Impact of a school meal programme on the dietary intake of children, aged 9-11 years, in a low decile school in South Auckland, New Zealand

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Abstract

Background: The prevalence of the multiple burdens of malnutrition, characterised by the coexistence of obesity and undernutrition, is increasing worldwide, including in New Zealand (NZ). These lead to inadequate growth and development towards adulthood due to associated non-communicable diseases and micronutrient deficiencies. The current food environment contributes towards reduced access to nutritionally adequate meals. Therefore, nutrition programmes, policies and guidelines have been developed by government bodies such as the Ministry of Health and charitable trusts. Feed the Need (FTN), is a school meal programme that provides lunch meals to children in decile one and two schools in South Auckland, NZ.

Aim: The aim of my thesis is to explore the effect of a school meal programme on children's (9-11 years) dietary intake during school hours in a low decile school in South Auckland, NZ. School staff and children's perceptions of the school meal programmes will also be evaluated.

Methods: Eighty-two children completed self-administered food records under supervision for two weeks. FTN meals were offered to all children on alternate days (FTN week) during week one, with FTN meals being absent in week two (non-FTN week). Dependent t-tests, Kruskal Wallis and post-hoc tests were used to analyse energy, macronutrient and micronutrient intake during school hours. Dietary intake for boys and girls during school hours was compared to 40% of the NZ Nutrient Reference Values (NRVs) and the United Kingdom (UK) dietary guidelines. This was to identify whether the children's dietary intake met current recommendations. In addition, dietary intake for all children was compared between food sources including dairy, home, school food programmes, FTN and other food sources. Two focus groups were conducted with school staff and children to identify their perceptions of the school meal programme.

Results: Dietary intake was higher in energy, carbohydrate, dietary fibre, sugars, protein, total and saturated fat, calcium and iron during the FTN week ($p<0.05$) in

comparison to the non-FTN week. Girls did not meet dietary fibre recommendations during non-FTN week when compared to 40% of the dietary guidelines, whereas boys did not meet dietary fibre recommendations in both weeks. Boys and girls exceeded total fat intake recommendations by 15% and 21% during the FTN week, respectively. Overconsumption of saturated fat intake during the FTN and the non-FTN week was also observed. This is likely attributed to the local food environment, which allows easy access to unhealthy discretionary food items such as crisps, corn snacks, biscuits, cookies and pies. In addition, use of cheap cuts of meat in FTN meals increases their saturated fat content. During the FTN week children consumed food from all sources and did not use one food source as their major food provider. In contrast, during the non-FTN week food from home was the major food source for the children's dietary intake during school hours.

Conclusions: FTN meals add to the children's usual dietary intake and contribute towards the oversupply of energy, total and saturated fat. Modifications of FTN meals are required to reduce the saturated fat content of the meals. To reduce the prevalence of childhood obesity and undernutrition, implementation of school food and meal programmes should accompany interventions that are designed to reduce the intake of unhealthy discretionary foods.

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Abbreviations

Acronym	Full form
AMDR	Average Macronutrient Distribution Range
BMI	Body Mass Index
CVD	Cardiovascular Disease
EAR	Estimated Average Requirement
ECE	Early Childhood Education Centre
EER	Estimated Energy Requirement
FIS	Fruit in Schools
INFORMAS	International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support
MoH	Ministry of Health
NCD	Non-communicable disease
NRVs	Nutrient Reference Values
NSLP	National School Lunch Program
NZ	New Zealand
PEM	Protein Energy Malnutrition
SBP	School Breakfast programme
SES	Socioeconomic status
UK	United Kingdom
US	United States
WHO	World Health Organization

Chapter 1: Introduction

1.1 Background

Nutrition is essential during the critical stages of childhood, as optimal nutrition is essential for adequate growth and development towards adulthood. Nutritional requirements change throughout the different life stages and are justifiably different between children and adults (Ministry of Health, 2012). In addition, children accounted for ~20% of the total New Zealand (NZ) population, in 2015 (Statistics New Zealand, 2015). In an environment with limited food and nutrition, the body's physiological response is to delay growth (Cameron & Bogin, 2012). Therefore, the Ministry of Health (MoH) has developed the food and nutrition guidelines, which outline evidence-based nutrient and physical activity recommendations.

The multiple burdens of malnutrition are defined as the coexistence of obesity and undernutrition and related non-communicable diseases (NCDs), among individuals and populations, across different life stages (World Health Organization, 2016a). Adequate nutrition during childhood is essential as excessive food intake can cause childhood obesity or overweight while inadequate food intake can lead to undernutrition and malnutrition (Mahan, Escott-Stump, & Raymond, 2011; Tanumihardjo et al., 2007). Childhood obesity is defined as the Body Mass Index (BMI) of >30kg/m^2 at 18 years and specified for exact age from 2-18 years by the International Obesity Task Force. For example, for a 9-year-old child a BMI of >22.71kg/m^2 is equivalent to >30 kg/m^2 in adults and is considered obese (Cole & Lobstein, 2012; World Obesity, 2016). In NZ, one in nine (11%) children were obese in 2014/15 which consisted of 15% Maori and 30% Pacific children (Ministry of Health, 2015).

The increasing childhood obesity trend is highly attributed to the food environment, which is defined as the physical availability, quality, promotion, cost of food, policies in place and socio-cultural beliefs related to food (Ni Mhurchu et al., 2013). In addition, the current food environment is defined as obesogenic due to its obesity promoting characteristics. These include the production of energy-dense and nutrient lacking

foods that are affordable and efficiently marketed (Boyd A. Swinburn et al., 2011; Vandevijvere, Swinburn, Food, Obesity/non-communicable diseases Research, & Support, 2014). Children who are obese or overweight at younger ages are more likely to continue this trend into adulthood (Cunningham, Kramer, & Narayan, 2014; D. Freedman et al., 2008; D. S. Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007). This trend is of concern as obesity has been associated with Cardiovascular Disease (CVD) (D. S. Freedman et al., 2007; Han, Lawlor, & Kimm, 2010), pulmonary disorders (Gilliland et al., 2003), diabetes and cancer (Lim et al., 2013; World Health Organization, 2013).

Another factor that contributes towards inadequate childhood nutrition is food insecurity, which is the loss of complete access to enough food for an active healthy lifestyle that is acceptable and safe for each individual (Drewnowski & Darmon, 2005; Ministry of Health, 2003). Food insecurity has been associated with poor diet quality as it leads to reduced food quantity as income depletes, eventually developing into nutrient deficiencies (Bloem, Semba, & Kraemer, 2010). Research suggests that individuals in need prioritise foods that are energy dense and nutritionally poor (I Darnton-Hill & Cogill, 2010; Ruel, Garrett, Hawkes, & Cohen, 2010). Furthermore, this pattern is observed in low income countries, which are experiencing a nutrition transition with an increased consumption of high fat, energy dense foods and a sedentary lifestyle (Barry M Popkin, 2001). This is a serious issue due to its significant contribution towards undernutrition with 795 million people undernourished worldwide (FAO, IFAD, & WFP, 2015).

1.2 Justification for this study

It has been shown that having lunch can have a positive influence on the behaviour of a child. In addition, consuming lunch has been shown to improve working memory in children whereas having no lunch has showed memory impairment (Schroeder et al., 2015). Food insufficiency has been linked with negative effects on a child's academic record and psychosocial outcomes (Alaimo, Olson, & Frongillo, 2001; Riggs, Chou, Spruijt-Metz, & Pentz, 2010). This shows the importance of food consumption within a school environment, where cognitive stimulation is continuously required. In addition,

the food and nutrition guidelines have been developed to allow adequate childhood growth and development. As a result, it would be beneficial to identify whether the children's dietary intake during school hours meets dietary recommendations. Currently, there is no NZ research that analyses and compares the dietary intake of children between differing food sources during school hours. This would allow identification of whether school meal programmes impact the children's standard diet including consumption of any energy-dense foods.

School meal programmes aim to reduce childhood hunger in children from low socioeconomic areas. The introduction of healthier foods in school, such as a salad bar or through school meal programmes, has been found to increase fruit and vegetable consumption and decrease fat consumption in the United States (US) (Hendy, Williams, & Camise, 2005; Slusser, Cumberland, Browdy, Lange, & Neumann, 2007). Therefore unsurprisingly, school meal programmes have been considered a strategy to battle childhood obesity and undernutrition (Moffat & Thrasher, 2016). However, there is limited research investigating the impact of school meal programmes on the dietary intake of children, in NZ. In addition, the perceptions of the school staff involved and children towards the school meal programmes will be evaluated.

For the purposes of this thesis school food programmes are defined as any programmes that provide food items to the children during school hours. These include Kidscan, Milk in Schools, Fruit in Schools and a breakfast programme. Whereas, a school meal programme provides a meal such as a lunch meal to the children during school hours. The school meal programme analysed in this thesis is Feed the Need (FTN), which is a charitable trust that provides soups, stews and casseroles to children in decile one and two schools (Feed the Need, 2016).

1.3 Problem statement

The multiple burdens of malnutrition and related health consequences are increasing worldwide. The current food environment has a major role in reducing access to nutritionally adequate meals and hence impacting a child's growth and development. School is an ideal environment to improve access to healthier meals while addressing

socioeconomic disparities and status'. Therefore, school meal programmes such as Feed the Need (FTN) have been developed and aim to reduce hunger in school-aged children. However, there is limited NZ research evaluating the effect of school meal programmes on the dietary intake of children from low decile schools.

1.4 Aim of this study

To investigate the impact of a school meal programme on the dietary intake of children in a low decile school in South Auckland and to evaluate the perceptions of school staff and children about the benefits of the school meal programme.

1.4.1 Specific Objectives

Identify the benefits of the school meal programme in children aged 9-11 years through:

1. Analysis of the nutritional intake during school hours using self-administered food records and FoodWorks software to assess whether the children's dietary intake meets the nutritional requirements and recommendations of the Ministry of Health.
2. Analysis of the contribution of specific food sources towards the dietary intake of the children during school hours through comparison of nutritional analysis between the food sources.
3. Identification of the perceptions of school staff and children towards school meal programmes by conducting focus groups.

1.5 Structure of this thesis

This thesis is structured intro four chapters: The first chapter discusses the background related to childhood nutrition. This chapter also describes the justification for the research conducted. The second chapter is the literature review, focusing on childhood nutrition, growth and development. It provides a narrative of the current issues preventing adequate growth and development of children. The review also reflects on the current initiatives that aim to improve childhood nutrition and reduce the prevalence of childhood obesity and malnutrition, in NZ and internationally.

Chapter three is the research study, written as a manuscript and includes an abstract, introduction, methodology, results, discussion and conclusions section. This chapter focuses on the research conducted with the aim to identify the impact of school meal programmes on the dietary intake of children, aged 9-11 years old. Chapters two and three have been formatted in accordance with the requirements for a manuscript to be submitted in the Public Health Nutrition Journal. The final chapter provides an overview of conclusions and final recommendations. It reflects on how the aim and objectives of this thesis were achieved and summarises the findings for each specific objective. In addition, strengths and limitations of the research are discussed followed by final recommendations for future research.

1.6 Researcher's contribution

Name	**Contribution to the thesis and research**
Nitasha Walia	Main researcher, involved in and supervised data collection, data entry in FoodWorks and other software used, conducted nutritional and statistical analysis, interpretation of results and main author of thesis.
Prof. Bernhard Breier	Main academic supervisor, application for ethics, development of study strategy and design, provided support with interpretation of results and reviewed thesis. Provided funding support through the Massey University Research Fund.
Dr. Carol Wham	Academic co-supervisor, provided support with development of the food record template, interpretation of results and reviewed thesis.
Samantha Ansell	Collaborating researcher involved in and co-supervised data collection and assisted with data entry into FoodWorks and other software used.
Alex Lawn, Amanda Whitford,	First year Dietetics students who assisted with data

Bani Ichhpuniani, Emily Sycamore, Lisa Henderson	collection through self-administered food records at Manurewa South School.
Arysbeth Pinata Santana, Jeanette Rapson	Third year nutrition students who assisted with data collection through self-administered food records at Manurewa South School.

Chapter 2: Childhood nutrition, growth and development: A review from a public health perspective

2.1 Introduction

Poor childhood nutrition has been associated with health conditions during adulthood (Cunningham et al., 2014; D. Freedman et al., 2008; D. S. Freedman et al., 2007; Jääskeläinen et al., 2012; Kaikkonen et al., 2013). Overweight and obesity are most commonly a result of over-nutrition, through the excess consumption of energy dense and nutrient lacking foods (Ministry of Health, 2015; Y. C. Wang, McPherson, Marsh, Gortmaker, & Brown). Childhood obesity has increased immensely over the past few years in New Zealand (NZ) and throughout the world (Ministry of Health, 2015; Y. C. Wang et al.). Recent research indicates that obese children are at an increased risk of developing diseases such as Type 2 diabetes, heart disease, and liver disease (Anderson et al., 2016). Although, the health risk factors associated with obesity are widely recognized, obese children are also exposed to psychosocial ramifications. Childhood obesity is a significant contributor to behaviour and emotional issues such as low self-esteem and depression (Cornette, 2008; Pizzi & Vroman, 2013). Obesity is also a major economic burden to the healthcare system with an estimated cost of $1 billion per annum, in NZ, including the lost productivity and costs to the society (B. Swinburn, Dominick, & Vandevijvere, 2014).

In addition, undernutrition is a concern due to its likelihood of further developing into micronutrient deficiencies that can alter growth. Poor nutrition can have a detrimental impact on the body's ability to fight infections. During an infection the immune system requires various nutrients and without these nutrients, the infection progresses (Robert E Black et al., 2008). This can compromise growth through appetite suppression, increased loss of nutrients and impaired nutrient absorption. Interestingly, improved nutrition can prevent the progression of an infection (Dewey & Mayers, 2011). Research also suggests that undernourished children are less sociable, attentive, more fearful and likely to have negative emotions in comparison to better nourished children (Baker-Henningham, Hamadani, Huda, & Grantham-McGregor, 2009). In addition, the coexistence of obesity and undernutrition describes the

multiple burdens of malnutrition at the individual, household and population level, across the lifespan.

2.2 Childhood nutrition

2.2.1 Nutrition guidelines and recommendations

The Ministry of Health (MoH) in NZ, have developed the food and nutrition guidelines for healthy children and young people aged 2 – 18 years, which outline nutrient and physical activity recommendations based on current evidence (Ministry of Health, 2012). These guidelines are designed to prevent any nutrient deficiencies and inadequate macro- and micronutrient intakes likely to contribute to certain chronic diseases (Cameron & Bogin, 2012). The MoH, in conjunction with the Australian Government, have also developed the Nutrient Reference Values (NRVs) for Australia and NZ, which provide recommendations for nutritional intake based on age and gender, as supported by current evidence (Ministry of Health, 2006). Table 2 outlines the key nutrients required for growth and development and their function in childhood nutrition.

Table 1: Key nutrients required for growth and development of children, aged 9-11 years.

Nutrient	Dietary intake recommendations for boys	Dietary intake recommendations for girls	Function
Energy[1] (kJ/day)	6800-7700	6400-7000	Adequate energy intake is required for daily physiological function of the human body. A balance of energy intake and expenditure is required for optimal growth throughout childhood (B. M Popkin, Adair, & Ng, 2012). Excessive energy intake can result in overweight or obesity and ultimately obesity-related co-morbidities. In contrast, inadequate energy intake can cause muscle wasting, stunting and over a longer timeframe, severe malnutrition. (Mann & Truswell, 2012).
Carbohydrates[2] (g/day)	242	227	Carbohydrates are the main energy source in a diet and they are required for cell and brain function (Ministry of Health, 2006, 2012). Dietary fibre is a non-digestible carbohydrate that improves satiety (Wanders et al., 2011) and has been shown to decrease serum cholesterol indicating a cardio-protective role in children (Ruottinen et al., 2010). Another form of carbohydrates is sugar and excessive consumption has been shown to increase waist circumference, reduce
Dietary fibre[4]	24	20	

Sugars[5]	-	-	high-density lipoprotein cholesterol (Kosova, Auinger, & Bremer, 2013) and increase weight (Te, Mallard, & Mann, 2013; Vartanian, Schwartz, & Brownell, 2007) in children.
Protein[3] (g/day)	31	24	Protein is required for building and repairing tissue. It can be used as an energy source similar to other macronutrients however its primary role is being the structural and functional element within cells. During growth and development, protein synthesis is dominant, to allow for muscle formation (Ministry of Health, 2006, 2012).
Fat[2] (g/day)	71	66	Fat is a source of fat-soluble vitamins such as Vitamin A, D, E and K and plays an important role in their absorption. It is also an essential precursor for various hormones and is part of the cell membrane structure in the human body (Ministry of Health, 2006, 2012). A low dietary fat intake has been associated with a lower body weight (Hooper, Abdelhamid, et al., 2015). In addition, high polyunsaturated fat and low saturated fat intake has been shown to reduce cardiovascular disease risk (Hooper, Martin, Abdelhamid, & Davey Smith, 2015).
Saturated fat[2] (g/day)	22	21	
Calcium[3] (mg/day)	800	800	Calcium is an essential mineral required for bone deposition and is involved in muscle contraction, blood clotting and nerve conduction (Greer & Krebs, 2006). Adequate calcium intake is essential to promote optimal bone mineral density

			and content formation during childhood (Ondrak & Morgan, 2007).
Iron[3] (mg/day)	6	6	Iron is required for haemoglobin production and oxygen transport in the body. Inadequate iron intake can result in low iron stores, which can lead to iron deficiency and eventually anaemia (Beard, 2001; Ministry of Health, 2006).

