seeds' for FR and 'fruits and vegetables' at BB. The overweight BMI group least frequently consumed 'breads, cereals and grains', 'milk, dairy and alternatives', 'protein foods' and 'discretionary foods' at FR, whereas 'fruits and vegetables' and 'fats, nuts and seeds' at BB. The normal BMI group similarly had the lowest intake of 'fats, nuts and seeds' at the FR but 'fruits and vegetables' at BB.

The findings of the most frequently consumed food groups at the FR contrasts with the least frequently consumed food groups at BB, where all three BMI groups were found to have the lowest intake of 'fruits and vegetables' in this setting.

Figure 3 shows the total frequency each food category was selected in the FR for the 'breads, grains & cereals' group, over five days.

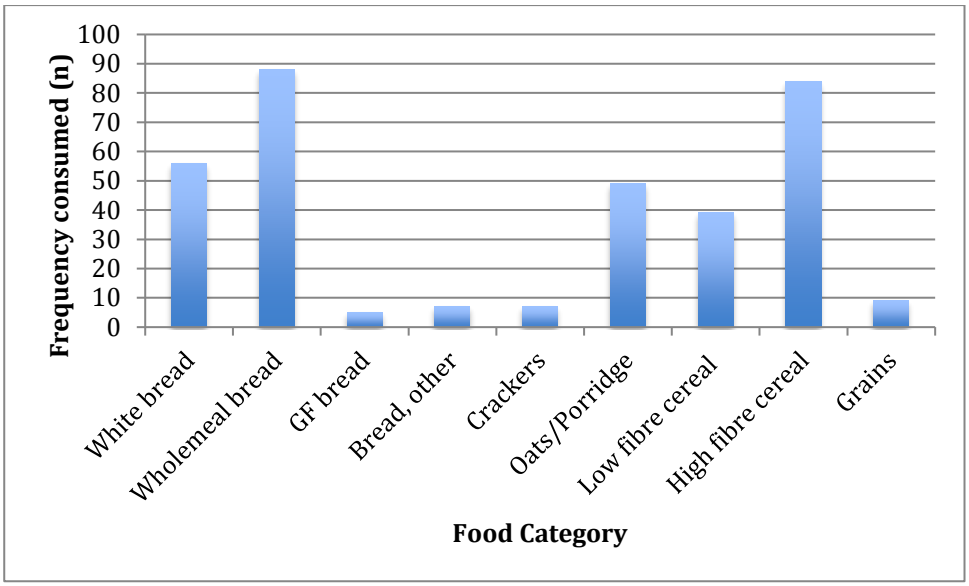

Figure 3 Frequency of each food category consumed by all participants in 'Breads, grains & cereals' category within five days (FR)

As shown in **figure 3,** in the FR, wholemeal bread was chosen more often than white bread, and high fibre cereal chosen more often than low fibre cereal, however these intakes were similar.

Figure 4 shows the total frequency each food category was selected by participants in the BB for the 'breads, grains & cereals' group, in a one-off videoed breakfast buffet observation.

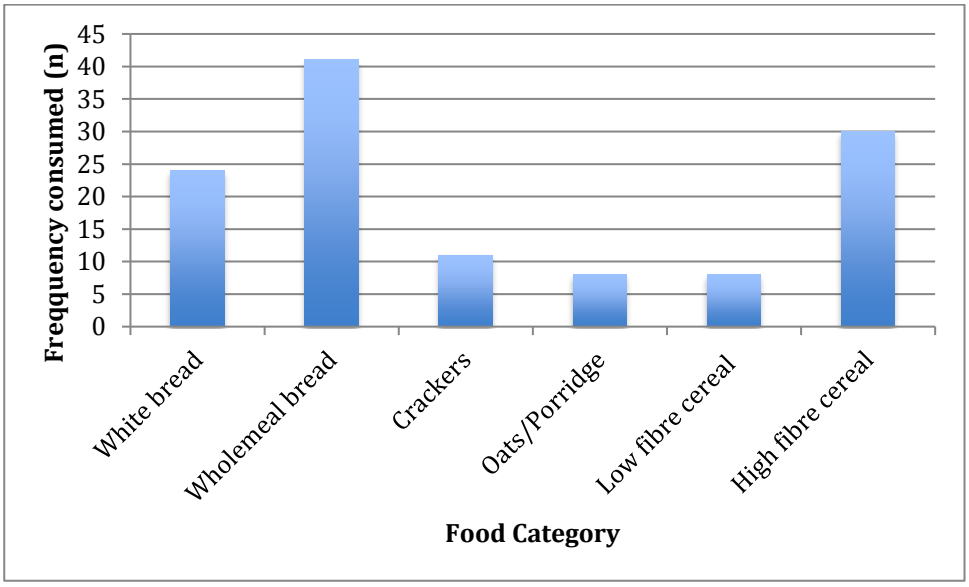

Figure 4 Frequency of each food category consumed by all participants in in 'Breads, grains & cereals' category at one off videoed breakfast buffet (BB)

At the breakfast buffet, wholemeal bread was chosen more often than white bread, and high fibre cereal over low fibre cereal, shown in **figure 4**. In comparison between the two breakfast settings, low fibre cereal was a more popular choice at the FR compared to the BB.

Figure 5 shows the total frequency each food category was selected in the FR for the 'milk, dairy & alternatives' group, over five days.

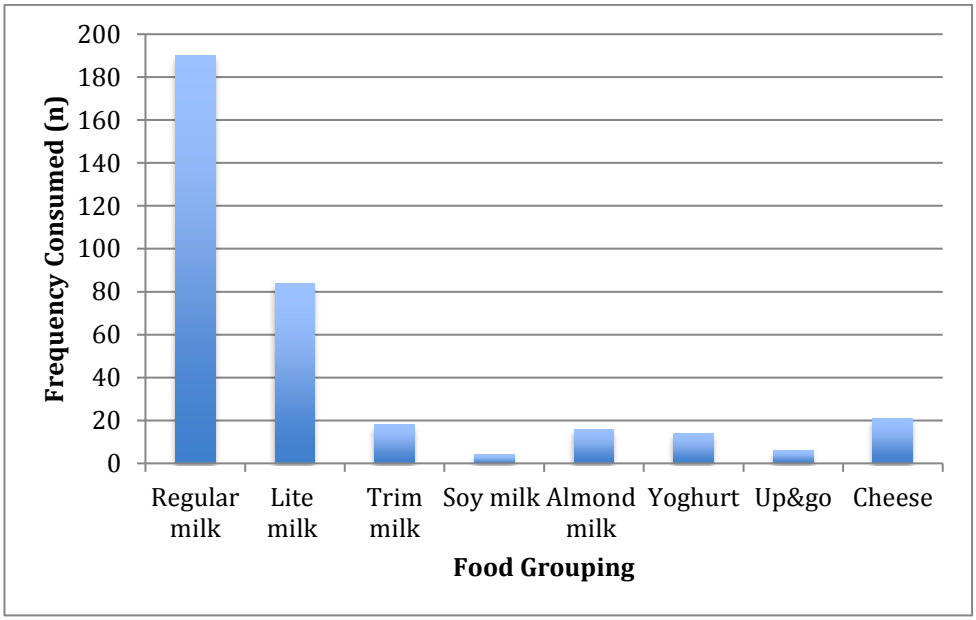

Figure 5 Frequency of each food category consumed by all participants in in 'Milk, dairy and alternatives' category within five days (FR)

In the FR, regular milk was chosen over lite or trim milk, and there were low numbers of yoghurt and Up&Go consumed, as shown in **figure 5.**

Figure 6 shows the total frequency each food category was selected in the BB for the 'milk, dairy & alternatives' group, in a one-off videoed breakfast buffet observation.