Dietary intake for boys and girls represents the nutrient reference values, unless otherwise specified:
[1]Estimated energy requirements for children, aged 9-11 years old, determined using a physical activity level of 1.4 (light activity),
[2]United Kingdom dietary recommendations for 7-10 year old children (Public Health England, 2016),
[3]Estimated average requirements for 9-11 year old childern,
[4]Adequate intake for children aged, 9-13 years old,
[5]No nutrient reference values present for children aged 9-11 years old in New Zealand (Ministry of Health, 2006, 2012).

Table 1 outlines the key nutrients required during childhood growth and devlopment. It also outlines the dietary recommendations for children aged 9-11 years and function of the key nutrients.

2.2.2 The importance of adequate nutrition during childhood

Adequate nutrition is essential for optimal childhood growth and development. However, poor nutrition is becoming increasingly prevalent, as seen in childhood obesity and undernutrition. Table 1 highlights the key nutrients required for adequate growth during childhood. Micronutrient deficiencies are more common in developing countries although calcium and iron deficiencies are still prevalent in developed countries such as NZ. One of the main sources of calcium are dairy products such as milk and children, aged 3-10 years old, who avoided milk have been found to be shorter with a smaller skeleton and a lower bone mineral density (Ruth E Black, Williams, Jones, & Goulding, 2002). In addition, low calcium intake has been linked with development of rickets in children. This is linked with the catabolism of Vitamin D in the body during low calcium intake (Munns et al., 2006; Pettifor, 2004; Thacher, Fischer, Isichei, & Pettifor, 2006).

Another essential micronutrient is iron, which can be consumed in two forms: haem iron from animal food sources and non-haem iron through plant sources. Haem iron has a higher absorption rate compared to non-haem iron (Pasricha et al., 2010) therefore vegetarian children are more at risk of developing an iron deficiency (Gorczyca, Prescha, Szeremeta, & Jankowski, 2013). Iron deficiency in school-aged children has been found to negatively affect school achievement such as lower math scores (Halterman, Kaczorowski, Aligne, Auinger, & Szilagyi, 2001).

Nutrition interventions during early childhood have been linked with better economic outcomes during adulthood such as increased wages (Hoddinott, Maluccio, Behrman, Flores, & Martorell, 2008). In addition, a follow-up assessment for the Turkish Early Enrichment Project found that nutrition education and interventions during early childhood resulted in improved educational achievement, occupational status and age of initial employment (Kagitcibasi, Sunar, Bekman, Baydar, & Cemalcilar, 2009). A longitudinal analysis on Filipino children found that nourished children performed better at school due to increased productivity. This was also attributed to these children entering school at an earlier age and having a larger timeframe to grasp concepts and learning (Glewwe, Jacoby, & King, 2001). In contrast, stunting during

childhood has been negatively associated with formal employment during adulthood (Carba, Tan, & Adair, 2009).

2.2.3 The obesogenic environment

The obesogenic environment refers to all obesity-prompting influences within the environment. These can include access to unhealthy food items or beverages, marketing of unhealthy food items, brands or fast food outlets and pricing of food, which can result in excess consumption of energy-dense and nutrient lacking foods (Lake, Townshend, & Alvanides, 2010). Importantly, research indicates that excess consumption of energy-dense and nutrient lacking foods contributes to weight gain and an increased Body Mass Index (BMI) (Guallar-Castillón et al., 2007; Y. Wang et al., 2007). In addition, consumption of large portions and sugar-sweetened beverages increases the risk of children being overweight or obese (Brown, Kelly, & Summerbell, 2007). A cross-sectional study conducted in New York city (n = 624,204 school children) aimed to identify the relationship between individual and school-level sociodemographic characteristics and obesity. Multivariate analysis found that children receiving discounted or free school lunches were at an increased risk of being overweight or obese. This was attributed to energy-dense foods being cheaper in comparison to healthier alternatives such as fruits and vegetables (Rundle et al., 2012).

A major contributor to the obesogenic environment is the clear majority of fast food. A comprehensive longitudinal study, involving 20,000 school-attending adolescents in the United States (US), identified a positive relationship of fast food consumption and breakfast skipping on weight gain (Niemeier, Raynor, Lloyd-Richardson, Rogers, & Wing, 2006). Data from the US School Nutrition Dietary Assessment Study showed that a significant proportion of vegetable consumption was from French fries (Ronette R. Briefel, Crepinsek, Cabili, Wilson, & Gleason, 2009). In addition, the CASPIAN-IV study (2015), conducted in Iran, highlighted the relationship between the consumption of sugar sweetened beverages and increased likelihood of obesity, in students aged 6-18 years (Payab et al., 2015). The European Youth Heart Study found similar results (Zheng et al., 2014).

Food marketing to children has been associated with food preferences, consumption patterns and purchasing requests (Cairns, Angus, & Hastings, 2009; Cairns, Angus, Hastings, & Caraher, 2013; Hastings, McDermott, Angus, Stead, & Thomson, 2006). This is of concern as the prevalence of childhood overweight and energy intake has been positively associated with the number of advertisements to children's television. In addition, a stronger observation was observed when the advertisements focused on unhealthy discretionary foods (Halford, Boyland, Hughes, Oliveira, & Dovey, 2007; Tim Lobstein & Dibb, 2005).

2.2.4 Non-communicable diseases

Non-communicable diseases (NCDs) such as cardiovascular disease (CVD), type 2 diabetes, coronary heart disease and cancers (World Health Organization, 2013, 2016c) are increasing globally (Lim et al., 2013). In addition, nutrition-related risk factors such as obesity and overweight are significant contributors to NCDs (Robert E Black et al., 2013; Guh et al., 2009; World Cancer Research Fund / American Institute for Cancer Research, 2007). Obesity and overweight also contribute significantly towards increased risk of hypertension (Khan, Lala, Patil, Mathur, & Chauhan, 2010; Raj, Sundaram, Paul, Deepa, & Kumar, 2007) and raised blood cholesterol levels in children and adolescents (Tim Lobstein & Jackson-Leach, 2006). Furthermore, CVD risk factors such as obesity or overweight and hypertension are more likely to be present in children from families with a low socio-economic status (Angelopoulos, Milionis, Moschonis, & Manios, 2006).

Elevated blood pressure is a major risk factor for CVD (Kearney et al., 2005). Similar to obesity, an elevated blood pressure in childhood carries into adulthood (Juhola et al., 2011). However, a healthy diet can prevent this trend. Reduction of elevated blood pressure has been associated with increased vegetable consumption and socioeconomic status (SES). Household SES cannot be modified from a public health perspective but increasing the exposure to vegetables can be achieved (Kelly et al., 2015). The Bogalusa heart study highlighted the adverse effects of childhood obesity, where an elevated childhood BMI was independently associated with increased CVD

risk (D. Freedman et al., 2008). Interestingly, reduced intake of sweetened beverages has been associated with a lower blood pressure in adults (Chen et al., 2010).

2.2.5 Undernutrition in children

The World Health Organization (WHO) define the multiple burdens of malnutrition as the presence of both obesity and undernutrition or diet-related NCDs, within an individual, household or populations, across different life stages (World Health Organization, 2016a). In terms of undernutrition, starvation results in unintentional weight loss and is caused by Protein Energy Malnutrition (PEM) (Reilly, 2002; Younis, Ahmad, & Badpa, 2015). PEM is the most common form of undernutrition and can be classified into Marasmus or Kwashiorkor malnutrition (Malina, Bouchard, & Bar-Or, 2004). In addition, muscle wasting, stunting and micronutrient deficiencies such as iron, vitamin A, iodine and zinc are the main characteristics of malnutrition (Müller & Krawinkel, 2005). The WHO highlighted the prevalence of stunting at 159 million people worldwide. The WHO also identified that approximately 1 of 13 children had muscle wasting in 2014, globally (United Nations Children's Fund, World Health Organization, & World Bank Group, 2015).

The prevalence of undernutrition in hospitalised children ranges from 5% - 40% in developed countries (Aurangzeb et al., 2012; Doğan et al., 2005; Joosten & Hulst, 2011) and is predominant in areas with poverty and deprivation (Uauy, Corvalan, & Dangour, 2009). It has also been associated with increased risk of mortality from infectious diseases such as diarrhoea, pneumonia and measles (Bhutta et al., 2013; Robert E Black et al., 2013). Importantly, undernutrition has various consequences for children including poor cognitive functioning (Kar, Rao, & Chandramouli, 2008a, 2008b; Susan P. Walker et al., 2011) and emotional, and behavioural issues during adolescence (Susan P Walker, Chang, Powell, Simonoff, & Grantham-McGregor, 2007).

2.2.6 The multiple burdens of malnutrition

The multiple burdens of malnutrition are the coexistence of undernutrition with obesity and overweight or diet-related NCDs, across the different life stages. These can exist at the individual level, such as in an overweight adult who was stunted during

childhood, and in a household, through an obese mother but an underweight child. The multiple burdens of malnutrition can also occur on a population level, which is the presence of both undernutrition and obesity in the same community or country (World Health Organization, 2016a). Low-income countries such as Thailand and South Africa are experiencing the obesity transition with high overweight levels (B. M. Popkin & Gordon-Larsen, 2004) and increased prevalence of NCDs such as diabetes and CVD (Ian Darnton-Hill, Nishida, & James, 2004). Additionally, many countries such as Latin America and Vietnam are facing the multiple burdens, with presence of undernutrition and micronutrient deficiencies as well as an increasing trend of obesity and chronic diseases (Le Nguyen et al., 2013; Uauy & Monteiro, 2004; World Health Organization, 2016b; World Health Organization Regional Office for the Western Pacific, 2015). Therefore, the need for an intervention that targets the multiple burdens is evident.

2.3 Determinants of childhood health in low decile areas

2.3.1 Socioeconomic disparities

A wide range of evidence suggests that a low SES encourages sedentary behaviours and prevents physical activity (Brodersen, Steptoe, Boniface, & Wardle, 2007; Fairclough, Boddy, Hackett, & Stratton, 2009; Haerens et al., 2007; Hanson & Chen, 2007; Tandon et al., 2012). A low-income family's home environment can include increased screen time and reduced physical activity. A longitudinal, observational cohort study found that low-income households were 13% and 14% less likely to have bikes and jump ropes, respectively. Furthermore, they were more likely to have television (38%) and DVD (25%) players in their bedrooms, which also identified that these children were more likely to spend time watching television with the family, compared to physical activity (Tandon et al., 2012).

As identified above, SES correlates with the likelihood of developing obesity during childhood (Aceves-Martins, Llaurado, Tarro, Sola, & Giralt, 2016; Singh, Kogan, Van Dyck, & Siahpush, 2008; van Stralen et al., 2012), due to its association with reduced physical activity and poorer diets (Hanson & Chen, 2007). Sedentary behaviour and snacking are risk factors for being overweight during childhood (Lioret, Touvier, Lafay,

Volatier, & Maire, 2008). An example would be snacking while watching television, which is likely to promote weight gain. In addition, children aged 7-10 yearsold were more likely to eat big portions during main meals, which may result in over-consumption. NZ research shows that television viewing correlates to an increased frequency of snacks, fast foods, soft drinks and sweet foods consumption (Utter, Scragg, & Schaaf, 2006). Unsurprisingly, households in a low socioeconomic area also have increased exposure to fast food outlets, which sell energy-dense nutrient lacking foods (Smoyer-Tomic et al., 2008) and have been associated with a low fruit and vegetable intake (Kamphuis et al., 2006).

NZ Maori and Pacific children are at an increased risk of being overweight or obese (E. C. Rush, Plank, Davies, Watson, & Wall, 2003). Research indicates that Maori adults are more likely to consume fast-food in comparison to NZ Europeans and Pacific adults (Smith, Gray, Fleming, & Parnell, 2014). This pattern could be similar in children as the parents are often in control of what food is consumed. Additionally, Smith et al. (2014) noted a lack of research identifying factors that contribute to this fast-food consumption in Maori. Affordable and convenient food options need to be available for families with limited time, independent of their socioeconomic status. Fast-food options with better nutrition are recommended, which could be implemented using school meal programmes for children.

2.3.2 Accessibility and Availability

Dietary intake can be significantly affected by the level of access and availability of food. A cross-sectional study (n=534 school aged children) identified an association between the availability of unhealthy foods and eating behavior (Haerens et al., 2007). It is becoming common practice for schools in low socioeconomic areas to be surrounded by various retail food outlets. This is easy access to food for school attending children. However, the issue is the quality of food being sold by the food outlets and bought by the children. This is part of the current food environment and has been associated with unhealthy dietary behaviours and poor health outcomes (Booth, Pinkston, & Poston, 2005; Holsten, 2009; Ni Mhurchu et al., 2013).

Unhealthy discretionary foods are snacks and beverages that are energy-dense but low in nutrients. These can include food from the vending machine, school tuck shops or any other food bought off the school premises. A cross-sectional US study with 287 schools and 2,314 children found that those who ate school lunches consumed less energy (159 calories) from unhealthy discretionary foods in comparison to children who did not eat school lunches (201 calories) (Fox, Gordon, Nogales, & Wilson, 2009). Therefore, a child can be eating unhealthy discretionary foods as a replacement for a missing lunch.

Research has identified that the increase in fast-food purchasing (Hearst, Pasch, & Laska, 2012) and consumption (Boone-Heinonen et al., 2011; R. Wang & Shi, 2012) is associated with high-fast food density. This association is found present in both the home and school environments (He et al., 2012). In addition, fast-food outlets, takeaways and convenience stores have been associated with a heavier BMI (Jennings et al., 2011). The ratio of healthy to unhealthy food outlets is an important factor and improved access to healthier food items could play a role in battling the obesity epidemic (Ni Mhurchu et al., 2013). It has been found that predominance of healthy food stores located near homes promotes fruit and vegetable purchasing behavior (Mason, Bentley, & Kavanagh, 2013). Stocking the retail food stores with healthier food alternatives, with point-of-purchase promotions, has also been shown to improve dietary intake of children (Gittelsohn et al., 2010). Furthermore, supermarket and fruit and vegetable store density has been associated with a lower weight status among children (Jennings et al., 2011). Therefore, macro-level policies and regulations would be of most value to improve the food environment currently surrounding children (He et al., 2012).

2.4 Current initiatives to improve childhood nutrition

2.4.1 Obesity and its related non-communicable diseases

The International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support (INFORMAS) is a global framework designed to monitor and support interventions developed to promote healthy food

environments and reduce obesity and NCDs. It consists of three modules: process, which focuses on monitoring of public and private sector organisational policies and actions. The impact module monitors characteristics of food environments such as food labelling, prices, composition, provision, retail, promotion, and trade and investment. Finally, the outcome module focuses on the quality of the population diet, risk factors such as behavioural, physiological and metabolic factors, and health outcomes (Kumanyika, 2013; B. Swinburn et al., 2013; Vandevijvere et al., 2014).

The WHO have developed recommendations including healthy eating guidelines for schools and phasing out of unhealthy discretionary foods from the school environment (Nishtar, Gluckman, & Armstrong, 2016; World Health Organization, 2016d). In addition, the WHO have identified several risk factors including low fruit and vegetable, high salt and high saturated fat intake as well as physical inactivity. Recommendations for the national system response include reducing unhealthy food marketing to children and national policies limiting saturated and trans fat within the food supply (World Health Organization, 2013, 2016c).

Various policies have been implemented in NZ and internationally with an aim to reduce obesity and its related NCDs. NZ and other countries such as Australia, China and Brazil require packaged foods retailers and producers to display nutrient content on packaging. South Korea, Ireland, Spain and United Kingdom (UK) have undertaken legislative action on food marketing to children. Mexico has established several food policies including school food guidelines, junk food tax, food reformulation such as reduced fat content of milk distributed through programmes (Hawkes, Jewell, & Allen, 2013; Vandevijvere & Swinburn, 2015). Although, national governments may find it difficult to establish policies due to resistance from commercial food and media sectors (Fraser, 2013; Moodie et al., 2013). Competition for funding between several sectors e.g. between health preventative services can also be a barrier, as governments are required to prioritise sectors that receive the funding. In addition, strong evidence for benefits from proposed policies is difficult to provide without implementation (Vandevijvere & Swinburn, 2015).

Food environments should be improved and a need for policies and action has been established (Lal, Moodie, Ashton, Siahpush, & Swinburn, 2012). The national government is required to aid in reducing obesity and NCDs (Hawkes et al., 2013; B. Swinburn et al., 2013; Boyd A. Swinburn et al., 2011), as it is a major stakeholder with the power and authority to initiate a significant change. NZ has been commended for developing dietary guidelines that are food based, reduction of trans fat in foods, interpretive front of pack labelling such as the health star rating and systems-based actions for communities such as healthy families. In addition, NZ has various programmes that aim to improve childhood nutrition, which are summarised in Table 2.

NZ has also been criticised for limited or lack of implementation for various food policies such as for reducing unhealthy food marketing to children. There needs to be support for healthy food choices and local communities to reduce the prevalence of unhealthy food outlets, especially around schools and early childhood education centers (ECEs) (B. Swinburn et al., 2014). Furthermore, there is a need for policies that monitor investment and trade agreements due to their ability to impact availability, affordability and accessibility of food (Friel, Gleeson, et al., 2013; Friel, Hattersley, et al., 2013).

2.4.2 Strategies to reduce the multiple burdens of malnutrition

In an aim to reduce the multiple burdens of malnutrition globally, the WHO has designed six targets with the 2025 deadline. These target maternal, infant and young child nutrition (World Health Organization Regional Office for the Western Pacific, 2015) and includes reduction in prevalence of stunting in children under five by 40%. Another target is that childhood overweight and muscle wasting should be maintained, if not reduced (World Health Organization, 2014). An action plan for obesity prevention and improved childhood nutrition for the western Pacific and east Asian regions including NZ has been developed, which establishes the same targets by 2025. Recommendations focusing on children include reduced unhealthy food and beverage marketing to children and food and beverage standards for schools (World Health Organization Regional Office for the Western Pacific, 2015). These have not yet been

undertaken in NZ however, they are underway internationally. An example is the National Healthy School Canteen Guideline implementation in 2010, in Australia (Government, 2013; Tanya, Melissa, & Maggie, 2016). Additionally, South Africa has voluntary guidelines that school canteens can undertake (Hawkes et al., 2013).

2.4.3 Programmes and policies in New Zealand

The MoH have developed various programmes to improve nutrition in schools. In October 2015, MoH initiated the childhood obesity plan, which includes 22 targeted initiatives, increased support and broad population approaches. This plan targets those below 18 years of age and aims to prevent and manage obesity. It is structured to include public information, health sector, food industry, physical activity, sports and education (Ministry of Health, 2016a). In addition, NZ has various government-led and organisation-led programmes that aim to improve childhood nutrition, as summarised in Table 2.

Table 2: Summary of New Zealand programmes aiming to improve childhood nutrition.

Programme - developers	**Description**	**Findings/Aimed outcome**
Government-led programmes		
Active Families - Ministry of Health (Wood & Johnson, 2015)	Community based health programme targeting low-income families that provides free education on healthy eating and physical activity through sessions.	• Majority (85%) of the involved families (n = 138) identified positive changes in their child including increased confidence, willingness to participate in activities and improved fitness. • Children understood the importance of physical activity (93%) and healthy eating (83%). • Majority (86%) of the families were found to have made changes to their diets and 95% reported choosing healthy food and drinks for consumption.
Fruit in Schools (FIS) - Ministry of Health (Boyd, Dingle, Campbell, King, & Corter, 2007)	Fruit is provided to primary schools for distribution to children during school hours.	• Improved children's knowledge about healthy eating. • Approximately, 57% (n=591) of the children were aware of 5+ a day, which increased to 77% one year after FIS was implemented. • Consumption of fizzy drinks decreased from 35% to 7%, before FIS and one year after implementation, respectively. • Supports healthy eating school environments e.g. changes in classroom practices or student behaviours.

Organisation-led programmes

Project Energize - Sport Waikato (E. Rush et al., 2012)	Energizers support schools and its staff to develop initiatives that improve physical activity of children and healthy eating.	• Reduced levels of elevated blood pressure and body fat accumulation over 2 years, among 5 and 10 year olds. • Prevalence of being obese or overweight was reduced by 31% in younger and 15% in older children in comparison to non-participants, five years after the trial. • BMI was reduced by 3% and 2.4% in younger and older children, respectively. • Physical fitness was higher among participants and these improvements were observed for boys and girls, both Maori and non-Maori children as well as different socio-economic statuses.
School breakfast programmes (SBP) such as KickStart - Fonterra and Sanitarium (Mhurchu et al., 2012)	Weetbix and milk are provided to primary schools for distribution to children during school hours.	• No significant impact on the children's school attendance, academic records, grades, behaviour and food security. • Significant correlation was found between SBP and short-term hunger. However, it was also found that children who attended school at least 50% of the time the SBP was available, were more likely to attend school.

Organisation-led programmes (outcomes not yet researched)

Cook for life - Nestle (Nestle, 2016)	Nutrition education and cooking classes for young people in South Auckland. Recipes and education resources are also provided.	• Aims to teach students how to prepare healthy, tasty and affordable meals.
Heart Start* - Heart Foundation (Heart Foundation, 2016a)	Curriculum-based programme developed for schools that wish to promote healthy eating and physical activity. Contains 11 modules including tuckshop rules/guidelines, fuelled4life and tools and resources to improve the local food environment.	• Aims to achieve a healthier learning environment for students through an award system for schools.
Just Cook - NZ Nutrition Foundation (Just cook, 2016)	Promotes healthy cooking events in the community by providing cooking kits with recipes, ingredients and spot prizes.	• Aims to promote healthy cooking in the community. Meals prepared in cooking challenges are required to be affordable and family friendly.

*Heart foundation offers three awards that start from Heart start followed by Heart start excellence and the final award is Heart schools. Schools can register online and are required to complete specific modules to achieve the award (Heart Foundation, 2016b).

2.5 The school environment

2.5.1 The importance of nutrition in the school environment

The school environment is a significant contributor towards determining the dietary intake of children and is the ideal environment to reduce childhood obesity (Ronette R. Briefel et al., 2009; Fox, Dodd, Wilson, & Gleason, 2009). A cross-sectional study conducted in 2009 aimed to understand this impact. The study recruited a total of 2,314 children from 287 schools in the US. It was found that children from schools with no food stores or lunch bars had a lower consumption of sugar-sweetened beverages. Furthermore, to reduce the intake of unhealthy discretionary foods characteristics of a school meal programme were found to be ideal (Ronette R. Briefel et al., 2009). A systematic review identified that school based nutrition programmes increased the fruit and vegetable intake in children (Howerton et al., 2007). Interestingly, the 7 studies reviewed used a theoretical framework including the social cognitive theory, as part of their research.

The school environment should be targeted when promoting healthy eating behaviour in school-aged children. A cross-sectional study identified that children without access to à la carte menu in their school were more likely to meet requirements for fruits, vegetables and total, and saturated fat intake. It was also identified that foods high in fat and sugar-sweetened beverages, such as foods found in vending machines, were displacing fruits and vegetables (Kubik, Lytle, Hannan, Perry, & Story, 2003). This highlights the importance of exposure to certain food types and its impact on eating behaviour. Increasing the variety and nutrient quality of foods offered, could be a solution. Kubik et al. (2003) suggested that creativity and a means to generate revenue for the school food service will be essential for healthy school meal programmes to be successful and sustainable.

A systematic review aimed to identify the effectiveness of interventions in the school environment for promoting fruit and vegetable intake. The review recruited 19 cluster studies and found somewhat controversial results in comparison to other research. Multicomponent interventions and free fruit and vegetables were found to be non-effective. Although, computer-based interventions, such as educational computer

games, were effective at increasing the fruit and vegetable consumption. In addition, this was suggested to be a cheaper alternative to other interventions within the school. It should be noted that the recruited studies were conducted internationally and not in NZ, hence findings might not be applicable to this demographic (Delgado-Noguera, Tort, Martínez-Zapata, & Bonfill, 2011).

2.5.2 Barriers to healthy eating in schools

Barriers to promoting healthy eating include financial, economic, social factors and the school environment. Research indicates that school staff strongly preferred to serve meals that coincided with the children's preferences, as meals served during school hours may have been their only proper meal during the day. Furthermore, societal pressure to serve meals similar to the children's home environment was perceived by the schools. These meals are often what can be afforded by the families e.g. fast or processed foods and hence healthy eating is not supported within the local community. Another challenge was providing healthy meals on a budget. The increasing cost of food ingredients including vegetables presents as a barrier to providing meals that are both healthy and palatable. It was felt that increased funding of fruits and vegetables would be required to overcome barriers to healthy eating in schools (Lucarelli et al., 2014).

A cross-sectional survey conducted in Australia interviewed 479 primary school principals. The aim was to identify the perceptions towards fruit and vegetable breaks and the barriers preventing implementation. Majority (99.5%) of the principals had a positive attitude towards the school being a healthy eating environment for the children. However, 41% of the principals reported that the demanding school curriculum resulted in limited time being available to implement these programmes. In addition, lack of parental support and limited availability or cost of fruits and vegetables were highlighted as major barriers (Nathan et al., 2011).

2.5.3 School meal programmes

School meal programmes aim to prevent child hunger, especially in children from low socioeconomic areas. They are designed to provide nutrition to the most vulnerable

children and improve their growth and development (Ruel, Alderman, Maternal, & Group, 2013). In the US, school lunches must contribute to one-third of a child's daily protein, calcium, iron, vitamin A and C requirements while breakfast should contribute one-fourth (Department of Agriculture, 2012). Bhutta et al. (2013) indicate that approximately 1 million deaths can be prevented in children, aged <5 years, with population access to evidence-based nutrition interventions globally. A systematic review conducted on 18 studies found that school-fed children gained an average of 0.39 kg more than control group over 19 months; with a weight gain of 0.71kg more over 11.3 months in lower quality studies. School attendance also improved with an average increase of 4-6 days per child. Furthermore, the children showed improvements in mathematics and short term cognitive tasks (Kristjansson et al., 2009).

It has been proposed that educational outcomes are affected in four ways: physical, cognitive, behavioural development and through school environment (Sorhaindo & Feinstein, 2006). School meal programmes improve the nutritional status, concentration and cognitive function, enrolments, attendance and educational outcomes in school-aged children (Adelman, Gilligan, & Lehran, 2008; Belot & James, 2011; Kazianga, de Walque, & Alderman, 2014). Feed me better is a school meal programme that aims to provide affordable and nourishing school meals for children in Greenwich. It was identified that children who participated in this programme improved in Mathematics, English and Science (Belot & James, 2011). Children spend a significant amount of their time at school, which contributes significantly to their caloric intake. Therefore, alterations made to the food offered at school can impact intake significantly (Dietary Guidelines Advisory Committee, 2010).

2.5.4 Perceptions of school staff and children towards school meal programmes

The number of school meal programmes has increased markedly over recent years. To improve the dietary quality and compliance towards school meal programmes it is important to understand the perceptions of those involved. A feasibility analysis aimed to identify the perceptions of children, aged 7-10 years old, school staff and caterer's, towards the school meals (Day, Sahota, Christian, & Cocks, 2015). The study found that

meals consumed at school were expected to be similar to food served at home. Food was thought to be of lower quality if made off school site, which can impact likelihood of consumption. Some children associated increased freedom of choice with control over meal selection while others felt that removing the choice would mean promoting consumption of fruit and vegetables daily. In many instances providing filling meals takes priority over providing a nourishing meal. The concern appears to be regarding the immediate needs of children e.g. hunger and not long term health (Moore, Murphy, Tapper, & Moore, 2010).

Another qualitative study, conducted in Greece, identified that parents had many barriers to preparing healthy meals including financial issues, lack of time for food preparation and resistance by their children towards these meals. Majority of the parents from the recruited 14 schools felt school meals programmes had a significant impact in their child's daily intake. This was especially true for fruit, milk and bread consumption and promoted healthy eating. It was further reported that meals being provided at school reduced their stress of having to prepare a meal daily. The same ideas were reflected in the children's perceptions. Furthermore, they could acknowledge the financial benefits the meals provided for their families (Dalma et al., 2016).

2.5.5 School food programmes in New Zealand

There are currently no government-funded school meal programmes in NZ, although there are food programmes such as Fruit in Schools (FIS) (Table 2). In addition, there are various organisation-led school food and meal programmes in NZ that aim to support school-aged children in low-socioeconomic areas. FIS programme was developed by an interagency group which includes seven different agencies including the MoH and Ministry of Education. This food programme aims to increase fruit and vegetable intake to promote health in school-aged children and increase awareness of healthy eating and physical activity. The programme provides free fruit to low-decile school throughout NZ (Ministry of Health, 2016b). In addition, Fonterra is involved in providing free milk to primary school children throughout NZ (Anchor, 2017; Fonterra, 2017).

KidsCan is an Auckland based charitable trust, which feeds over 21,000 children per week. Through the Food for Kids programme, KidsCan provides nut bars, fruit pottles, raisins, baked bean cans, bread loafs and spreads to low-decile school across NZ. In addition, the trust runs other programmes including Raincoats for Kids and Shoes for Kids (KidsCan, 2017). School meal programmes are also increasing and aim to feed children in low-decile schools. Feed the Need (FTN) is another charitable trust that provides lunch meals to six, decile one and two, primary schools in Manurewa and Takanini, Auckland. This school meal programme provides lunch meals on 2-3 days per week during the winter terms, which includes a variety of soups, stews and casseroles, which are served with bread rolls (Feed the Need, 2016).

2.6 Summary

This review of the literature highlights the key issues preventing adequate childhood nutrition, growth and development. Childhood obesity is a major risk factor in the development of various NCDs, such as Types 2 diabetes, CVD and cancer. It is a preventable risk factor that incurs a major financial cost to the healthcare system annually in NZ. The key driver of childhood obesity is the current obesogenic food environment. This is attributed to the increased availability of cheap, energy-dense and nutrient lacking food items that are well marketed. In addition, obesity is becoming increasingly prevalent in the presence of undernutrition as defined by the multiple burdens of malnutrition, which is increasing worldwide as well.

Undernutrition is a concern due to the risk of developing into micronutrient deficiencies, muscle wasting and stunting during childhood. These have shown to result in poor outcomes such as wages earned during adulthood. Therefore, various nutrition programmes, guidelines and policies aiming to improve childhood nutrition have been developed by government bodies such as the Ministry of Health, in NZ. In addition, nutrition programmes have been developed by charitable trusts however, there is a need for improvement. Interventions targeting the multiple burdens are evident and future interventions should aim to reduce the children's access to unhealthy discretionary foods, reduce unhealthy food marketing to children and

promote consumption of healthier food items, especially in the low socioeconomic areas. School is an ideal environment to introduce healthier food items and beverages to promote lifelong healthy eating behaviours as dietary intake during school hours contributes significantly towards children's total daily intake. School food programmes, such as FIS, have been found to significantly improve children's diet quality during school hours. However, there is limited research evaluating the effect of school meal programmes on the children's dietary intake during school hours, in NZ.

Chapter 3: Impact of a school meal programme on the dietary intake of children in a decile one school in South Auckland

3.1 Abstract

Objectives: To investigate the impact of a school meal programme on the dietary intake of children, aged 9-11 years old, in a decile one school in South Auckland. To evaluate the perceptions of school staff and children about the benefits of the school meal programme.

Design: Cross-sectional study design. Self-administered food records were used to collect dietary intake information of 82 children. Feed the Need (FTN), a school meal programme, was available during week one of data collection (FTN week) but absent during week two (non-FTN week). Dietary intake during school hours was compared to 40% of the New Zealand Nutrient Reference Values and United Kingdom dietary guidelines to assess whether the children's dietary intake during school hours met recommendations. The dietary intake for all children was compared between food sources. Two separate focus groups were conducted with school staff and children.

Setting: Decile one school in South Auckland, New Zealand

Subjects: Children, aged 9-11 years old.

Results: During the FTN week, the children consumed more energy, carbohydrate, dietary fibre, sugar, protein, total and saturated fat, calcium and iron ($p<0.05$). Dietary fibre recommendations were only met by girls during the non-FTN week (9.13 ± 7.39g). Total, and saturated fat were overconsumed by boys and girls during both weeks. During the FTN week, the children consumed food from all food sources whereas during the non-FTN week, home was the major food source. In addition, children were consuming unhealthy discretionary foods such as crisps, corn snacks, biscuits, cookies and pies from the dairy during the FTN week and the non-FTN week.

Conclusions: FTN meals were contributing towards the excessive intake of energy, total and saturated fat and were being consumed in addition to the children's usual

dietary intake. Modifications of the FTN meals are required to reduce their saturated fat content. In addition, interventions targeting the local food environment are necessary to reduce the children's access to unhealthy discretionary foods.