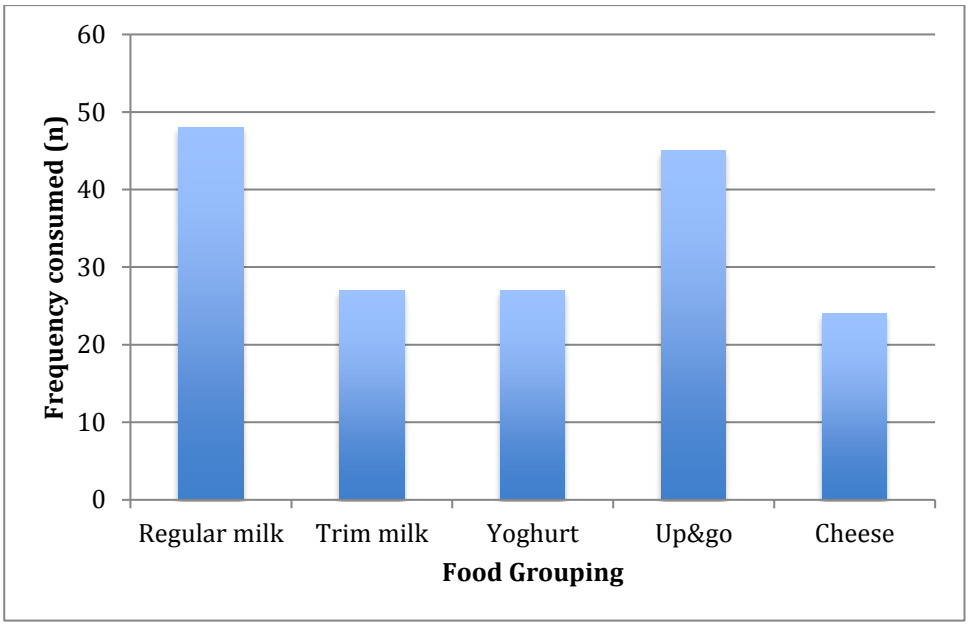

Figure 6 Frequency of each food category consumed by all participants in 'Milk, dairy and alternatives' category at one off videoed breakfast buffet (BB)

Regular milk was chosen over trim milk**,** however there was more trim milk chosen than at the FR, as shown in **figure 6.** There was a high frequency of Up&Go consumed at the BB, which was not reflected in the FR.

3.5 Discussion

The findings of this study demonstrated that nutrients and food choice at breakfast differed considerably between observed intakes at a breakfast buffet (BB) compared to recorded intake with a 5-day food record (FR). Most recruited participants were categorised into the obese category in both the FR and BB respectively (63%, 57%), resulting in lower numbers in both overweight and normal BMI groups. The obesity category was filled quicker and oversampled compared to other categories. This reflects obesity prevalence in Pacific women and is in line with the NNS results reporting that 66% of Pacific females were obese (Ministry of Health, 2012). The obese and normal BMI groups were most commonly inconsistent breakfast eaters (both 44%), whereas the overweight group were most commonly breakfast eaters (40%). These findings could suggest that consistent breakfast intake is not necessarily related to body weight, but may have an effect on subsequent intake throughout the day, which was not investigated in this study.

Breakfast recommendations for the purpose of discussion in this thesis are defined as 25% of the NRV recommendations. In both breakfast settings, energy intake was below breakfast recommendations (2175kJ) for all BMI groups, except for overweight group at the buffet. There were no differences found for energy intake between BMI groups. This study looked at the breakfast meal in isolation, and therefore it cannot be assumed that energy and nutrient requirements were not met throughout the rest of the day. Other studies have investigated this (Holt et al., 1999; Levitsky & Pacanowski, 2013), and found that the nutritional composition of breakfast can affect the energy density of foods consumed later in the day. A significantly higher energy intake was observed for all three BMI groups in BB as opposed to the FR, which could in part be explained by results from a study by Hetherington, Anderson, Norton, and Newson (2006), finding eating with friends increased energy intake by 18%. The findings that more energy was consumed in a buffet setting may support that when more food is available, or a social environment is introduced, participants will be more likely to consume larger quantities of food. There may be a lack of self-inhibition in these settings, as non food-related environmental stimuli has been found to induce a significant intake regardless of hunger or palatability of the meal (Bellisle, Dalix, & Slama, 2004).

Only the overweight and normal BMI groups met the recommended protein intake requirements (as a %E at breakfast) in the FR (19.0%E, 15.8%E respectively), however none of the BMI groups met the ADMR for protein (%) at the BB, all falling below 15%E. In comparison,

the NNS (Ministry of Health, 2011) found that Pacific females aged 19-50 years consume between 16.0-17.2% of energy from protein, therefore meeting requirements. Again it is important to acknowledge that because breakfast was analysed in isolation, other meals may have contributed significantly to total daily protein intake and it can therefore not be concluded that the overall diet is lacking in protein. Interestingly, these same trends were not seen in total protein intake (g), with all BMI groups meeting recommendations in both breakfast settings. While total protein intake (g) in this study was similar at the FR and BB, the distribution of macronutrients was different. A significantly lower percentage of protein from energy at the BB was replaced with other macronutrients, with higher percentages of either total fat or carbohydrates consumed amongst the three BMI groups at the BB. The lower percentage of energy from protein at the BB could have occurred due to the lack of cooked protein dishes and therefore a 'protein food' group, which was due to logistical reasons such as food safety and cost. There were however many other protein-rich sources were available at the BB such as milk, yoghurt and cheese, categorised in the 'milk, dairy and alternatives' group. It therefore cannot be concluded whether the contribution of energy from protein changed due to the environment, or whether it was due to lack of availability of protein choices that resulted in protein being replaced with other macronutrients. It is important to include sources of protein at breakfast, with literature suggesting that breakfasts containing protein reduce overall daily energy intake, due to feelings of satiety (Burley et al., 1987; Holt et al., 1999; Leidy et al., 2013). Protein is considered the most satiating macronutrient (Journel et al., 2012), with meals high in protein being more filling than those with less protein. This is supported by research by Blom et al. (2006) finding that a higher protein breakfast (58.1% protein) reduced subsequent energy intake later in the day, as well as Hoertel et al. (2014) finding anywhere from normal (13g protein) to high protein levels (35g protein) to reduce sweet and savoury food cravings, with further reduced cravings with higher protein meals.