3.2 Introduction

In New Zealand (NZ), population estimates of 2015 indicated that children accounted for ~20% of the total population (Statistics New Zealand, 2015). The Ministry of Health (MoH) identified that, in 2014/15, 11% of the children were obese and 22% were overweight (Ministry of Health, 2015). In addition, low socioeconomic status is one of the risk factors contributing towards childhood obesity (Aceves-Martins et al., 2016; Ministry of Health, 2015; Singh et al., 2008; van Stralen et al., 2012). In absence of interventions, it has been estimated that by 2025, 268 million school-aged children (5-17 years) may be overweight, including 91 million children being obese, worldwide (T. Lobstein & Jackson-Leach, 2016).

A major contributor toward childhood obesity and undernutrition is the current obesogenic environment which allows easy access to energy dense and nutrient lacking foods that have a low cost and are efficiently marketed (Boyd A. Swinburn et al., 2011; Vandevijvere et al., 2014). Children from schools in low socioeconomic areas are the most at risk due to the density of unhealthy food stores being highest near schools in most deprived areas. In addition, a convenience store is, on average, located within 500 metres of schools in most deprived areas (Vandevijvere, Sushil, Exeter, & Swinburn, 2016). The prevalence of the multiple burdens of malnutrition, defined as the co-existence of over- and undernutrition, is increasing worldwide (Tzioumis & Adair, 2014). In developed countries, such as NZ, prevalence of undernutrition ranges from 5% - 40% in hospitalised children (Aurangzeb et al., 2012; Doğan et al., 2005; Joosten & Hulst, 2011). Furthermore, in 2014, the World Health Organization (WHO) highlighted that 1 in 13 children had muscle wasting globally (United Nations Children's Fund et al., 2015).

School food programmes, such as Kidscan, Milk in Schools, Fruit in Schools and breakfast programmes, have been developed to reduce childhood hunger and provide food items to low decile schools (Anchor, 2017; Fonterra, 2017; KidsCan, 2017; Ministry of Health, 2016b). In addition, school meal programmes such as Feed the Need (FTN) have been developed with the same purpose and provide lunch meals during school hours (Feed the Need, 2016). Internationally, school meal programmes

have been used to improve childhood nutrition and reduce prevalence of childhood obesity and malnutrition (Cullen, 2016). However, in NZ, the contribution of school meal programmes towards the children's dietary intake is largely unknown. This is especially important as children can consume 30% - 40% of their total daily intake during school hours (Bell & Swinburn, 2004; Regan, Parnell, Gray, & Wilson, 2008; Walton, Hannon, & Flynn, 2015). Therefore, the overall aim of this study was to investigate the impact of FTN meals on the dietary intake of children in a low decile school in South Auckland. Perceptions of the school staff and children, about the benefits of school meal programmes, will also be evaluated.

3.3 Methodology

3.3.1 Study Design

This cross-sectional study aimed to assess the impact of a school meal programme on the dietary intake of children aged 9-11 years old (n=82) from Manurewa South School (Decile 1), in South Auckland. The dietary intake for all children was collected through supervised self-administered food records. Figure 1 shows an overview of the study design for food record collection. These data were collected from three different classrooms, room 13, 14 and 15, for children in grades 5-6, during the FTN week days and the non-FTN week days. FTN meals were provided to children during the winter term on alternate days during week one including Monday, Wednesday and Friday. School food programmes available at the school included Kidscan, Milk in Schools, Fruit in Schools and a breakfast programme (Refer to Appendix A for a list of the school food programmes and FTN, their availability throughout the week and the foods they provide).

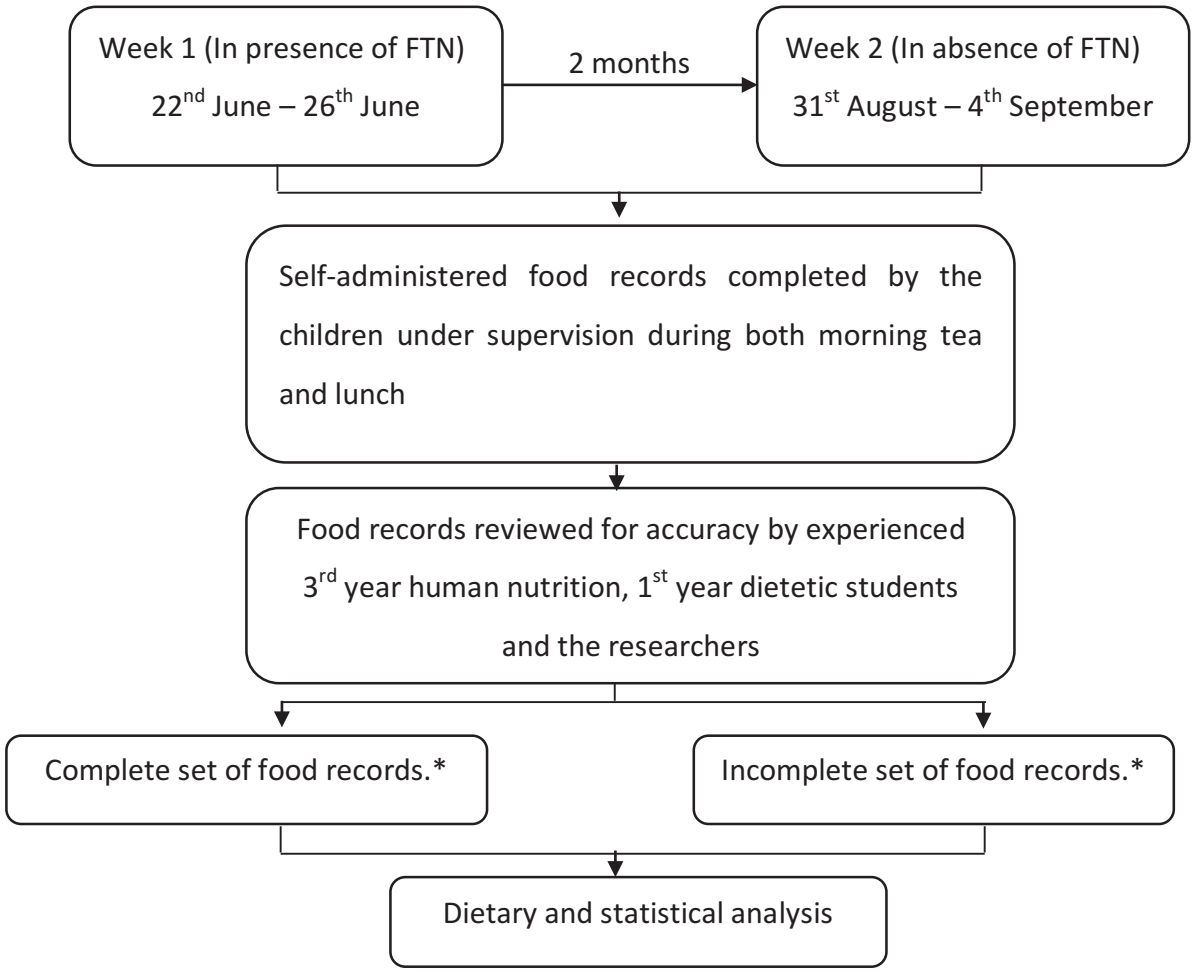


Figure 1: Overview of study design for food record collection

*A complete set included food records that contained information for both morning tea and lunch from each student on a specific day. Therefore, the complete set excluded any food records for which a student had missed either of the two data collection times for the day. An incomplete set included food records where a child had only completed either morning tea or lunch section of the food record for a specific day.

3.3.2 Ethical approval

A screening questionnaire and notification of low risk research involving human participants was completed and accepted in 2014 by the Massey University Human Ethics Committee, as part of a similar study conducted in 2014. This was a low risk study with an identical description of ethical issues present; hence amendment of the previous ethics application was granted. Following discussions with the principal and senior staff of the school, students to be involved in the study were notified by the school on behalf of the research team.

3.3.3 Participants

Participants included in this study were children aged 9-11 years old (n=82) of NZ European, Maori or Pacific ethnicity from a decile one school in South Auckland. Children who identified as NZ European, Afghanistani, American, Indian, Irish or Scottish were allocated to the NZ European and Others group. Whereas, children who were Maori or both NZ European and Maori were placed in the Maori group. Children who identified as being Pacific or Fijian were allocated to the Pacific group. Finally, children who identified as Maori and Pacific were allocated to the Pacific group based on conversations with thesis supervisors and the school staff.

3.3.4 Data Collection

Self-administered food records were used in this study, with a section for the children's demographic details, food items or beverages consumed during morning tea and lunch and food source for each food item or beverage consumed (Refer to Appendix C for the food record template). A brief introduction to completing the food records was provided to all children by the researchers prior to the first session of data collection. Prior to the start of data collection, the nutrition students were also introduced to the food records and the importance of accuracy and consistency of

data collected was emphasised. These nutrition students were third year human nutrition students, first year dietetic students and the researchers involved.

During each of the data collection periods, food records were used to collect dietary data from Monday to Friday. These food records were completed after each meal time (morning tea and lunch time) to meet the classes' different schedules (Figure 2). Packaged food sizes were used to guide the children for portion sizes of selected foods. These included crisp packets of 20g (small), 40g (medium), 120g (large) and model snack packs from the local dairy consisting of a fruit drink bottle, fruit strings, a packet of small cookies, a packet of crisps or cheese rings and cream filled biscuits. The students completed the food records under the guidance of the nutrition students. A total of five well-trained nutrition students were present for data collection during each day. After each data collection session, the nutrition students reviewed the food records to ensure readability and accuracy.

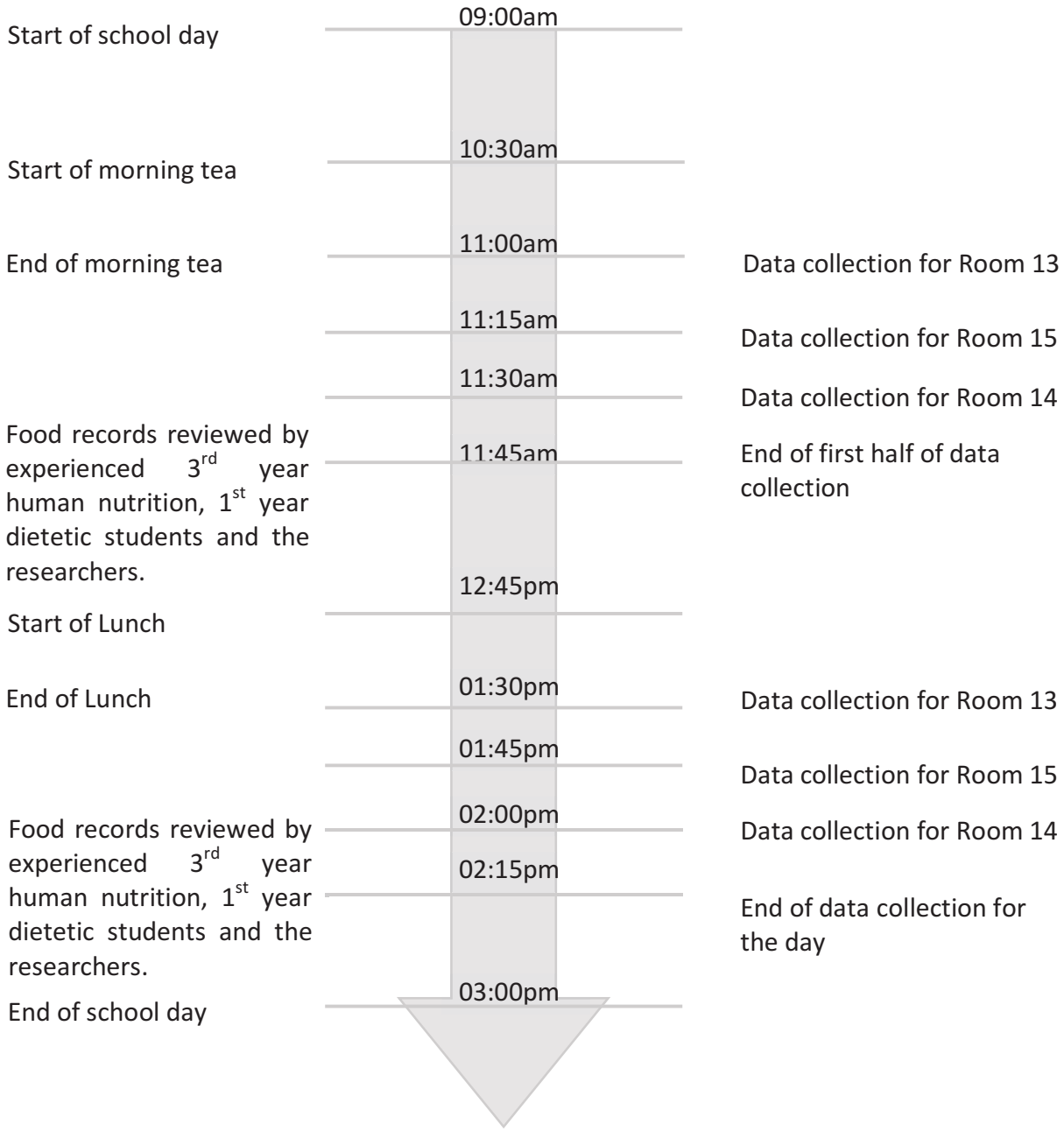


Figure 2: Data collection during a school day.

3.3.5 Dietary Analysis

Xyris software, FoodWorks 7.Ink was used to obtain the nutrient intakes from the food records for each child. The abridged database was used, which included food items from the New Zealand FOODfiles (2010) in the FoodWorks software. When the children did not recall food quantities, several assumptions were made (Refer to Appendix A for a full list of assumptions used). In addition, foods or drinks not available in the FoodWorks database were entered to their closest available match, which included adjustment for quantity if needed (See Appendix A for a detailed list of

the foods and quantities used). Additionally, food records from students that were fasting (n=2) were excluded from analysis for the days they undertook fasting, while students who did not eat anything during school hours or meal time due to a lack of food were included.

In NZ, there are no guidelines for dietary intake during school hours, although the recommendations for the United States (US) suggest that one-third of daily intake must be obtained from school lunches (Centers for disease control and prevention, 2011). Studies indicate that children consume approximately 30% - 40% of their total daily intake during school hours (Bell & Swinburn, 2004; Regan et al., 2008; Walton et al., 2015). However, dietary intake during school hours with a breakfast and a lunch meal programme can be upto 50% of the total daily intake in children (Cullen, 2016). Dietary intake within a low decile school is unknown however for the purposes of this study a guideline of 40% of the Nutrient Reference Values (NRV's) and the United Kingdom (UK) dietary guidelines was adopted. The upper range of 40% has been used, as it is predicted that children from a low decile school consume larger proportions of the total daily food intake during school hours in comparison to their intake at home.

Dietary intake during school hours, of boys and girls, was compared to 40% of the Estimated Average Requirements (EAR) for 9-13 year old children. An EAR estimates the daily nutrient requirements for 50% of healthy individuals in a specific age and gender group (Ministry of Health, 2006). Research indicates that children from low-income families have various barriers to regular exercise, such as financial and time management constraints by the parents (Holt, Kingsley, Tink, & Scherer, 2011; Quarmby & Dagkas, 2013). The school used in this study is decile one hence high proportion of children belong to a low socio-economic community. Therefore, a low physical activity level of 1.4 (sedentary) was used to estimate the dietary energy requirements for children included in this study. FTN recipes were also analysed individually in FoodWorks.

3.3.6 Statistical Analysis

IBM SPSS Statistics 22.0.Ink was used to analyse the students' characteristics and nutrient profiles. The results reported are based on the normality assumption of outcomes. This assumption is supported by the central limit theorem and no extreme values were found after descriptive analysis (Fitrianto & Hanafi, 2014). A sample size of >30 was hence considered "large" and reported as a mean ± standard deviation. The sample sizes were identified for the FTN week and the non-FTN week, then split and categorised by age, gender and ethnicity for each week.

Dietary intake for the children was analysed, to compare differences in intake between the FTN week and the non-FTN week. This was further categorised by gender, to compare the dietary intake for boys and girls to 40% of the NZ NRV's and the UK dietary guidelines. In addition, there are no NZ guidelines for intake of carbohydrate, sugars, total, and saturated fat in 9-11-year-old children. Therefore, UK dietary guidelines were used in addition to the NZ NRV's due to their similarities. Furthermore, for the purposes of this study it was important to identify whether total, and saturated fat intakes were adequate due to their strong association with heart disease (Hooper, Martin, et al., 2015). Databases with nutrient profiles from the complete set were used during statistical analysis for total dietary intake during school hours. Whereas, the incomplete set was used where morning tea and lunch were analysed separately. Dependent t-tests were used to identify whether FTN meals made a significant impact on nutrient intake. This was also specified for gender, morning tea, and lunch and day.

Dietary intake was also categorised by food source including dairy, home, school food programmes, FTN and other food sources. Other food sources included food items from peers, subway and unspecified food sources. Dependent t-tests were used to compare means during the FTN week and the non-FTN week. A p-value of <0.05 was considered statistically significant for all tests. Kruskal-Wallis and post-hoc tests were used to compare differences in dietary intake between the food sources during the FTN week and the non-FTN week. A p-value of <0.005 for the FTN week and <0.008 for the non-FTN week was considered statistically significant with a Bonferroni correction.

3.3.7 Focus groups

Two different focus groups (A and B) were conducted after data collection with food records was completed, at a time suitable for all the participants to attend. The purpose of the focus groups was to identify the perceptions of the school staff and children towards the school meal programme. In addition, both focus groups emphasised on school meal programmes and each focus group was overseen by one of the two researchers. Moderator guides were developed for use during the focus groups to provide guidance and a focus group outline to the researchers conducting each session (Refer to Appendix C for moderator guides used during each focus group).

The aim of session A was to conduct a focus group with school staff involved in the processes that provide food to the children during school hours. The school staff included teachers from Room 13, and 15 and the receptionist. The receptionist was included due to their heavy involvement with the parents and arranging food, and snacks for children with no food to consume during school hours. Open-ended questions were used to gather the participants' thoughts, feelings and beliefs about the school meal programme and their perceived benefits. Topics discussed included perceived benefits of FTN meals, FTN in relation to other school food programmes, likes and dislikes about FTN, improvements required in FTN and sustainability.

Session B aimed to identify the perceived benefits of food provided to the children during school hours. The session included two children from each of the three involved classrooms (n=6). In addition to the open-ended questions for discussion, an A3 paper and coloured markers were used during the session to allow the children to draw or write their thoughts, feelings and beliefs towards the food provided during school hours. Topics discussed included likes and dislikes of the FTN meals and thoughts in relation to unhealthy discretionary foods and wastage of any food. Both focus groups were audio recorded with consent from all participants. These recordings were used for analysis, which included identification of key themes in relation to school meal programmes.

3.4 Results

The findings from the research study will be presented in this chapter. Firstly, the participant characteristics are displayed. The dietary intake of the children is presented for the FTN week and the non-FTN week, which is compared to 40% of the NZ NRVs and the UK dietary guidelines for boys and girls. The dietary intake for all children is also compared between food sources during the FTN week and the non-FTN week. Main findings of the focus groups are presented last.

3.4.1 Participant Characteristics

Table 1 outlines the participant characteristics. Maori (44%) and Pacific (38%) children made up majority of the sample group. Additionally, there was an almost equal distribution of boys (54%) and Girls (46%) with an age range of 9-11 years.

Table 3: Participant demographics and Characteristics (n=82)

Ethnicity Group	n (%)
New Zealand European and Others[1]	15 (18)
Maori[2]	36 (44)
Pacific[3]	31 (38)
Gender	
Boys	44 (54)
Girls	38 (46)
Age	
9-years-old	35 (43)
10-years-old	37 (45)
11-years-old	10 (12)

[1]Other ethnicities included Afghanistani, American, Indian, Scottish and Irish.
[2]Maori ethnicity group included children who identified solely as Maori as well as those who identified as being both New Zealand European and Maori.
[3]Pacific ethnicity included children who identified as solely Pacific or Fijian as well as those who identified as being both Maori and Pacific.

3.4.2 Dietary intake compared during the feed the need week and the non-feed the need week:

The children's dietary intake was higher in the presence of FTN meals, compared to the week when FTN meals were absent (Table 4). The mean energy intake for the children was 3312.2kJ during the FTN week, which was 37% ($p<0.05$) higher in comparison to 2422.5kJ during the non-FTN week. In addition, the FTN meals

improved some aspects of the children's nutrient intake such as Iron, dietary fibre and protein, which were 73%, 55% and 52% higher during the FTN week, respectively. However, the sugar and saturated fat intake were also higher by 27% and 33%. The percentage of energy from protein was 13% higher during the FTN week, suggesting that when meals from FTN were provided, a higher proportion of energy was consumed through protein sources. In addition, FTN meals had no significant impact on the morning tea total energy, carbohydrate, dietary fibre, sugar, protein, total and saturated fat, calcium and iron intake. In contrast, the dietary fibre, protein, total and saturated fat, calcium and iron intake from the lunch meal was higher during the FTN week (Refer to Appendix B Table 7 for the dietary intake of the children during morning tea and lunch for the FTN week and the non-FTN week). Iron intake during the lunch meal was affected the most, as children's intake was 124% higher with FTN meals. In addition, protein and saturated fat intake was 106% and 103% higher during the FTN week.

Table 4: Mean daily nutrient intakes during school hours of the FTN week and the non-FTN week for children, aged 9-11 years, from a low decile school in South Auckland.

	Mean ± SD			
	FTN week	Non-FTN week	p-value	Increase (%)
Energy (KJ)	3312.2 ± 1922.9	2422.5 ± 1536.6	**0.00**	37%
Carbohydrate total (g)	99.8 ± 59.1	75.7 ± 49.1	**0.00**	32%
Carbohydrate (% Energy)	51.1 ± 12.3	52.5 ± 11.3	0.22	
Dietary fibre (g)	9.04 ± 6.58	5.82 ± 3.53	**0.00**	55%
Total sugars (g)	47.1 ± 36.1	37.0 ± 31.2	**0.00**	27%
Protein (g)	26.1 ± 19.8	17.1 ± 14.5	**0.00**	52%
Protein (% Energy)	13.1 ± 5.4	11.6 ± 5.7	**0.00**	13%
Total fat (g)	30.9 ± 23.6	22.7 ± 17.3	**0.00**	36%
Fat (% Energy)	33.2 ± 12.0	32.8 ± 11.6	0.71	
Saturated fat (g)	14.1 ± 11.4	10.6 ± 9.9	**0.00**	33%
Saturated fat (% Energy)	15.1 ± 6.5	14.9 ± 6.6	0.75	
Calcium (mg)	301.7 ± 279.0	228.1 ± 187.2	**0.01**	32%
Iron (mg)	4.04 ± 3.76	2.34 ± 2.45	**0.00**	73%

Results are presented as mean ± standard deviation for the dietary intake of the children during the FTN week and the non-FTN week. P-values were calculated using

dependent t-tests. Percentage increase was calculated to report the increase from the non-FTN week to the FTN week, where differences ($p<0.05$) were identified.

3.4.3 Dietary intake compared during the feed the need days and the non-feed the need days:

The energy, carbohydrate and protein intake of the children was higher during the FTN days (Monday, Wednesday and Friday) of the FTN week compared to their respective days during the non-FTN week ($p<0.05$) (See Appendix B Table 8 for the nutritional analysis of the children's dietary intake during the FTN days and their resepective non-FTN days). In addition, dietary fibre intake was higher during the FTN week on Monday and Wednesday by 54% and 98%, respectively. Sugar intake was 108% higher on Friday during the FTN week compared to Friday during the non-FTN week. Total fat intake was higher by 144% on Wednesday and 98% on Friday during the FTN week compared to the non-FTN week. Saturated fat intake was also higher on Wednesday (150%) and Friday (110%) in comparison to their respective non-FTN days. Furthermore, calcium intake on Monday and Iron intake on Tuesday during the FTN week was 175% and 127% higher, respectively.

3.4.4 Dietary intake of boys and girls compared to the New Zealand nutrient reference values and the United Kingdom dietary guidelines:

One of the important findings of this study compares the dietary intake of boys and girls to 40% of the NZ NRV's and UK dietary guidelines for boys and girls, as shown in Table 5. Boys overconsumed energy by 265.4kJ in comparison to the upper range of the Estimated Energy Requirement (EER) during the FTN week, while under-consumed energy by 450.4KJ, compared to the lower range of the EER during the non-FTN week. Girls overconsumed energy by 567.0kJ during the FTN week. These results are consistent with the UK energy intake guidelines of 3040kJ for boys and 2840kJ for girls, as they are not significantly different to the upper range of the NZ EER of 3080kJ (boys) and 2800kJ (girls).

Dietary fibre intake was higher during the FTN week however boys did not meet the NZ recommendation of 9.60g during either week. Girls met the NZ and UK recommended intake of 8.00g only during the FTN week. Protein intake was also

higher during the FTN week although boys and girls met NZ recommendations of 12.40g and 9.60g during both weeks. This is consistent with the UK recommendations of 11.3g for boys and girls. The UK recommendations suggest that boys and girls aged 7-10 years should consume <28g and <26g total fat, respectively. However, this was over-consumed by boys and girls during both weeks. This finding was comparable with the saturated fat recommendation of <9g for boys and <8g for girls.

Calcium intake for boys and girls did not meet the NZ recommendations of 320mg during either week, however, the UK recommendations of 220mg was met by boys during the FTN week and girls during both weeks. In contrast, NZ recommedations for Iron of of 2.40mg were met for boys during the FTN week and for girls during both weeks. Although, the UK recommendation of 3.5mg were only met during the FTN week for boys and girls. In terms of the Average Macronutrient Distribution Range (AMDR), percentage of energy intake from protein did not meet the recommended range of 15-25% for boys and girls during both weeks, although percentage intake was higher during the FTN week. In addition, percentage intake from saturated fat was higher than the recommended <10% during both weeks for boys and girls.

Table 5: Mean daily nutrient intake of Boys and Girls during the FTN week and the non-FTN week in comparison to the recommended intake during school hours.

		Mean ± SD				Mean ± SD		
	Recommended intake for Boys	Boys during FTN week	Boys during non-FTN week	p- value	Recommended intake for Girls	Girls during FTN week	Girls during on-FTN week	p-value
Energy (KJ)	2720-3080[1], 3040[6]	3345.4 ± 2162.5	2269.5 ± 1443.5	**0.00**	2560-2800[1], 2840[6]	3367.0± 1877.1	2598.0 ± 1626.0	**0.00**
Carbohydrate (g)	na[5], 97[6]	96.8 ± 61.1	70.5± 44.1	**0.00**	na[5], 91[6]	103.1 ± 58.4	81.8 ± 53.8	**0.01**
Carbohydrate (% Energy)	45-65[4]	49.8 ± 13.4	52.1 ± 12.0	0.19	45-65[4]	51.9 ± 11.0	52.9 ± 10.6	0.5
Dietary fibre (g)	9.6, 8[6]	8.68 ± 6.65	5.28 ± 4.32	**0.00**	8[6]	9.13 ± 7.39	6.57 ± 3.53	**0.02**
Total sugars (g)	na[5]	42.5 ± 33.2	33.1 ± 22.3	**0.01**	na[5]	50.5 ± 38.6	41.6 ± 38.9	0.11
Protein (g)	12.4, 11.3[6]	27.5 ± 23.2	15.6 ± 11.8	**0.00**	9.6, 11.3[6]	25.9 ± 18.5	18.6 ±17.0	**0.00**
Protein (% Energy)	15-25[4]	13.6 ± 5.4	11.5 ± 6.2	**0.01**	15-25[4]	12.6 ± 5.3	11.7 ± 5.8	0.28
Total fat (g)	na[5], 28[6]	32.1 ± 28.5	21.5 ± 17.4	**0.00**	na[5], 26[6]	31.4 ± 22.2	23.6 ± 17.4	**0.01**
Fat (% Energy)	20-35[4]	34.0 ± 12.9	32.78± 11.8	0.52	20-35[4]	33.0 ± 11.2	32.7 ± 11.6	0.86
Saturated fat (g)	na[5], 9[6]	14.3 ± 12.2	10.2 ± 9.3	**0.01**	na[5], 8[6]	14.2 ± 11.0	11.0 ± 9.1	**0.02**
Saturated fat (% Energy)	<10[4]	15.5 ± 6.8	15.0 ± 6.7	0.61	<10[4]	14.9 ± 6.0	14.7 ± 6.4	0.80
Calcium (mg)	320.03, 220[6]	295.7 ± 294.5	210.8 ± 172.5	**0.03**	320.03, 220[6]	306.8 ± 282.8	237.1 ± 237.2	0.17
Iron (mg)	2.4, 3.5[6]	4.21 ± 4.52	2.12 ± 2.05	**0.00**	2.4, 3.5[6]	3.91 ± 3.84	2.93 ± 3.22	0.16

Results are presented as mean ± standard deviation for the dietary intake of boys and girls during the FTN week and the non-FTN week. P-values were calculated using dependent t-tests and compare the differences between the FTN week and the non-FTN week.

Recommended intake for boys and girls represents 40% of the estimated average requirement, determined using the nutrient reference values for 9-13 year olds, unless otherwise specified:
[1]Estimated energy requirements for 9-11 year olds determined using a physical activity level of 1.4 (light activity).
[2]Adequate intake for 9-13 year olds.
[3]Estimated average requirements for 9-11 year olds,
[4]Recommended average macronutrient distribution range for most normally growing healthy children and young people,
[5]Not applicable (na) as nutrient reference values not present for children, aged 9-11 years olds, in New Zealand (Ministry of Health, 2006, 2012).
[6]UK Dietary recommendations for 7-10 year olds (Public Health England, 2016).

3.4.5 Dietary intake compared between the different food sources for all children:

Dietary intake was categorised by food sources (dairy, home, school food programmes, FTN and other sources) and compared between the FTN week and the non-FTN week, as presented in Table 6. Energy, cabohydrate, sugar and iron intake from school food programmes for all children was higher the during the FTN week by 36%, 48%, 46% and 105% in comparison to the non-FTN week, respectively. Interestingly, saturated fat intake from home was 33% higher during the non-FTN week compared to the FTN week. During the FTN week energy was 170%, carbohydrate was 156% and total sugar intake was 201% higher for all children in comparison to the non-FTN week. In addition, total, and saturated fat and iron intake was 233%, 238% and 150% higher during the FTN week, respectively.

Another important finding of this study compares the dietary intake of children between food sources during the FTN week and the non-FTN week, as presented in Table 6. During the FTN week, home provided more energy at 30% of the total mean energy intake in comparison to dairy (18%) and FTN meals (26%). FTN meals provided more energy in comparison to the school food programmes (18%). In addition, school food programmes provided a higher mean energy intake in comparison to dairy although dairy contributed greater towards the variation of energy intake by 205.6kJ. Carbohydrate intake was higher from home at 33% of the total meal intake and school food programmes at 21% in comparison to dairy and FTN at 18% and 19%, respectively. FTN provided 36% of the total mean dietary fibre intake, which was higher in comparison to 23% from the school food programmes. In addition, home contributed towards 26% of the total mean dietary fibre intake, which was greater than 10% from dairy.

During the FTN week, food bought from dairy contributed least towards the children's total sugar intake at 17% in comparison to 32% from home and 30% from school food programmes. Total sugar intake from food brought from home (32%) was also higher than the meals provided by FTN (10%). Food from dairy also contributed least towards the children's protein intake at 13% of the total mean protein intake in comparison to 25% and 17% from home and school food programmes, respectively. Although, FTN

meals provided greater protein at 40% of the total mean intake in comparison to 17% from school food programmes. Additionally, food brought from home provided 28% of the total mean fat intake which was higher in comparison to food bought from the dairy at 19%. However, food from the dairy (19%) contributed greater towards the total fat intake in comparison to the food provided by the school food programmes (12%). Food brought from home was also higher in saturated fat at 26% compared to 19% from dairy. In addition, saturated fat intake from the dairy was higher in comparison to the school food programmes, which contributed towards 12% of the total mean intake. FTN meals provided more saturated fat (32%) in comparison to home (26%) and school food programmes (12%).

Home (23%) and school food programmes (31%) provided more calcium in comparison to food from dairy (10%) for all children during the FTN week. In addition, calcium intake from home during the non-FTN week was higher than intake from dairy at 23% compared to 10%, respectively. School food programmes also provided more calcium compared to dairy at 31% of the total mean calcium intake. During the FTN week, Home provided 44% of total calcium intake which was higher in comparison to 10% from dairy. Food from home and school food programmes contributed more towards iron intake at 26% and 17%, respectively, in comparison to food from dairy at 13% for all children during the FTN week. FTN meals provided more iron at 38% compared to 17% from school food programmes.

Interestingly, during the non-FTN week, Home contributed the most towards mean energy, carbohydrate and dietary fibre intake at 51%, 50% and 52%, respectively. In addition, protein (51%), total (52%), and, saturated fat (51%) and iron (62%) intake for all children was also greatest from home.

Table 6: Mean daily dietary Intake of children aged 9-11 years old, categorised by the source of the food provided, during the FTN week and the non-FTN week.