In contrast to findings by W. Miller et al. (1990) that total fat intake increased with increases in body fat content, this study found no significant differences between BMI groups for total fat (%) and for total fat (g) consumed. The mean total fat intake (%E) for all three BMI groups at both breakfast settings was within recommended ranges (20-35%E). Our study did find that saturated fat (%) exceeded the recommendations of <10%E for all three BMI groups in both FR and BB settings, similar to the NNS findings of 13.5%E for Pacific women (Ministry of Health, 2011). Neither total fat (%E) nor saturated fat (%E) significantly differed between the two breakfast settings in our study. Our study did find a significantly higher intake of total fat (g) and saturated fat (g) at the BB compared with FR for both obese and normal BMI groups,

which is similar to findings that fat intake increases in social environments (Hermstad et al., 2010; Patel & Schlundt, 2001; Story et al., 2002; Viskaal-van Dongen et al., 2009), with the percentage of calories from fat to be higher when eating with other people compared to eating alone. These higher fat intakes at the BB may be due to higher fat food available, the social environment or underreporting in the FR. Overweight and obese individuals have been found to underreport fat intake (Braam, Ocke, Bueno-de-Mesquita, & Seidell, 1998; Goris, Westerterp-Plantenga, & Westerterp, 2000), which may have been a factor in this study. The physical BB environment providing 'discretionary foods' high in saturated fats and sugar could have encouraged consumption of these foods due to a "one-off" situation. High fat foods can result in passive overconsumption, due to not providing sensory signals in accordance with nutrient density (Viskaal-van Dongen et al., 2009). Mouth feel and taste could further lead to consumption of large quantities of foods (Blundell, 1996). There was a higher mean intake of 'discretionary foods' (biscuits, muffins, bakery foods etc.) at the BB (1.2-1.6 serves) compared with the FR (0.4-0.5 serves). These higher intakes primarily came from the muffins and cookies at the BB, and it can be speculated that these foods may not be commonly available or consumed daily at the breakfast meal. It is likely the higher intakes of the 'discretionary foods' group are a contributing factor to higher total fat and saturated fat intakes at the BB.

The percentage energy intake from carbohydrates in our study were similar to the NNS findings of 46.5-49.3% energy for Pacific women (Ministry of Health, 2011) for the obese, overweight and normal BMI groups respectively at the FR of (50.9%E, 43.6%E, 49.4%E) and the BB (52.1%E, 52.5%E, 52.5%E). The ADMR carbohydrates (45-65%E) were met for all BMI groups between both breakfast settings, except for the overweight BMI group at the FR. All three BMI groups had a significantly higher total intake of carbohydrates (g) at the BB compared with FR (all $P<0.001$). However, only the overweight group consumed a significantly higher percentage of energy from carbohydrate. Therefore, despite the higher actual carbohydrate intake (g), the carbohydrate (%E) was not altered significantly for both the obese and normal BMI groups. The higher intake of carbohydrates (g) at the BB may have replaced intakes of protein (g) at the BB. The mean portions of 'breads, cereals and grains' group consumed were lower at the FR (0.5-0.6 serves) than the BB (1.1-1.4 serves), which may have contributed to the higher carbohydrate (g) intake at the BB. Within this food group, wholegrain bread was a more popular choice than white bread at both breakfast settings. This was an interesting finding, as the NNS found that Pacific adults were twice more likely to choose white bread compared to non-Pacific adults (Ministry of Health, 2012). This may reflect

socio-economic factors resulting in purchase of white bread as a cheaper alternative, and on that the family prefers, or lack of education surrounding the importance of wholegrains. While 'fruits and vegetables' contribute to overall carbohydrate (g), their intakes were more consistent between the FR (0.5-1.5 serves) and BB (1.0-1.1 serves) and therefore unlikely to be as much of a contributing factor to the difference in carbohydrate (g) consumed between the two breakfast settings. It is important to encourage consumption of carbohydrates, such as breads and breakfast cereals, at the breakfast meal for overall energy regulation, with a study by Holt et al. (1999) finding that when comparing iso-energenic breakfasts, a carbohydrate – rich breakfast had a significantly lower total energy intake at the end of the day compared to a fat-rich breakfast.

The mean intake of dietary fibre at breakfast in the FR for Pacific women of all BMI groups did not meet recommendations. Optimal dietary fibre intake is important due to its role in reducing the risk of cardiovascular disease and diabetes, and assisting in preventing obesity (Ministry of Health, 2011). Our FR findings for fibre intake reflect findings from the NNS (Ministry of Health, 2011), with mean dietary fibre intake for Pacific females at 17.5g (25%=4.38g) being below recommendations of 25g (25%=6.25g) (National Health Medical Research Council, 2005). Worldwide there appears to be a similar trend, with studies finding average dietary fibre to be below recommendations with median intakes of 15g (25%=3.75g) in the USA, (Howarth et al., 2001; Slavin & Green, 2007), and 20g (25%=5g) in the UK (Bingham et al., 1979). Our study found dietary fibre to be significantly higher in the BB setting for the obese (*P<0.001),* overweight *(P=0.003)* and normal *(P=0.008)* groups, with both the obese (6.3g) and overweight (6.8g) groups meeting recommendations. This is likely to be due to the higher intakes of 'breads, cereals and grains' food group, as this food group significantly contributes to overall dietary fibre intake. Breakfast cereal consumption in particular has been found to be associated with higher intakes of dietary fibre, as well as higher intakes of carbohydrates and certain micronutrients, and lower intakes of fat (Galvin et al., 2003; Ruxton & Kirk, 1997; Stanton Jr. & Keast, 1989). In our study, high fibre cereals (>5g fibre per 100g) were more popular than low fibre cereals at both the FR and BB, but low fibre cereals were more frequently chosen in the FR. While not investigated in this study as breakfast was analysed in isolation, Holt et al. (1999) found a high fibre breakfast was associated with less food intake throughout the morning and a slower return of hunger. Education around choosing a high fibre breakfast cereal could be an important focus, as this can be a confusing choice for consumers due to the marketing around cereals and the multitude of products to choose from. It is important to encourage Pacific women to purchase and consume high fibre

breakfast foods, so these foods need to be an economical option and it is imperative that price is not a barrier in purchasing these foods. Public health campaigns can work alongside supermarkets to advertise the price comparison between high fibre breakfast foods and other discretionary items, to educate the population in general that these foods can be part of a budget-friendly healthy diet.