	Mean ± SD		
	FTN week	Non-FTN week	**p-value**[*]
Energy (kJ)			
Dairy	363.4 ± 941.0 (18)	365.4 ± 1020.2 (26)	0.97
Home	630.4 ± 1153.1 (30)	732.0 ± 1211.8 (51)	0.12
School food programmes[**]	366.6 ± 735.4 (18)	268.4 ± 593.4 (19)	**0.02**
FTN	539.2 ± 1243.0 (26)	Na	na
Other	170.1 ± 604.4 (8)	62.9 ± 352.4 (4)	**0.00**
p-value [&]	**0.00**[1,2,3,5,6,7,8,9]	**0.00**[1,2,3,4,6,8]	
Total mean intake	2069.0 ± 2890.8	1428.7 ± 2198.4	**0.00**
Carbohydrate (g)			
Dairy	11.0 ± 28.0 (18)	11.0 ± 32.6 (25)	0.99
Home	20.6 ± 36.0 (33)	22.3 ± 35.0 (50)	0.37
School food programmes[**]	13.1 ± 27.0 (21)	8.87 ± 19.71 (20)	**0.00**
FTN	11.4 ± 27.0 (19)	Na	na
Other	5.4 ± 19.2 (9)	2.09 ± 12.0 (5)	**0.00**
p-value[&]	**0.00**[1,2,3,5,6,7,8,9]	**0.00**[1,2,3,4,6,8]	
Total mean intake	61.6 ± 85.8	44.2 ± 68.8	**0.00**
Dietary Fibre (g)			
Dairy	0.46 ± 1.65 (10)	0.30 ± 1.11 (11)	0.05
Home	1.20 ± 2.55 (26)	1.40 ± 2.66 (52)	0.15
School food programmes[**]	1.08 ± 2.94 (23)	0.87 ± 2.01 (32)	0.22
FTN	1.69 ± 3.86 (36)	Na	na
Other	0.19 ± 0.74 (4)	0.12 ± 0.69 (4)	0.11
p-value[&]	**0.00**[1,2,3,6,8,9]	**0.00**[1,2,3,4,6,8]	
Total mean intake	4.72 ± 7.40	2.67 ± 4.45	**0.00**
Total Sugars (g)			
Dairy	4.87 ± 14.86 (17)	5.12 ± 19.4 (24)	0.81
Home	9.44 ± 19.52 (32)	9.19 ± 16.6 (43)	0.80
School food programmes[**]	8.70 ± 18.83 (30)	5.96 ± 12.18 (28)	**0.00**
FTN	3.00 ± 7.83 (10)	Na	na
Other	3.04 ± 12.39 (10)	1.01 ± 6.25 (5)	**0.00**
p-value[&]	**0.00**[1,2,3,5,6,7,8,9]	**0.00**[1,2,3,6,8]	
Total mean intake	29.1 ± 44.3	21.2 ± 37.2	**0.00**
Protein (g)			
Dairy	2.13 ± 6.57 (13)	2.17 ± 7.06 (22)	0.93

Home	4.00 ± 8.24 (25)	4.97 ± 9.52 (51)	0.07
School food programmes**	2.75 ± 5.32 (17)	2.21 ± 4.41 (22)	0.10
FTN	6.33 ± 15.05 (40)	Na	na
Other	0.79 ± 3.06 (5)	0.44 ± 3.08 (5)	0.06
p-value&	**0.00**[1,2,3,6,7,8,9]	**0.00**[1,2,3,4,6,8]	
Total mean intake	15.9 ± 23.9	9.76 ± 15.62	**0.00**
Total Fat (g) Dairy	3.70 ± 10.63 (19)	3.77 ± 10.7 (29)	0.90
Home	5.50 ± 13.26 (28)	6.92 ± 14.7 (52)	0.10
School food programmes**	2.38 ± 6.41 (12)	1.99 ± 5.85 (15)	0.36
FTN	6.07 ± 16.49 (31)	Na	na
Other	1.73 ± 6.62 (9)	0.52 ± 2.94 (4)	**0.00**
p-value&	**0.00**[1,2,3,5,6,7,8,9]	**0.00**[1,2,3,4,6,8]	
Total mean intake	19.3 ± 30.7	13.2 ± 22.5	**0.00**
Saturated Fat (g) Dairy	1.67 ± 5.04 (19)	1.82 ± 5.40 (30)	0.59
Home	2.32 ± 5.72 (26)	3.09 ± 6.66 (51)	**0.05**
School food programmes**	1.09 ± 3.20 (12)	0.92 ± 2.75 (15)	0.39
FTN	2.83 ± 7.74 (32)	Na	na
Other	0.88 ± 3.45 (10)	0.26 ± 1.57 (4)	**0.00**
p-value&	**0.00**[1,2,3,5,6,7,8,9]	**0.00**[1,2,3,4,6,8]	
Total mean intake	8.79 ± 14.09	6.08 ± 10.60	**0.00**
Calcium (mg) Dairy	15.6 ± 81.2 (10)	11.9 ± 51.7 (10)	0.40
Home	38.2 ± 111.5 (23)	50.3 ± 120.6 (44)	0.12
School food programmes**	50.3 ± 78.7 (31)	47.8 ± 76.2 (42)	0.81
FTN	47.8 ± 145.7 (29)	Na	na
Other	9.31 ± 44.1 (6)	5.16 ± 40.7 (4)	0.14
p-value&	**0.00**[1,2,3,5,6,7,8,9]	**0.00**[1,2,3,6,8]	
Total mean intake	163.5 ± 266.6	115.1 ± 194.2	**0.00**
Iron (mg) Dairy	0.28 ± 1.08 (13)	0.20 ± 0.81 (18)	0.17
Home	0.58 ± 1.46 (26)	0.71 ± 1.71 (62)	0.13
School food programmes**	0.39 ± 1.41 (17)	0.19 ± 0.76 (17)	**0.02**
FTN	0.84 ± 2.25 (38)	Na	na
Other	0.10 ± 0.43 (4)	0.04 ± 0.25 (4)	**0.00**
p-value&	**0.00**[1,2,3,6,7,8,9]	**0.00**[1,2,3,4,5,6,8]	
Total mean intake	2.23 ± 3.92	1.13 ± 2.27	**0.00**

Results are presented as mean ± standard deviation for the dietary intake of all children during the FTN week and the non-FTN week, as categorised by food sources

(dairy, home, school food programmes, FTN and other food sources. Other food sources included unspecified food sources, peers and subway. P-values used to identify the differences in the children's dietary intake between the FTN week and the non-FTN week were calculated using dependent t-tests. Values were significant at <0.05. Whereas, Kruskal-wallis and post hoc tests were used to calculate p-values that identified dietary intake differences between the food sources during the FTN week and the non-FTN week. Values were significant at <0.005 for the FTN week and <0.008 for the non-FTN week, after the bonferroni correction was used.

[*]Values represent differences between the FTN week and the non-FTN week from the food sources.

[&]Values represent difference between food sources during the FTN week and the non-FTN week:

[1]Dairy and Home

[2]Dairy and School food programmes

[3]Dairy and Other food sources

[4]Home and School food programmes

[5]Home and FTN

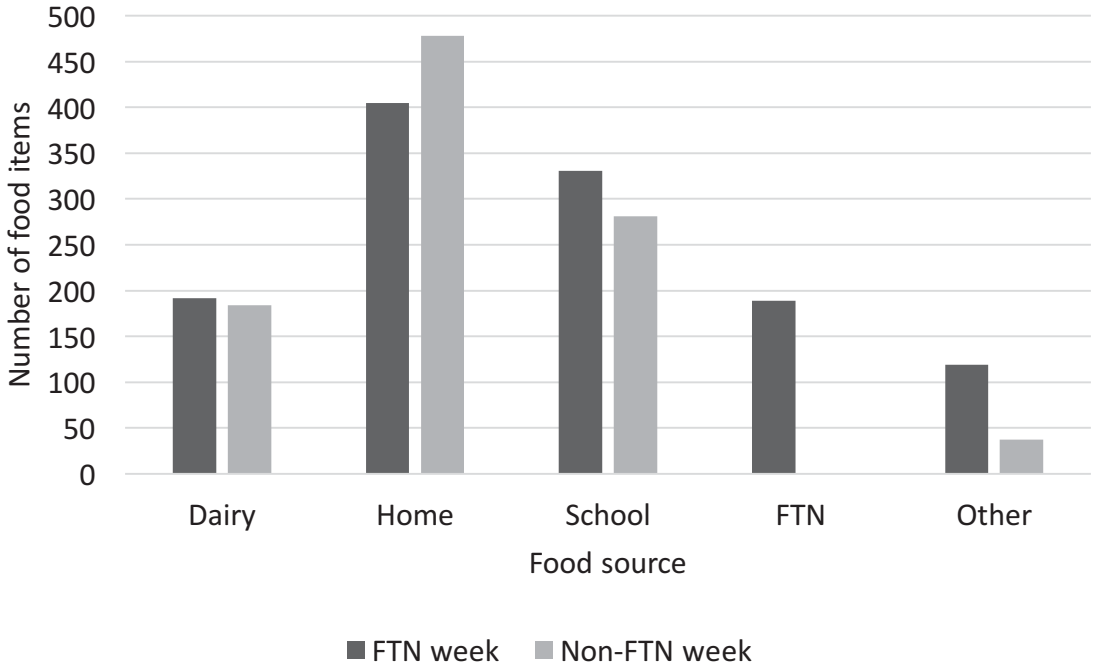
[6]Home and Other food sources

[7]School food programmes and FTN

[8]School food programmes and Other food sources

[9]FTN and Other food sources.

**School food programmes includes Kidscan, Fruit in Schools, Milk in Schools and a breakfast programme.



The figure above reports the total number of food items that were consumed by the children from all food sources (dairy, home, school, FTN and other) during the FTN week and the non-FTN week, calculated through counts. In addition, school includes food programmes such as Kidscan, Milk in Schools, Fruit in Schools and a breakfast programme.

Figure 3: Total number of food items being consumed from different food sources for all the children who completed the food records during the FTN week and the non-FTN week.

Energy, Carbohydrate, total sugar and iron intake from school food programmes was higher ($p<0.05$) during the FTN week (Table 6). This is further reflected in the number of food items being consumed (Figure 3), with 50 extra food items being consumed during the FTN week. During the non-FTN week, there was a higher reliance on food brought from home as 73 extra food items were consumed, in comparison to the FTN week. Interestingly, only saturated fat intake was affected with a 33% increase in intake from home during the non-FTN week. In addition, energy, carbohydrate, total sugar, total, and saturated fat and iron intake from other food sources was higher during the FTN week. The reported number of food items consumed was higher by 82 food items from other food sources, during the FTN week.

3.4.6 Focus group findings from the school staff:

The staff expressed appreciation for the school food and meal programmes and felt it filled a need for the children such as through providing bread.

> "*It's great to have the opportunity to have these offered to our school for our children. So we absolutely appreciate what's coming in…"*.

They further felt that it exposed the children to new foods that aren't normally available for them outside the school environment. This included foods such as pineapple, cherry tomatoes and honey that the children's families may find expensive to buy. In addition, FTN played an important role in developing the children's discipline and table manners.

> "*You also notice with our children too, that a lot of our children are walking around with food and it's like I think they do this at home that they just have their meal and carry on around and now they're sitting at the table*".

> "*The thing I also like is the responsibility that the children have dealing with waste as well they have to recycle the cartons, they have to fold the cartons…"*.

FTN meals provided support for the parents through providing meals for their children, in the time of greatest need.

> "*…the winter months seem to be the neediest months for the families…the parents appreciate it, that there is something for their children…something hot in their tummy*".

This was further extended into the home environment as the children could take leftovers home and educate their families about new foods that were consumed. Majority of the feedback from the school staff was positive although they also expressed their dislike about the current limited availability of FTN meals and potential absence of the programme in the future (Refer to Appendix B for the detailed decription of all the themes identified from the focus groups conducted with the school staff).

3.4.7 Focus group findings from the children:

The children held appreciation for the school food and meal programmes available to them and felt privileged to be part of their school.

> *"It makes me feel appreciative to have all of these things because not a lot of schools get things; I'm glad that our school got chosen to have these things".*

They further expressed the contribution of these programmes to their physical and emotional well-being. This was provided through satiety after meals and having enough energy to play. Their emotional well-being was further aided through improved food security that was experienced.

> "*They are so joyful…after all those years of having a minimum of things, they get free things that will help them throughout life*".

It was identified that the children had significant nutrition knowledge and an understanding of FTN meals providing a better quality of meal in comparison to their normal food intake. Although, the children were concerned about the wastage that occurred from their school garden and FTN meals and felt these weren't appreciated enough.

> "*I feel stink because I don't want to let food go to waste…some people in the world don't even get food, we need to be respectful for the food we get*".

The children also disliked FTN meals being available only during winter months and felt they are needed during the entire year (See Appendix B for the detailed decription of all the themes identified from the focus groups conducted with the children).

3.5 Discussion

The overall aim of this research was to evaluate the impact of a school meal programme on the dietary intake of children aged 9-11 years old, in a decile one school in South Auckland. This chapter will begin by discussing the participants' characteristics, followed by a discussion of their dietary intake in comparison to the nutrient intake recommendations by the MoH and the UK. This will be further followed by a discussion of the dietary intake as categorised by food sources during the FTN week and the non-FTN week. Then the perceptions of school staff and children towards the school meal programme will be compared to the trends in dietary intake of the children during the FTN week and the non-FTN week. The main outcomes of this study will be discussed throughout with recommendations for future interventions. Finally, limitations and recommendations from this research study will be discussed.

3.5.1 Participant characteristics

The majority of the children were Maori (44%) and Pacific (38%), which was higher compared to the 2013 NZ census at 33.8% and 35.7%, respectively (Statistics New Zealand, 2013). In addition, this study investigated only one school therefore is not representative of the entire NZ children's population and may be a better representation of children, aged 9-11 years, in South Auckland.

3.5.2 Dietary intake of children, aged 9-11 years, during the feed the need week and the non-feed the need week:

During the FTN week, the children's energy intake was 37% higher in comparison to the non-FTN week. FTN meals improved some aspects of the children's nutritional intake including dietary fibre, protein and iron. However, the meals also increased the children's carbohydrate, sugar, total and saturated fat intake. The dietary intake from the children's lunch meal was higher in presence of FTN meals and no changes were observed in the morning tea dietary intake when FTN meals were not available. These findings suggest that FTN meals were adding to the children's usual dietary intake, which is the first main outcome of this study. A school meal programme in Punjab, India resulted in the opposite effect, as the lunch meal was found to be substituting

food brought from home. Although, the aim of the school meal programme was to supplement meals from home to improve the nutritional intake of the children (Mehta, Grover, & Kaur, 2013). Whereas, the National School Lunch Program (NSLP) increased the children's protein and calcium intake similar to this study although the children did not consume these meals in addition to their usual dietary intake (Gordon & Fox, 2007).

3.5.3 Dietary intake in comparison to the New Zealand nutrient reference values and dietary guidelines in the United Kingdom:

The second main outcome of this study is that the children's dietary intake during school hours did not meet most of the recommendations. FTN meals increased the energy consumed by 47% in boys and 25% in girls during the FTN week, which resulted in excessive energy intake in comparison to the NZ EER. Although, dietary recalls (24-hour) have shown that energy was adequately consumed through the NSLP, in the US (Clark & Fox, 2009). Comparison to the NZ NRVs and UK dietary guidelines also suggested that the children's total, and saturated fat intake exceeded recommendations during the FTN week and the non-FTN week, which is comparable to the dietary intake through school meals in Sweden and the US (Gleason & Suitor, 2003; O'Brien & Vernarelli, 2016; Osowski, Lindroos, Barbieri, & Becker, 2015). Therefore, FTN meals were contributing to the oversupply of energy, total and saturated fat in the children's dietary intake during school hours. This is concerning due to the strong association of energy, sugar, total and saturated fat with weight gain, dental carries, diabetes, heart disease, overweight and obesity (B. M. Popkin & Hawkes, 2016; Boyd A Swinburn, Caterson, Seidell, & James, 2004; The Royal Society of New Zealand, 2016).

During the FTN week, the children's dietary fibre intake was higher in comparison to the non-FTN week and hence met the UK dietary guidelines. The NZ NRVs were also met, except by boys during the FTN week as their dietary fibre intake did not meet the recommendation by 10%. Wholemeal bread or bread rolls instead of the current white bread and rolls from KidsCan and FTN, respectively could be beneficial. In addition, use of vegetables from the school vegetable garden during meal times would also increase the dietary fibre intake. However, it is also important to consider the role of dietary

fibre in satiety, as food consumed in excess could mean children remain satiated for longer (Slavin & Green, 2007) and hence consume less food after school.

During the non-FTN week, boys and girls met the NZ protein recommendations of 12.40g and 9.60g, and UK recommendations of 11.30g. This was comparable to the NSLP meals, in the US (Clark & Fox, 2009). Although, presence of FTN meals was not required to support the children's protein intake to meet recommendations. It is also important to consider that protein intake improves satiety and may reduce appetite after meals (Johnstone, 2013). Therefore, future studies evaluating the impact of school meals during school hours on the dietary intake of children at home are indicated. Calcium intake did not meet the NZ recommendations, however during both weeks the milk from milk in schools arrived after the lunchtime data collection session on various occasions, hence intake is likely underestimated.