B vitamins are important nutrients that are often consumed at breakfast, due to being found in breads, cereals and dairy products (Mann J. & Truswell A., 2007). This study found the mean intake of folate in the FR for the obese, overweight and normal BMI groups (73.2µg, 68.3µg, 68.2µg respectively) to be below recommendations of 80µg, and only the obese (133.7µg) and overweight (102.9µg) BMI groups met recommendations at the BB. The NNS (Ministry of Health, 2011) found that 27% of women in New Zealand are at risk of deficiency, which is a concern due to the relationship between folate deficiency in pregnancy and neural tubal defects, where folate plays a role in cell growth and development (Mann J. & Truswell A., 2007). For vitamins B6, the obese, overweight and normal BMI groups met recommendations of 0.3µg (National Health Medical Research Council, 2005) at both the FR (all 0.4µg) and BB (1.3µg, 0.9µg, 0.8µg respectively) with these intakes being significantly higher at the BB. The mean at the FR is similar to that of the NNS (Ministry of Health, 2011) reporting mean intakes of 0.4-0.5mg (25% of 1.7-1.8mg) for Pacific women. Meeting recommendations of vitamin B6 is important due to its role in folate metabolism and homocysteine concentrations (Tucker et al., 2004), and is found in a range of foods such as fruit and bread and cereal products. It is interesting that intakes of total folate and vitamin B6 were significantly higher at the BB than the FR, with folate in particular meeting recommendations only at the BB. This may be due to the higher mean intake of 'breads, cereals and grains' seen at the BB (1.1-1.4 serves) compared with the FR (0.5-0.6 serves). Fortified cereals in particular contribute significantly to the mean daily intake of vitamin B6 and total folate (Galvin et al., 2003), and intake should be encouraged to meet micronutrient intakes. The first intervention should be encouraging Pacific women to eat a wider range of foods, such as regular consumption of B-vitamin rich breakfast foods and fruit and vegetables, to meet folate and vitamin B6 requirements.

The mean calcium intake from the NNS was 151.3mg (25% of 605mg) for Pacific women (Ministry of Health, 2011), below recommendations of 250mg (25% of 1000mg) (National Health Medical Research Council, 2005). Our study similarly found the mean intake of calcium for all BMI groups to be below recommendations in the FR for the obese, overweight and normal BMI groups (169.1mg, 182.0mg, 162.4mg respectively). The NNS (Ministry of Health,

2012) found that calcium intakes were significantly lower for Pacific females than non-Pacific females (-152.mg, *P<0.005)*, and that the prevalence of inadequate calcium intake in Pacific females was estimated to be 92.3% (Ministry of Health, 2012). Calcium is not widely distributed across food groups, being primarily found in milk and dairy products (Ministry of Health, 2011). Milk and dairy products are commonly consumed at breakfast, and studies have found this to contribute significantly to the daily intake of calcium in many individuals (International Food Information Council, 2008; Ortega et al., 1998; Song, Chun, Obayashi, Cho, & Chung, 2005) with milk being the single largest contributor to calcium in the diet in New Zealand (Ministry of Health, 2011). Interestingly, calcium intakes were significantly higher in all groups at the observed BB (obese *P<0.001,* overweight *P=0.005* and normal BMI *P=0.006),* all meeting recommendations. This reflects the higher servings of 'milk, dairy and alternatives' consumed at BB (1.1-1.9 serves) compared with FR (0.3-0.5 serves). Low fat dairy is a beneficial choice as it has been found to facilitate weight loss (Ganji & Kafai, 2004), due to the role of protein in satiation (Journel et al., 2012), alongside bioactive compounds in calcium such as angiotensin-converting enzyme inhibitors and branched chain amino acids (Zemel, Thompson, Milstead, Morris, & Campbell, 2004). The increased availability and food choice at the BB may have encouraged a higher intake of 'milk, dairy and alternatives' foods. Within this food category, regular full fat milk was the preferred choice of milk at both the FR and BB. Interestingly, trim milk was chosen more frequently at the BB than during the FR, and we could speculate that full fat milk is preferred at home, but participants chose trim milk at BB due to being observed. There may also be barrier such as lack of trim milk being available in the home, and drinking regular milk if that is what the family overall prefers. In the interest of both increasing calcium and protein intake, and decreasing saturated fat intake, Pacific women should be encouraged to purchase low fat (1% fat) or trim milk (<0.5% fat) compared to regular milk (3% fat), and consume this at the breakfast meal. It is important at a public health level that this milk is encouraged as being the healthy choice for all adults. Using popular Pacific role models, such as sports people or media personalities, campaigns can be developed to encourage trim milk as a great choice at the breakfast meal

The trends of nutrient intake and food choice relating to breakfast skipping helps to further understand the nutrients that are commonly missed when this meal is not consumed. While literature suggests that breakfast consumption is associated with a lower body weight (Deshmukh-Taskar et al., 2010; Huang et al., 2010; Niemeier et al., 2006; Ruxton & Kirk, 1997) this was not found in this study, while this could be due to low numbers of overweight and normal BMI participants recruited. All breakfast eating behaviour groups fell below breakfast

recommendations for energy intake: regular breakfast eaters (76.6%), inconsistent breakfast eaters (65.9%) and breakfast skippers (39.9%). Literature has similarly found breakfast intake is important in meeting total daily nutrient intake for energy, (Affenito et al., 2005; Croezen et al., 2009; Kerver et al., 2006) as well as nutrients such as dietary fibre and calcium, with requirements less likely to be met if not consumed at breakfast. The mean intakes of macronutrients (protein, total fat, saturated fat, carbohydrates and dietary fibre) were all significantly lower as the frequency of breakfast skipping increased, with a study by Deshmukh-Taskar et al. (2010) similarly finding showed that breakfast skippers have lower intakes of dietary fibre in particular. 'Regular breakfast eaters' and 'irregular breakfast eaters' met recommendations for all nutrients at breakfast except for dietary fibre (78.4%, 54.4% respectively), whereas 'breakfast skippers' fell below for protein (g) (66.7%), protein (%E) (93.3%) and dietary fibre (32.0%). Interestingly, all three breakfast eating behaviour groups exceeded recommendations for saturated fat (%E). This suggests that when 'breakfast skippers' do eat breakfast the food is often high in saturated fats, and therefore unlikely to be a healthy breakfast option. 'Regular breakfast eaters' met recommendations at the breakfast meal for all micronutrients, and these intakes were significantly lower for breakfast eating behaviour groups, reflecting findings in literature that breakfast skippers have the lowest intakes of all micronutrients except sodium (Kerver et al., 2006). A study by Croezen et al. (2009) found that females who skip breakfast had lower calcium intakes compared to those who do not skip breakfast, and our study found both 'irregular breakfast eaters' and 'breakfast skippers' fell short of recommendations (82.2% and 34.1% respectively). 'Irregular breakfast eaters' also fell below recommendations for total folate (80.4%), as did 'breakfast skippers' (60.1%), with this group also below recommendations for vitamin B6 (33.3%). Despite this study only looking at the breakfast meal in isolation, research on this topic by Leidy et al. (2013) suggested that consuming breakfast leads to beneficial metabolic alterations that control appetite and food intake regulation, which may assist in weight management. Our study does however indicate which nutrients are commonly consumed at breakfast, and whether these nutrient recommendations are likely to be met if this meal is regularly consumed. It is important to encourage the consumption of having nutritious breakfast foods every day, through behaviours such as eating breakfast with the family every day. Public health campaigns should encourage this message, alongside promoting healthy options such as high fibre breakfast cereals, wholegrain bread, low fat milk and dairy products, fruit and eggs. These can be marketed through social media such as Facebook, with challenges involved. This also sends a message with the aim to promote ongoing healthy habits of eating the breakfast meal together, and providing the family with healthy options to start the day off well.

One of the strengths of this study was the rigorous determination of the breakfast meal. A specific definition accepted within the literature was used to define “breakfast”. Collaboration with a public health organisation, ‘The Fono’ was another strength of the study, as this organisation supported recruitment of Pacific participants. The Fono also provided insight into specific Pacific recipes, food choices and meals. Another strength was the gold standard method of dietary assessment used. A 5-day food record, including at least one weekend day, was used. A rigorous process of checking the food intake data was also undertaken by researchers to clarify intakes with participants.

There are also several limitations for this study. As this study has a cross-sectional design, cause-and-effect associations cannot be established. The women that participated in this study may not be a representative sample of the New Zealand population, due to recruitment being primarily through church groups and healthcare providers, as well as barriers such as convenience and transport for participants. Another limitation was that the breakfast meal has been analysed in isolation without nutritional information from the overall daily intake. This was due to a time barrier preventing the complete dataset from the study being available to compare breakfast intake with overall daily intake. While this study still provides valuable insight into breakfast intake and choices, conclusions about dietary adequacy is limited to breakfast specifically. Similarly, associations between BMI and breakfast skipping habits do not give insight in our study regarding possible changes in intake later in the day. The social and environmental factors differed between participants at the breakfast buffet, and this may have influenced food choice and were not consistent throughout. For example, some participants ate breakfast with their friends or family, some with strangers, and some alone. This may have affected amounts of foods eaten and foods chosen based on social desirability, which would have contributed to overall nutrients consumed. Because this was not standardised between the different participants, this was a limitation at the BB, however we aimed not to interfere with people’s natural habits and choices in such a situation. This study also had some limitations specifically regarding the Pacific women it was focused on. The buffet breakfast may not have been inclusive of enough breakfast options that were typical of a Pacific breakfast, therefore not providing a valid comparison with the food diaries.

In conclusion, the results regarding breakfast intakes and choices of Pacific women in this study can be used to determine focus areas for future public health interventions. It provides insight into which nutrients do not meet recommendations, which food groups are skipped,

and where a gap could be to provide education on the importance of having certain foods at breakfast to encourage optimal health. From a nutrient perspective, FR breakfast intakes were high in saturated fat, and low in dietary fibre, total folate and calcium, with significantly higher intakes seen at the breakfast buffet, yet a significantly lower percentage of protein contributing to energy at the BB. These changes highlighted that the breakfast environment can influence food choices, with the mean servings of 'breads, cereals and grains', 'milk, dairy and alternatives' and 'discretionary foods' all being higher in the BB. While these foods groups were all higher in total, specific food groupings within the categories showed that servings of trim milk were higher at the BB, and low fibre cereals were more chosen more often in the FR. Investigation into breakfast eating behaviours found that participants regularly consuming breakfast is more likely to meet intakes of dietary fibre, B vitamins and calcium, and that these nutrients significantly decline with breakfast skipping. However interestingly, 'breakfast skippers' still exceeded the <10% recommendation for saturated fats indicating even when small amounts of foods were consumed, they were likely to be high in saturated fats. Overall the findings from this study support the importance of regularly eating breakfast. They indicate that dietary fibre, total folate and calcium intakes are often low at this meal, however these can be higher in a different buffet-style environment, and that there were no consistent trends seen at the breakfast meal between obese, overweight and normal BMI groups.

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Chapter 4 Conclusions and Recommendations

4.1 Aims of research

Obesity is an increasing health problem worldwide, with New Zealand having the third highest adult obesity rate out of fifteen countries in the OECD (Ministry of Health, 2016), being the leading modifiable risk factor for health loss in the country. There are disproportionately higher numbers of obesity in Pacific Island adults in New Zealand when compared to the general population (Chansavang et al., 2015), with 66% of Pacific adults obese (Ministry of Health, 2016). There is a global association between skipping breakfast and obesity (Horikawa et al., 2011) with Pacific people in particular having irregular eating habits and commonly skipping breakfast (Ministry of Health, 2003, 2012).

Few studies have investigated the breakfast meal of Pacific Island women, and the relationship this may have with body composition. A meta-analysis by Horikawa et al. (2011) reviewed 19 studies of breakfast consumption in Asian and Pacific regions, their findings suggesting that a positive association between skipping breakfast and obesity is global, inclusive of Pacific regions. However this research did not specifically focus on the Pacific Island population group, New Zealand or women.

The aim of this sub-study was to explore recorded and observed breakfast intake and practices in Pacific Island women aged 18-45 years of different body compositions in New Zealand, analysing nutrient intake, food choice, and effects of breakfast skipping. This included an extensive analysis of the existing literature on breakfast habits and the relationship with body composition and food groups. The objectives were to: assess and compare food and nutrient intakes from reported (5-day food record (FR)) and observed (videoed breakfast buffet (BB)) breakfast meals of Pacific Island women in different BMI groups; determine associations between skipping breakfast and dietary intake of different BMI groups at the recorded breakfast; and to explore and compare food groups chosen by Pacific Island women in different BMI groups at reported and observed breakfast occasions. Analysis of these tendencies provides a deeper understanding into whether there is a relationship between the breakfast meal and body composition in Pacific Island women in New Zealand. This study is the first study to specifically focus on the breakfast meal in Pacific Island women in New Zealand,

with a particular focus on the nutritional content, food choice and eating behaviours at this meal.

This study was part of the wider cross-sectional PROMISE study at Massey University, Albany, Auckland. It analysed a 5-day food record and videoed breakfast buffet of 174 Pacific pre-menopausal women aged 18-45. The bioelectrical impedance analysis (BIA) was used to measure weight and body mass index (BMI), with the BMI being used to categorise participants into obese (BMI≥30), overweight (BMI ≥25 - <30) or normal (BMI ≥18.5 - <25). Dietary intake and food group choices at breakfast were analysed for all Pacific women who completed the study, with associations between BMI and environment also investigated, comparing habitual intake from a 5-day food record with observed intake at a breakfast buffet.