The percentage protein was 13% higher during the FTN week compared to the non-FTN week, suggesting that during the FTN week a higher proportion of energy was consumed from protein rich foods. However, boys and girls did not meet percentage protein recommendations, when compared to the AMDRs for protein, at 15-25%. Whereas, percentage saturated fat intake was higher than the <10% AMDR recommendation during both weeks. Therefore, children had a higher proportion of energy intake from foods rich in saturated fat than compared to foods rich in protein.

FTN meals during the FTN week provided a higher percentage protein intake from milk powder, meats and legumes used. During the school day, a higher contribution of saturated fat to energy intake was likely from consumption of unhealthy discretionary foods such as crisps, corn snacks, biscuits, cookies and pies, from the dairy during both weeks (Refer to Appendix B table 12 for the incidences of consumption for these food items). However, the higher saturated fat intake during the FTN week can also be attributed to the use of cheap cuts of meat that are usually higher in fat compared to lean meat. This finding was especially evident in the non-vegetarian soups as the percentage saturated fat contribution towards energy intake was higher in comparison to their vegetarian alternatives, where cheap cuts of meats were not used (Refer to

Appendix B tables 10 and 11 for the nutritional analysis of FTN meals and their respective ingredients list).

3.5.4 Dietary intake of the children during school hours as categorised by the food sources during the feed the need week and the non-feed the need week:

The dietary intake for all the children was categorised by food sources including dairy, home, school food programmes, FTN and other (unspecified food sources, peers and subway). Dietary intake analysis by food sources is one of the most important findings of this study, as there is limited research in NZ evaluating the nutrient intake for children during school hours from the various food sources. During the FTN week, food brought from home contributed greater towards total mean energy intake at 30%, in comparison to dairy (18%) and FTN (26%). In addition, FTN meals provided more energy compared to food from the school food programmes (18%). School food programmes provided a higher mean energy intake in comparison to food bought from dairy. Therefore, during the FTN week the children were more likely to consume food from all sources and not use one food source from which they consumed majority of the food. In contrast, during the non-FTN week, home was the major food source for energy intake of all children, as it provided 51% of the total mean energy intake, which is the third main outcome of this study.

School food programmes provided a higher energy, carbohydrate, sugar, saturated fat and iron intake for all children during the FTN week compared to the non-FTN week, as compared in table 6. This can be explained by a higher number of food items being consumed from school food programmes during the FTN week in comparison to the non-FTN week. There was an increased need for kidscan, fruit in schools, bread in schools and milk in schools during the FTN week as more bread (91%), fruit (25%) and milk (15%) was consumed in comparison to the non-FTN week. There was also a heavier reliance on jam and peanut butter in sandwiches, with 33 incidences of consumption during the FTN week and none during the non-FTN week. During the non-FTN week, 73 extra food items were consumed from home compared to the FTN week. However, nutrient analysis showed that only saturated fat intake was impacted with a 33% higher intake during FTN week compared to non-FTN week. Therefore, in

absence of FTN meals an increased number of food items rich in saturated fat were being consumed by the children, suggesting a need for school food and meals programmes.

The fourth main outcome of this study suggests that food brought from home during the FTN week (28%) contributed greater towards the total mean fat intake during the FTN week in comparison to food bought from the dairy (19%). This was also observed during the non-FTN week with home providing the most total fat at 52% of the total mean intake, in comparison to all food sources. In addition, these findings were also observed for the children's saturated fat intake during the FTN week and the non-FTN week.

The mean energy intake for all children from other food sources was 171% higher during the FTN week compared to the non-FTN week. The carbohydrate, sugar, total, and saturated fat and iron intake was also higher during the FTN week. This is likely due to improvements in food recall by week two (non-FTN week) and hence the children's ability to fill out the food records more accurately. The concept of food sources during the non-FTN week was better understood by the children as they had the opportunity to complete food records during the FTN week first.

3.5.5 Perceptions of the school staff and children towards the school meal programme:

The children did not wish to waste meals and observations suggest that some children were consuming upto 3 serves of FTN meals in one sitting. School staff and children also expressed appreciation and gratitude towards all school food and meal programmes that were offered. The children felt that the school meal programmes aided in satiety and energy levels throughout the school day, hence FTN is proving successful at preventing child hunger. The findings from this focus group were quite different to another study, which identified that the children wished for school meals to be similar to meals prepared at home. In addition, they associated meals prepared off the school site to be of poorer quality (Day et al., 2015).

3.5.3.2 Strategies for improvement of the feed the need meals and the dietary intake of the children during school hours:

Modification of FTN meals is required to reduce the saturated fat content of these meals. This is similar to the recommendation made as part of the school health policies and programs study in the US, in 2007 (O'toole, Anderson, Miller, & Guthrie, 2007). Currently, there are no NZ dietary guidelines for meals served during school hours therefore FTN meals may benefit through following the recommendations for the US school meal programmes such as the NSLP. In addition, NZ dietary guidelines could follow the national standard of the NSLP, which requires the school meals to meet one-third of the children's daily protein, calcium and iron requirements. Percentage energy from fat and saturated fat should also be less than 30% and 10% of total energy intake (Department of Agriculture, 2012). In addition, a government law such as the National School Lunch Act may be beneficial, which also requires school meal programmes to meet minimum nutritional requirements. The act further includes sample menus with ideal food ingredients and their amounts, that can be used to meet the nutritional requirements of children (United States Department of Agriculture, 2016). Finally, school meal programmes should be provided daily and not limited to three days during the school week. Future work is required to develop clear policy guidance.

Interventions targeting the local food environment are needed to reduce the children's access to unhealthy food items, which has also been recommended by other studies in the US (R. R Briefel, Wilson, & Gleason, 2009) and UK (Upton, Taylor, & Upton, 2015). In addition, unhealthy food marketing to children should be reduced and increased access to cheaper healthy foods is needed. This is to reduce the contribution of food brought from home towards the total and saturated fat intake of children during school hours. The recommendation of reduced unhealthy food marketing has been stated by the New Zealand Medical and Dental associations as well (New Zealand Dental Association, 2016; New Zealand Medical Association, 2014).

3.5.6 Limitations of this study

A key limitation of the present study is the small sample size (n=82) therefore, future studies should include a larger sample size from multiple schools to get a better representation of the NZ children's population. This was a cross-sectional study therefore no causal links can be made. However, new pathways for new studies and future research are evident. The present study analysed the dietary intake of children over two weeks; FTN week (during FTN) and non-FTN week (after FTN). Future studies should analyse the children's dietary intake over a longer timeframe and include non-FTN (before FTN is introduced) to obtain a better understanding of the children's usual dietary intake. Finally, the menu may have exerted an impact on the children's likelihood of consumption of the FTN meals. For example, one of the menu items, sloppy joes, was disliked by many children. Future school meal programmes should include some culturally appropriate recipes or ingredients such as taro and kumara in their menu.

3.6 Conclusions

In conclusion, the children were consuming FTN meals in addition to their usual dietary intake. Energy, total, and saturated fat recommendations were not met during both weeks and FTN meals were contributing towards an excessive intake. Most commonly consumed foods from the dairy included pies, crisps, corn snacks, cookies and biscuits, which are the likely sources of saturated fat intake during both weeks in addition to the FTN meals during the FTN week. Therefore, modification of FTN meals is required and perhaps a programme such as FTN has the potential to improve the children's nutrition if it follows dietary guidelines similar to the NSLP. During the non-FTN week, home was the children's main food source although it contributed towards a higher total and saturated fat intake in comparison to food from the dairy during both weeks. Therefore, improved access to cheap healthy food items and reduced unhealthy food marketing to children may be beneficial. In addition, interventions targeting the local food environment are also evident to reduce the children's access to unhealthy discretionary foods and therefore allowing an opportunity for better nutrition through school food and meal programmes.

Chapter 4: Conclusions and recommendations

4.1 Summary of findings

This cross-sectional study was designed to evaluate the impact of a school meal programme on the dietary intake of children in a low decile school in South Auckland. The study was conducted in Manurewa South School in South Auckland, New Zealand (NZ), with 82 children aged 9-11 years old. Dietary intake data of the children was collected using self-administered food records and assessed using FoodWorks software. Purpose-designed food records were used to collect the children's demographic information, foods and beverages consumed during morning tea and lunch time and the source for each food. Statistical analysis was conducted on the dietary intake during the Feed the Need (FTN) week and the non-FTN week including t-tests, kruskal-wallis and post-hoc tests.

The findings from this study will be summarised in accordance with the overall aim and three specific objectives, as defined in Chapter 1 (section 1.4):

The overall aim of this study was:

> *"to investigate the impact of a school meal programme on the dietary intake of children in a low decile school in South Auckland and to evaluate the perceptions of school staff and children about the benefits of the school meal programme".*

Overall, this study successfully met the aims and evaluated the impact of FTN meals on children's dietary intake and identified the school staff and children's perceptions towards the school meal programme. The dietary intake from school food programmes included KidsCan, Fruit in Schools, Milk in Schools, and a breakfast programme. In addition, the children's dietary intake within school hours during the FTN week was compared to the non-FTN week. The current research gaps in NZ that this study aims to fill includes the comparison of dietary intake during school hours between food sources. In addition, there is limited research in NZ evaluating the effect of school meal programmes on the dietary intake of children during school hours.

Therefore, the main outcomes of this study and findings are summarised through use of the three specific objectives:

1. *"Analysis of the nutritional intake during school hours using self-administered food records and FoodWorks software to assess whether the children's dietary intake meets the nutritional requirements and recommendations of Ministry of Health".*

Self-administered food records were used to collect the children's food and beverage intake data for morning tea and lunch during the FTN week and the non-FTN week. Dietary intake data from the food records was analysed through use of the FoodWorks software to identify the mean nutrient intake for the children during the FTN week and the non-FTN week. Finally, the dietary intake for boys and girls was compared to 40% of NZ Nutrient Reference Values (NRV's) and the United Kingdom (UK) dietary guidelines to assess whether the intake during school hours meets current recommendations.

The findings indicated that the children's dietary intake during the FTN week was higher compared to the non-FTN week. The boys and girls were consuming excessive energy in comparison to the recommended intake during the FTN week, which was 37% higher in comparison to the non-FTN week. In addition, the children's dietary intake during the FTN week was higher for lunch meals, when FTN meals were served and not during the morning tea. Therefore, one of the main outcomes of this study was that the children were consuming FTN meals in addition to their usual dietary intake. This is concerning as FTN meals also increased the children's total and saturated fat intake and contributed towards their overconsumption, in comparison to the recommendation of 28g and 9g for boys and 26g and 8g for girls, respectively. In addition, children were consuming crisps, corn snacks, pies, cookies and biscuits, which were the most commonly consumed foods from the dairy. This increased the saturated fat content of foods consumed during both weeks.

The dietary fibre and iron intake requirements were met during the FTN week although FTN meals require further improvements as the energy, carbohydrate, total and saturated fat recommendations were not met. Therefore, another main outcome of this study was that the children's dietary intake did not meet most of the recommendations during both weeks. During the FTN week, the children had a higher proportion of foods rich in saturated fat in comparison to protein. FTN meals do not need to increase their protein content as the children were meeting recommendations of 12.4g for boys and 9.6g for girls.

2. *"Analysis of the contribution of specific food sources towards the dietary intake of the children during school hours through comparison of nutritional analysis between the food sources".*

The children's dietary intake was categorised by food source, which included dairy, home, school food programmes, FTN and other food sources (peers, subway and unspecified sources). The dietary intake from the food sources was compared between the FTN week and the non-FTN week. In addition, dietary intake for all children was compared between food sources during the FTN week and the non-FTN week.

The third main outcome of this study was that during the FTN week the children consumed food from all sources whereas during the non-FTN week home was the major food source. In addition, the children had a higher reliance on school food programmes during the FTN week as children were consuming more food items from kidscan, Fruit in Schools and Milk in Schools. Whereas, during the non-FTN week there was an increased prevalence of food being brought from home, with 73 extra food items being consumed in comparison to the FTN week. Although, this resulted in an increased saturated fat intake during the non-FTN week. This allowed identification of the fourth main outcome of this study, which indicated that food from home provided more total and saturated fat by 9% and 7% in comparison to food brought from the dairy during FTN week, respectively.

3. *"Identification of the perceptions of school staff and children towards school meal programmes by conducting focus groups".*

Two separate focus groups were conducted after all data collection through food records was completed. Session A was conducted with teachers from room 13 and 15, and the school receptionist. Session B was conducted with two children from each of the three participating classrooms. Moderators guides were used during each session and key themes were identified after sessions were completed.

Findings from the focus group identified that FTN meals were preventing hunger. The children and school staff held appreciation and gratitude towards school food and meal programmes. They agreed that it aided in the children's satiety. In addition, the children showed concern about wastage of FTN meals however observations suggested that some children were consuming >1 portion per sitting. This is concerning as the children are consuming FTN in addition to their usual dietary intake and increasing portions consumed by school meal programmes may increase risk of overweight and obesity.

4.2 Impact of research findings

The present study successfully identifies the impact of FTN meals on the dietary intake of children in a decile one school. The results of this thesis provide implications for the FTN school meal programme in South Auckland. School meal programmes have been used as strategy to improve childhood nutrition (Moffat & Thrasher, 2016). Therefore, a programme such as FTN has the potential to improve childhood nutrition if it follows specific dietary guidelines to meet the nutritional recommendations of children.

This study presents interesting findings as it identifies that FTN meals are being consumed in addition to the children's usual dietary intake. Children can consume 30% – 40% of their total daily intake during school hours (Bell & Swinburn, 2004; Regan et al., 2008; Walton et al., 2015) therefore food provided at school can play a significant role in reducing prevalence of childhood obesity. In addition, a multi-factorial approach is required to improve childhood nutrition. A school meal programme such

as FTN is not enough to prevent childhood obesity and other interventions that reduce access to unhealthy discretionary foods and unhealthy food marketing to children may be needed, as recommended by the New Zealand Medical and Dental associations (New Zealand Dental Association, 2016; New Zealand Medical Association, 2014).

4.3 Strengths of this research study

A key strength of this study was the dietary data collection, through use of supervised self-administered food records as food records have been identified as a stronger predictor of energy and protein intake in comparison to the food frequency and 24-hour recalls (Prentice et al., 2011). In addition, food recall in children can be biased (Livingstone & Robson, 2000) therefore, packaged food size guides such as crisp packets in three different sizes and snack packs were provided as a reference. This was to improve the accuracy of food size estimation and brand reporting for commonly consumed food items by the children. The data collection sessions took place after each morning tea and lunch break, to minimise the time between consumption and reporting to reduce recall bias. In addition, an introduction to food records was provided to all the children prior to first data collection session. This was to allow the children to understand how to complete the food records accurately and children were also supervised by experienced nutrition students to ensure readability and accurate reporting.

Another strength of this study is the cross-sectional design, which was carried over a timeframe of two weeks (FTN week and non-FTN week). It allowed identification of the children's dietary intake during school hours at one-point in time. This study design allowed assessment of many outcomes (Levin, 2000) such as the dietary intake of children within school hours during the FTN week and the non-FTN week and as categorised by gender and food sources. It allowed generation of new trends for future research such as the identification of FTN meals adding to the children's usual dietary intake.

4.4 Limitations of this research study

A convenience sample of 82 children aged 9-11 years old from NZ European, Maori or Pacific ethnicity were included in this study. Although the dietary intake data collection through food records occurred on repeated occasions for each week the study only investigated the dietary intake of children from one school. Therefore, the findings from this study do not necessarily apply to the entire NZ children's population. Future research should include various schools across NZ to get a better representation of the entire children's population.

Another limitation is the possible misreporting of food sources during the FTN week. The number of food items or beverages consumed from unspecified food sources decreased by 50% from the FTN week to the non-FTN week. This decrease was attributed to the children's improved ability to report food sources by week two (non-FTN week). Although, the children were provided with an introduction to completing the food records and supervision by nutrition students, observations suggested that the concept of food sources was better understood with practice by week two of data collection. As a result, food consumption from food sources such as dairy, home, school food programmes and FTN may have been underreported as unspecified food sources were accounted for as part of the other food source classification. Finally, menu items such as sloppy joes were not enjoyed by children and could have contributed towards under-consumption of some FTN meals.

4.5 Final recommendations

Findings from this study suggest that FTN meals were being consumed in addition to the children's usual dietary intake. These meals were also contributing towards the excessive energy, total and saturated fat intake. Modification of FTN meals, such as reduced saturated fat content, is required. In addition, FTN meals improved the children's dietary fibre and iron intake and supported the children to meet requirements. Therefore, FTN meals have the potential to improve childhood nutrition with dietary guidelines such as the one-third recommendation for the National School Lunch Program (Department of Agriculture, 2012). In addition, as part of the National

School Lunch Act the school meals are required to provide meals that meet at least minimum nutritional requirements.