4.2 Main findings and conclusions

Objective 1: *To assess and compare food and nutrient intakes from reported (5-day food record (FR)) and observed (videoed breakfast buffet (BB)) breakfast meals of Pacific Island women in different BMI groups.*

The obese, overweight and normal BMI groups all had mean intakes of dietary fibre, total folate, and calcium below 25% of the recommended intakes in the FR. When comparing with the BB, these three BMI groups had significantly higher intakes of energy, PUFA, carbohydrate (g), sugars, dietary fibre, riboflavin, vitamin B6 and calcium compared with FR, and significantly lower intakes of cholesterol and protein (%). The 25% recommendations for dietary fibre, total folate and calcium were more likely to be met in the BB than the FR, except for the normal BMI group with mean intakes of dietary fibre and total folate still below the recommendations. Interestingly, the only significant difference for protein (g) between the FR and BB was a significantly higher intake for the obese BMI group, yet protein (%) was significantly lower at the BB for all three BMI groups. This suggests that while the grams of protein did not largely differ, the macronutrient distribution of the breakfast meal showed a lower % protein at the BB. These findings indicate that the social and physical environment where participants consume breakfast may have an influence on the intake of certain nutrients that are not usually consumed in sufficient amounts at breakfast to meet recommendations, and may also alter the macronutrient distribution of the meal.

Objective 2: *To determine associations between skipping breakfast and dietary intake of different BMI groups at the recorded breakfast.*

The obese and normal BMI groups were most commonly 'inconsistent breakfast eaters' (both 44%), whereas the overweight BMI group was 'regular breakfast eaters' (40%). This suggests that consistent breakfast intake is not necessarily related to body weight, but this meal may have an effect on subsequent intake throughout the day, which was not investigated in this study. Comparing 'regular breakfast eaters' to 'breakfast skippers', the 'regular breakfast eaters' had a significantly higher intake of energy, protein (g), total fat (g), saturated fat (g), PUFA, MUFA, carbohydrate (g), sugars, dietary fibre, thiamin, vitamin B6 and total folate. Interestingly, all three breakfast eating behaviour groups exceeded saturated fat (%) recommendations, being >10% energy intake. Mean intake of calcium significantly differed between the three breakfast eating behaviour groups, with only the 'regular breakfast eaters' meeting the 25% recommendations. Similarly, 'regular breakfast eaters' were the only group to meet 25% recommendations of dietary fibre and total folate. These findings support that consuming breakfast may be important in meeting calcium, dietary fibre and total folate requirements. This study also shows that regardless of frequency of breakfast consumption, the contribution of saturated fat in this meal exceeds requirements for Pacific Island females.

Objective 3: *To explore and compare food groups chosen by Pacific Island women in different BMI groups at reported and observed breakfast occasions.*

Six food groups were developed based on the Eating and Activity guidelines: breads, cereals and grains; milk, dairy and alternatives; fruits and vegetables; protein foods; fats, nuts and seeds; and discretionary foods. The 'protein food' category was not available at the BB, due to cost and food safety reasons. Servings of 'breads, cereals and grains', 'milk, dairy and alternatives' and 'discretionary foods' were all higher at the BB than the FR for all BMI groups. Analyses of the food groups support previous findings regarding calcium intake, as the 'milk, dairy and alternatives' food group, had higher intakes at the BB compared with FR, and this food group is a common source of calcium. Within this food group, it was found that full cream milk was the most popular choice at both FR and BB, yet trim milk was chosen more often at the BB. The 'breads, cereals and grains' food group had higher intakes at the BB compared to FR, which similarly relates to higher intakes seen in dietary fibre and total folate at a nutrient level. It was found that wholemeal bread was more popular than white bread at both FR and BB, however low-fibre breakfast cereals were consumed more often in the FR.

The lack of a 'protein food' category at the BB, due to cost and food safety reasons, may also support the significantly lower protein (%) found in all three BMI groups at the BB.

Hypothesis: *We predict that the breakfast habits of Pacific women will show tendencies of low fruit, whole grain and dairy products, resulting in low intakes of a range of vitamins and minerals, in habitual breakfast settings, with these habits being linked to an increased body weight.*

This hypothesis was partially proven in this study. It was found that Pacific women did have habitual intakes in the FR low in 'breads, cereals and grains' and 'milk, dairy and alternatives'. There were also low intakes of a range of vitamins and minerals, such as total folate and calcium. The intakes of these food groups and nutrients all increased in the BB setting. However unlike our hypothesis, fruit intake did not differ between breakfast settings, and wholegrain bread was chosen over white bread at both breakfast settings. There were no significant results to suggest different intakes of food groups, vitamins or minerals between the BMI groups.

4.3 New knowledge generated

The disproportionate numbers of obesity in Pacific Island females in New Zealand has lead to a greater focus on possible dietary habits that could contribute to this.

The main contribution from this study is insight into areas that could encourage healthy habits at the breakfast meal. The findings highlight the possible role of public health intervention in emphasizing the importance of whole grains and dairy products at the breakfast meal, to improve intakes of calcium and dietary fibre for overall health benefits. The results also demonstrate that breakfast consumption is a positive eating habit, with skipping breakfast associated with a decline in important nutrients such as protein, dietary fibre, vitamins B6, total folate and calcium, which may play a role in weight management and eating habits later in the day. Finally, it was found that there were significant differences in breakfast intake at the breakfast buffet meal compared to recorded intake, in particular significantly higher intakes of dietary fibre and calcium. While the results did not suggest a significantly different intake of food groups or nutrients between BMI groups, this may provide future research opportunities with the entire day analysed, rather than breakfast in isolation. These overall findings provide insight into environments that could influence food choice, and positively affect meeting nutrient recommendations.

4.4 Study strengths

One strength of this study was using a specific definition for breakfast, being the first meal consumed within 2 hours of waking, or between 6am and 10am. This was validated with sleep

diaries, and used as a definition rather than accepting a "self-reported" breakfast, which is commonly used in the literature, yet is open to subjectivity from participants and reduces consistency. Collaboration with a public health organisation, 'The Fono' was another strength of the study, as this organisation supported recruitment of Pacific participants, specifically within the three different BMI groups. The Fono also provided insight into Pacific recipes and meals. The method for dietary assessment was 5-day food diaries, including at least one weekend day, which were then checked by researchers to clarify intakes with participants. This food record method is a gold standard method for current intake, and more specific than a food frequency questionnaire (FFQ) that is commonly used in other studies, and therefore is another strength of this sub-study.

4.5 Study limitations

The key limitation of this study is that the breakfast meal is analysed in isolation to subsequent food consumed throughout the day. This was due to a time barrier preventing the complete dataset from the study being available to compare breakfast intake with overall daily intake. It is therefore difficult to determine the relationship between dietary intake at breakfast and body composition, as a large breakfast does not necessarily mean a large quantity of foods consumed later in the day, and vice versa. A large, healthy breakfast may be the sign of a healthy eating habit, and prevent subsequent snacking or unhealthy food choices later in the day. Conversely, a large breakfast may be indicative of an individual who consumes excessively large portions of foods constantly throughout the day. The same can occur in individuals who have a small breakfast, as this may actually be an unhealthy eating behaviour.

Recruitment of Pacific Island women was a challenge, particularly those of a normal body weight. The women that participated in this study may not be a representative sample of the New Zealand population due to barriers in recruitment. This includes issues such as convenience and transport, as well as recruitment being primarily through church groups and healthcare providers.

Finally the social and environmental factors differed between participants at the breakfast buffet, which may have influenced food choice and were not consistent throughout. For example, some participants ate breakfast with their friends or family, some with strangers, and some alone. This may have affected amounts of foods eaten and foods chosen based on social desirability, which would have contributed to overall nutrients consumed. Because this was

not standardised between the different participants, this was a limitation that was present at the buffet.

4.6 Recommendations

- The environment food is consumed in can have an effect on nutrient intake, with intakes of dietary fibre, calcium and total folate all significantly greater in the BB compared with FR. The intakes of these nutrients are low in many Pacific females, and inadequate intakes can put women at risk of negative health outcomes.
    - A public health campaign could be developed to encourage Pacific females to eat breakfast within a social setting, to encourage sufficient intake at this meal.
    - The focus of this campaign could be "eat breakfast as a family every morning" to start the day off right, and may encourage regular consumption of a healthy breakfast meal.
    - This message can be marketed through social media such as Facebook, with challenges involved. This could be a weekly challenge, such as posting a "selfie" with your family having breakfast together three times in one week, to go in the draw to win a healthy breakfast prize. This not only makes this a fun family activity, but also sends an underlying message with the hope to promote ongoing healthy habits of eating the breakfast meal together, and providing the family with healthy options to start the day off well.

- Interventions should focus on encouraging consumption of 'breads, cereals and grains', which was a food group consumed more at BB compared to FR, and related to intakes of fibre and folate.
    - It is important that consumption of a high fibre breakfast is encouraged, and that the Pacific women are aware of what these options are. It was observed that high fibre cereals were more popular than low fibre cereals in the BB environment, where they were available.
    - Handouts could be available at places such as The Fono and local supermarkets, with different recipes ideas of how to use breakfast cereals, such as different toppings. This focus would be on breakfast high in dietary

fibre and folate, and options that are quick and convenient but appealing. This may be as simple as Weetbix with yoghurt, fruit and honey.

- Alongside local supermarkets, advertising around the type of cereal being promoted could link in with current promotional sales of that cereal, to ensure that it is an economical option.
- It could be useful to develop basic informative posters that show the link between intake of certain nutrients and disease, such as dietary fibre and colorectal cancer or folate and neural tubal defects. These posters could make use of pictures and bright colours, and ensure that it is understandable for a wide range of health literacy levels.

- Interventions should focus on encouraging consumption of 'milk, dairy and alternatives', which was a food group consumed more at BB compared to FR, and related to intakes of calcium
  - Calcium has been known to play a role in weight management, which is beneficial for Pacific females who have disproportionately higher numbers of obesity compared with the general population.
  - While regular milk was a more popular choice at BB and FR, trim milk was chosen more at the buffet where it was available, and this may be an important focus to simultaneously reduce saturated fat intake in Pacific women.
  - Flip cards could be developed and distributed through local public health organisations, showing 'easy swaps' with healthier dairy choices, such as trim milk versus full fat. It could be visually effective to show how much fat in teaspoons is present in each glass, and how they compare.

- Dietary intakes of saturated fats are high in many Pacific females, with inadequate intakes of these nutrients putting the women at risk of negative health outcomes.
  - Saturated fat (%) was found to be >10% within all BMI groups at both FR and BB, as well as between all breakfast eating behaviour groups.
  - It may be beneficial to target church groups where shared food is often available. If 'discretionary foods' that are high in fat and sugar are available, it is likely they will be consumed at a higher rate than normal, which was seen in the buffet setting.

- If the church environment is on board having a “fruit first” policy, and removing highly processed snack foods, this may prevent high intakes of saturated fats, and send a positive message to the community about healthy breakfast choices.
- Instead, the church can be part of a “healthy breakfast” initiative which provides ideas and resources to create a healthy eating environment, with a focus on decreasing saturated fats. Recommendations would be focused on healthy options such as high fibre breakfast cereals, wholegrain bread, low fat milk and dairy products, fruit and eggs.
- Resources and activities will also be available, to further develop education on how to choose healthy options in buffet or feast situations. Positive health messages around eating with friends and family could be beneficial, such as posters of healthy “bring a plate” ideas, and how to base a meal around vegetables rather than fat.

- The behaviour of being a ‘regular breakfast eater’ is important in meeting recommendations for a wide range of nutrients, and this may influence subsequent intake of nutrients throughout the day.
    - A campaign could be developed with endorsement from well-known local Pacific “celebrities”, regarding the importance of eating breakfast every day. This may be either Pacific female athletes, or media personalities. Using the marketing model of ‘celebrity branding’, Pacific females may benefit from seeing well-respected Pacific people promoting this habit, and may similarly be influenced to consume breakfast daily.
    - The foods endorsed could encompass all other suggestions, such as Weetbix, Calci-trim milk, or fruit, ensuring that the foods being promoted encompass a healthy breakfast.

4.6.1 Recommendations for further research

- Analyse breakfast intake alongside dietary data throughout the day to determine the impact different nutrients at the breakfast meal have on food choice and eating behaviour later in the day, and whether there are associations with BMI.

- Requesting additional notes on feelings of fullness and satiety at different times of day to be added to the food records. This could assist in evaluating the effect breakfast consumption has on consuming foods later in the day.
- Additional studies that have even numbers of participants within each body composition group. While this may not be representative of the population, it would allow insight into the food choices and eating behaviours that are common within the different body composition groups.
- Record social and environmental factors for each participant to determine whether having others present etc. had an effect on nutrient intake and food choice at breakfast meal, as this could only be assumed at this stage.

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Appendices

Appendix 1 Author guidelines for narrative review: Journal of the Academy of Nutrition and Dietetics

1. **Title:** Identify report as Narrative Review of;
2. **Abstract:** Provide an unstructured summary including, as applicable: background, objective, brief summary of narrative review and implications for future research, and clinical practice or policy development;
3. **Introduction:** Describe the rationale for the review in the context of what is already known. Specify the key question(s) identified for the review topic;
4. **Methods:** Specify the process for identifying the literature search (e.g. years considered, language, publication status, study design and databases of coverage and;
5. **Discussion/Summary:** Discuss: 1) research reviewed including fundamental or key findings, 2) limitations and/or quality of research reviewed, and 3) need for future research. Provide an overall interpretation of the narrative review in the context of clinical practice and/or the Nutrition Care Process for registered dietitian nutritionists, clinical practice for other health professionals, policy development and implementation, or future research.

Appendix 2 Author guidelines for research paper: Journal of the Academy of Nutrition and Dietetics

1. **Structured abstract** included as the first page of the manuscript body;
2. **Introduction** stating the purpose and relevance of the study and the testable hypotheses and/or measurable objectives underlying the study design;
3. Clear and full description of **materials and methods**, including criteria for participant selection and reasons for excluding any data or subjects, sample size computation or how sample size was determined, referenced measurement instruments and quality control measures, summary details of statistical methods, and for randomized clinical trials include method of randomization;

4. Report of the **results** following the same order presented in the methods for clarity;
5. **Discussion** of the results should be compared with other published data of a similar nature using current literature along with implications of the results for further research or possible clinical application. For example, what do the results mean for the topic being investigated? In addition, a paragraph describing the strengths and limitations of the study should be included;
6. **Conclusions** should be succinctly stated and drawn only from reported results. They should not go beyond or overstate them. Implications for further research might be included;
7. Current and relevant peer-reviewed scientific **references**; and
8. **Tables/figures** with clearly written titles, headings, and footnotes that permit full interpretation without accompanying text

Appendix 3 Food categories for food record

Key	Food category	Foods recorded
1	Breads, cereals & grains	White bread Wholemeal bread Gluten-free (GF) bread Oats/porridge Grains (rice, quinoa, bagel) Bread, other (crumpet, naan, bagel) Crackers Low fibre cereal <5g/100g (cornflakes, rice bubbles, Cocopops, honey puffs) High fibre cereal >5g/100g (Special K, Sultana Bran, Weetbix, Nutrigrain, Toasted Muesli, Cheerios)
2	Milk, dairy products & alternatives	Regular milk Lite or low-fat milk Trim milk Soy milk Almond milk Cheese (cheddar, Colby, edam, cream cheese, processed, mozzarella, cottage) Yoghurt (assorted types, including coconut yoghurt) Up&Go

3	Fruit & vegetables	Fruit (strawberry, pear, nectarine, apple, mandarin, orange, banana, feijoa, grapes, kiwifruit, mango, pineapple, berries, tinned fruit, avocado, fruit-based smoothie) Non-starchy vegetables (sprouts, lettuce, onion, cauliflower, broccoli, cabbage, carrot, zucchini, kale, spinach, beans, tomato, mushrooms) Starchy vegetables (cassava, taro, kumara, potato)
4	Protein foods	Processed meat (sausage, bacon, ham, corned beef) Legumes (baked beans, chickpeas) Eggs (fried, scrambled, poached, boiled, omelette, frittata) Red meat (lamb, pork, beef) Chicken Protein powder Fish (mackerel, salmon, tuna)
5	Nuts, fats & seeds	Margarine Butter Nut butter (peanut, almond) Mayonnaise Oils (including rice bran, coconut, olive, canola, sesame, vegetable) Nuts (almonds, cashews, peanuts, brazil nut, hazelnut, pecan) Seeds (sunflower, pumpkin, flaxseed, chia seed, LSA) Coconut product (coconut flesh, oil, cream)

6	Discretionary breakfast foods (high fat or sugar)	Chocolate drink (chocolate milk, hot chocolate, milo) Noodles (e.g. 2 minute, mi Goreng, takeaway style) Soft drinks (Mountain Dew, Lemonade, Fanta, Ginger Ale, Coca Cola, energy drinks) Pies (includes Sausage rolls) Pizza French toast Burgers (includes McMuffins) Fried takeaways (includes fried chicken/fish/bread, fries, hashbrown) Sweets (lollies, chocolate) Cocorice Chips (doritos, grain waves, vege chips) Ice cream (Cornetto, gelato) Bakery food (Doughnut, cake, biscuit, scone, sticky buns, muffin) Pancakes/crepes Custard Nutella Snacks (muesli bar, chips)

Appendix 4 Food categories for breakfast buffet

Food category	Foods provided at buffet
Breads, grains and cereals	White bread Wholegrain bread Oats Crackers (breakfast crackers) Low fibre cereal <10g fibre (Ricies, Skippies, Honey Puffs) High fibre cereal (Weetbix, Light n Tasty, Toasted Muesli, Natural Muesli, Nutrigrain)
Milk, dairy and alternatives	Regular milk Trim milk Yoghurt Cheese Up & Go
Fruit & vegetables	Fruit (apple, banana, fruit salad cup)
Nuts, seeds and fats	Butter Margarine Nuts Nut butter (peanut butter)
Discretionary breakfast foods	Muesli bar Bakery foods (Muffin, Chocolate chip cookie) Hot chocolate sachet

Foods excluded from food group analysis	Sugar Marmite Strawberry jam Latte sachet – caramel/vanilla b Instant coffee Peppermint tea Green tea Black tea Juice, twist Juice, splash (50% water)

Appendix 5 Methods for participant recruitment

The Pacific Island female groups were targeted throughout Auckland using pamphlets, posters, word of mouth, emailing lists and social media. Specifically this included the patient database at the public health organisation (PHO) The Fono medical centre in West Auckland, Pacific contacts at Massey University, Pacific Health Magazine, university clubs, sporting clubs and social media advertisement pages for Massey University and Waitemata District Health Board.

Appendix 6 Additional FoodWorks methods

Raw ingredients were entered with a conversion factor so that the appropriate cooked portion was entered. Recipes provided were entered as individual ingredients in the 'recipe' section on Foodworks 7, alongside the number of servings.

Appendix 7 Study population

Group	Included for breakfast observation (n (%))	Included for 5-day food record (n (%))
Obese	89 (63)	83 (57)
Overweight	18 (13)	29 (20)
Normal	35 (24)	34 (23)
Total	142	146

Obese = BMI ≥30

Overweight = BMI 25.0-29.9

Normal = BMI 18.5-24.9

Appendix 8 Food group servings from food record

Food group	Number of servings (n (%))					
	0	**1**	**2**	**3**	**4**	**5+**
Breads, cereals and grains	22 (15.0)	31 (21.2)	30 (20.5)	26 (17.8)	17 (11.6)	20 (13.7)
Milk, dairy and alternatives	26 (17.8)	37 (25.3)	26 (17.8)	20 (13.7)	16 (11.0)	21 (14.4)
Fruits and vegetables	73 (50.0)	30 (20.5)	16 (11.0)	9 (6.2)	4 (2.7)	14 (9.6)
Protein foods	81 (55.5)	32 (21.9)	15 (10.3)	8 (5.5)	7 (4.8)	3 (2.1)
Fats, nuts and seeds	71 (48.6)	35 (24.0)	16 (11.0)	13 (8.9)	5 (3.4)	6 (4.1)
Discretionary foods	68 (46.6)	33 (22.6)	21 (14.4)	14 (9.6)	3 (2.1)	7 (4.8)

Appendix 9 Food group servings from breakfast buffet

Food group	Number of servings (n (%))		
	0	**1**	**2+**
Breads, cereals and grains	47 (33.1)	79 (55.6)	16 (11.3)
Milk, dairy and alternatives	26 (18.3)	70 (49.3)	46 (32.4)
Fruits and vegetables	79 (55.6)	58 (40.8)	5 (3.5)
Protein foods[1]	0	0	0

Fats, nuts and seeds	73 (51.4)	55 (38.7)	14 (9.9)
Discretionary foods	50 (35.2)	53 (37.3)	39 (27.4)

[1]*Protein foods were not available at the breakfast observation*