The percentage energy from saturated fat is overconsumed by the children during the FTN week and the non-FTN week. Therefore, a guideline that requires school meals to provide less than 30% and 10% percentage energy from fat and saturated fat may be beneficial for FTN meals. Food from home was also a greater source of total and saturated fat intake than dairy during the FTN week and all food sources during the non-FTN week. Therefore, reduced unhealthy food marketing to children and improve access to cheap healthy food items may be beneficial (New Zealand Dental Association, 2016; New Zealand Medical Association, 2014). Commonly consumed unhealthy discretionary food choices by the children during both weeks included cookies, biscuits, crisps, corn snacks and pies. Therefore, interventions that reduce the children's access to unhealthy discretionary foods are needed, which has been recommended by other studies as well (R. R Briefel et al., 2009; Upton et al., 2015).

This study analysed dietary intake of children within school hours during FTN programme (FTN week) and after FTN programme had finished for the year (non-FTN week). Future studies should analyse the children's dietary intake over a longer timeframe and include another non-FTN week that represents the timeframe prior to FTN starting for the year to better understand the children's usual dietary intake. Future studies can also analyse the children's dietary intake after school to identify the impact of school meal programmes on the children's evening meal.

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Appendix A: Supplementary methods

School food and meal programmes offered to all children in Manurewa South School, South Auckland, New Zealand

Day	Week 1 of data collection	Week 2 of data collection
Monday	Breakfast programme provided Bread and milo	
	Fruit in School provided fruit	
	FTN provided Butternut and bacon soup or vegetarian pumpkin soup and bread roll with butter	
Tuesday	Fruit in School provided fruit	
	Fonterra provided 250mL milk cartons	
Wednesday	Fruit in School provided fruit	
	FTN provided cowboy casserole or vegetarian casserole and bread roll with butter	
Thursday	Breakfast programme provided Bread and milo	
	Fruit in School provided fruit	
	Fonterra provided 250mL milk cartons	
	Option of ordering Subway through school available	
Friday	Fruit in School provided fruit	
	FTN provided sloppy joes and bread roll with butter	
	KidsCan provided Bread and muesli bars monthly.	

Assumptions used when entering food items or beverages from food records into Foodworks:*

- ”Nothing” written on food record = No food consumed
- Where **potato chip flavour/brand** is unspecified, Potato Crisps, Flavoured are used
- **Speciality crisps** (e.g. twisties, burger rings) all classified as Corn Snack, Cheese Flavour

  ”normal” pack of crisps is assumed to be a “medium size”
- 1 Pottle of **yoghurt** is assumed to weigh 125g
- 1 **yoghurt tube** = 70g
- Sandwich **spreads & Dressings** = 1T
- Any form of **fruit nuggets, sticks** and **Jellies** are all recorded under **“fruit jellies”**. Nutritional information for this was found from the Nice and Natural fruit strings NIP. Each snack pack weighs approx. 17g.
- **Snack pack of chocolate chip cookies/Biscuits** is approximately 2 regular chocolate chip cookies
- **Small Butter PCU** are assumed to be butter salted, 10g
- **Small juice box** = 125mL
- Where unspecified **snack bar** is recorded, 1 standard muesli is used
- Where **cake** unspecified is recorded, standard chocolate cake will be used @ 60g per slice
- ”Jelly cake” is assumed to represent something similar to a trifle dessert
- Any variety of **iced biscuits** are recorded as Hundred & Thousands iced biscuits.
- **Juice flavour** if unspecified assumed to be Juice, grape 125ml carton.

  Hot drinks where unstated are assumed to be 10g + hot water and 50mL of milk
- **Fizzy Drink unspecified** is presumed to be a standard 330mL can of Coca Cola

  Lollies unspecified are assumed to be a pack of fruit jellies
- **Peaches canned** medium size is assumed to be 400g and where liquid not specified **“Peached, canned in juice”** is used.
- Where **Jam** flavour is unspecified **“Jam, berry fruit”** is used.
- Where **Big ben pie** flavour is unspecified **“mince and cheese”** is assumed. Standard size = 170g.

- **Chocolate pudding** = 113g.
- Chicken cooking method unspecified then **"chicken, breast, deli-cooked, supermarket"** is used. Where amount in sandwich unspecified 0.5 cup is assumed per sandwich.
- **Lettuce** = 0.25 cup in 1 sandwich or wrap
- **Carrot** = 0.25 cup in 1 sandwich
- **Egg** = 1 whole boiled in 1 sandwich
- **Tomato** = 0.25 medium tomato in 1 sandwich or wrap
- **Sausages** flavour and amount unspecified then **"Sausages,prepckd, dry fried, asst meats&flvr"** used and 2 sausages presumed.
- If vegetarian soup not specified it is assumed to be the standard (non-vegetarian) soup option.
- "Some of ftn" assumed to be ½ a serve of soup.
- 2 weetbix assumed with 0.25 cup milk.
- Chicken salad sandwich or wrap assumed to contain ½ cup chicken breast and ½ vegetable salad .
- **Raisins** = 30g box
- **Cheese slice** = 15g, where flavour/ brand unspecified = **"Cheese, Cheddar, tasty".** Assumed to be 2 slices in 6 inch subway.
- "**A sandwich**" is assumed to be two slices of bread unless otherwise specified **a cheese sandwich** is assumed to contain 30g of cheese
- A serve of **Buja Mix** is considered to be 30g
- **Cucumber slices** in a sandwich when unspecified assumed to be 5 slices.
- **Biscuit** = "Biscuit,basic,NZ recipe"
- **Dried seaweed** 1 packet = 5g
- **Pringles** 10 chips assumed a small pack of 36g.
- **Macaroni cheese** small serve assumed to be 150g.
- **Muffin** – where flavour is not specified **"Muffin, blueberry**" is used.
- **Fruitful Breakfast,Hubbards** standard serve size assumed to be 30g.
- Where flavour of **crackers** is unspecified **"Cracker,assorted**" flavours is used with serve size of 20g if not specified.

- "**Popcorn,buttered,salted,commercial"** is used for **popcorn** unless otherwise stated.
- **"Strawberry biscuits"** are assumed to be **shrewsberry**.
- **Medium coke** assumed to be 500ml.
- **Cheese chips unspecified** are assumed to be corn snacks
- A **bottle of juice** assumed to be 350mL.
- Where cookies are unspecified they are assumed to be **"Biscuit, cookie, chocolate chip". "Large cookie" assumed to be "Cookies,Cookie Time,original".**
- **Chocolate unspecified = "Chocolate bar,milk".**
- 1 Up&Go assumed to be 350mL. Large = 600mL.
- Where quantity of Juice unspecified assumed to be a standard 125mL.
- Samosa – where quantity unspecified assumed to be 50g. "Samosa,veg filled,deep fried,retai"l used as a standard.
- Biscuit, Hundred&Thousands where quantity unspecified assumed to be 1 biscuit.
- Pizza flavour unspecified = "Pizza,BBQchic,large,bkd,comm,thick crust" used
- Tuna = Tuna,in spring water,canned,drained. 0.25 cup per slice of bread.
- One split stick is assumed to be the same as ½ of an lcm bar.
- French toast = Bread,white,sliced,prepacked + 25g Egg,whole,scrambled/2 slices
- Where snack pack contents** unspecified assumed to be a 20g small packet of potato crisps, flavoured.

*Water not added into Food Works Analysis, accurate measure not given and will not add value to analysis.

**Contents extremely variable e.g. can include small drink, fruit strings, chocolate fregos, chips packets and cookies or just a snack pack sized chips.

Alternate food items and beverages used when entering food records in Foodworks

Unidentified Food	Closest Match on Database	Quantity
Feed the Need Bread Buns	Bread Rolls, White, Pre-packaged	½ Long Roll = 1 Bun
“Chilli Peas”	Chickpeas, Dried	Potato Chip Pack Sizes
“Salad”	Salad,veg,w/ salad cream dressing,canned	1 Portion = 1Cup
Apple juice	Juice,crisp apple,Fresh Up	
Assorted Iced Biscuit Snack Pack	Hundreds and Thousands Iced Biscuits	1 small pack = 2 standard biscuits
Bbq pizza McCain	Pizza,BBQchic,large,bkd,comm,thick crust	1 slice
Biscuit – chocolate eclairs	Biscuit,chocolate coated	
Blueberry yoghurt	Yoghurt, asst fruits&flavours, sweetened	
Brownie	Cookie, peanut brownie	
Burger Rings/Twisties, Pop Jacks, Bongo, cheesy and crunchy chips	Corn snacks, cheese flavour	
Butter on feed the need buns	Margarine,reduced fat	10g
Caramel slice	Cake, gateaux	1 slice = 35g
Chicken Flavoured Rice Crackers	BBQ Flavoured Rice Crackers	
Chicken pie	Pie,mince&cheese	Standard size = 170g
Chocolate biscuit	Biscuit,chocolate coated	
Chocolate Fudge Bar	Chocolate Fudge Biscuits	1 Bar = 2 Biscuits
Chocolate fudge bar	Chocolate bar, milk	
Chocolate peanut biscuits	Biscuit, cookie, chocolate chip	
Chocolate wheelies	Biscuit, Chocolate Cream	30g per snack pack

Chocolate yoghurt	Yoghurt, asst fruits&flavours, sweetened	
Coconut chocolate cookies	Biscuit, cookie, chocolate chip	
Cookie Bear Cookies	Biscuit,basic,British recipe,baked	3 small biscuits = 1 standard biscuit
Cordial (mango & orange)	Juice, orange&mango, Just Juice	
Cracker Packet	Rice cracker,plain,composite	1 small pack = 20g
Cream doughnut	Doughnut, ring	
Doritos	Corn chips, cheese flavour	
Fruit bar	Fruit bar, strawberry	
Fruit bun	Spiced bun	
Fruit lollies	Hard candy Chupa chups, asst flavours	
Fruit nuggets	Fruit jelly	20 nuggets = 1 pack of 17g
Fruit O's	Fruitful Breakfast,Hubbards	
Fruit o's	Fruit jelly	
Fruit sticks	Cereal soft bar, frt filled, twited, flvr	
Fruit strings	Fruit jelly	
Ginger slice	Ginger cake	1 slice = 35g cake
Ginger teddies	Biscuit,basic,NZ recipe	20g
Gummy watch	Fruit jelly	
Homemade Brownie	Standard Chocolate Cake	1 piece = 35g
Instant Noodles Unspecified	Soup,chicken noodle,instant dry mix,Cup-a-Soup Lots-a-Noodles,Continental	1 Cup = 1 Pack
Just juice	Juice, orange&mango, Just Juice	

Kit Kat chocolate	Chocolate bar,milk	4 sticks = 1 large bar
Kiwifruit jam	Jam, berry fruit	
Lolly string	Fruit jelly	
Luncheon	Sausage, chicken luncheon	0.25cup, shaved
M'n'M cookie	Cookies,Cookie Time,original	
Mango juice	Juice, orange&mango, Just Juice	
Microwave Convenience Pizza	Pizza, Frozen, Individual Size, Hawaiian bkd	1 Pizza
Milk in Schools	Milk, Lite, 1.5% Fat	1 Carton = 125mL
Milky bar – coco and vanilla	Chocolate, Nestle milky bar	
Muffin	Muffin, Blueberry	
Nut bar	Fruit & nut bar	
Nutrigrain muesli bar	Milo snack bar	1 bar = 55g
Oat slice	Oatcake Biscuit	1 Bar = 40g
Oaty Slice Snack Bar		
Orange juice	Juice, orange&mango, Just Juice	
Oreo, any cream filled biscuits	Biscuit, Chocolate Cream	
Other Chocolate Baked Goods	Standard Chocolate Cake with Buttercream Icing	1 serve = 1 slice= 20g
Panda Chips	Potato crisps,flavoured	Snack Pack = 20g
Peanut bar	Chocolate bar, with peanuts	
Peanut chocolate coated bar		
Pizza bread loaf	Pizza,frzn,individual size,hawaiian bkd	1 Bread = 1 pizza
Poppa Jacks	Potato chips, Krispa	
Potato Chips	Potato Crisps, Flavoured	
Pottle of Yoghurt	Yoghurt, asst fruits&flavours,	

	sweetened	
Raspberry Fruit Drink	Grape Juice	125mL
Round pizza from bakery	Pizza, BBq chic, large, bkd, comm, thick crust	1 slice
Shaved roast beef	Beef,topside roast,lean,roasted	
Sour cream & chives crackers	Cracker,assorted flavours	
Sour cream & chives flavoured chips	Potato crisps,flavoured	
Sour cream and chives chips	Potato crisps,flavoured	
Steak and cheese pie	Pie,mince&cheese	Standard size = 170g
Strawberry flakes	Fruit jelly	3 flakes = 1 packet
Strawberry juice	Grape Juice	125mL
Strawberry wafer biscuits	Biscuit,wafer,raspberry,cream filled	
Strawberry yoghurt stick	Muesli bar,yoghurt coated,assorted	1 bar
Subway bread	Bread roll,white,pre-packaged	6 inch = 2 long rolls
Sugar doughnut	Doughnut, ring	
Sweet chilli crackers	Cracker,rice,BBQ flavours,baked	1 row = 10 crackers
Tim tam	Biscuit, chocolate coated	
Tomato and garlic flavoured pasta	Pasta,plain,boiled	1 small bowl = 1 cup cooked pasta and 0.25 cup sauce
	Sauce,pasta,chunky vege,tomato based	
Unspecified Bread	Bread,white,sliced,prepacked	
Vanilla cookie	Biscuit, cookie, chocolate chip	
Vanilla muffin	Muffin,assorted flavours,toasted	
Waffles	Pancake, plain	
Wholemeal Buns	Bread Rolls, Wholemeal, Pre-	½ Long Roll = 1 Bun

	Packaged	
Yoghurt stick	Yoghurt,asst fruits&flavours,sweetened	1 stick = 70g

Appendix B: Supplementary results

Table 7: Mean daily nutrient Intake during Morning tea and Lunch within school hours of children aged 9-11 years old from a low decile School in South Auckland

	Mean ± SD			Mean ± SD			
	Morning Tea during FTN week	Morning Tea during non-FTN week	p-value	Lunch during FTN week	Lunch during non-FTN week	p-value	Increase (%)
Energy (KJ)	1237.0 ± 1050.1	1240.0 ± 989.7	0.97	2008.2 ± 1500.2	1514.5 ± 6115.3	0.23	
Carbohydrate (g)	39.9 ± 31.6	39.2 ± 30.7	0.95	57.3 ± 40.3	47.8 ± 196.9	0.46	
Carbohydrate (% Energy)	50.5 ± 20.0	52.0 ± 18.1	0.35	49.6 ± 18.2	49.0 ± 18.5	0.71	
Dietary fibre (g)	2.69 ± 2.37	2.74 ± 2.24	0.83	5.59 ± 5.22	2.89 ± 2.58	**0.00**	98
Total sugars (g)	18.9 ± 19.6	18.4 ± 19.5	0.76	27.4 ± 26.0	25.7 ± 118.8	0.83	
Protein (g)	7.20 ± 8.53	7.61 ± 8.61	0.56	18.2 ± 16.7	8.82 ± 9.38	**0.00**	106
Protein (% Energy)	8.59 ± 6.54	9.20 ± 6.66	0.25	14.7 ± 7.07	12.1 ± 8.35	**0.00**	21
Total fat (g)	11.6 ± 12.8	11.8 ± 11.9	0.78	19.0 ± 20.2	9.55 ± 9.06	**0.00**	99
Fat (% Energy)	30.3 ± 17.6	31.2 ± 16.3	0.55	29.9 ± 15.9	28.5 ± 16.1	0.37	
Saturated fat (g)	5.20 ± 6.21	5.45 ± 5.97	0.61	8.91 ± 9.64	4.40 ± 4.80	**0.00**	103
Saturated fat (% Energy)	13.5 ± 9.39	13.9 ± 8.90	0.55	13.9 ± 8.03	12.8 ± 8.43	0.15	
Calcium (mg)	75.1 ± 104.9	96.6 ± 122.3	0.06	202.6 ± 210.6	135.2 ± 127.9	**0.00**	50
Iron (mg)	1.26 ± 1.64	1.21 ± 1.46	0.74	2.44 ± 2.89	1.09 ± 1.62	**0.00**	124

Results are presented as mean ± standard deviation for the dietary intake of the children during FTN week and non-FTN week, as categorised by morning tea and lunch. P-values were calculated using dependent t-tests with a <0.05g significance. Percentage increase was calculated to report the increase in mean for lunch during non-FTN week to FTN week, for any significant differences.

Table 8: Comparison of nutrient intake of children aged 9-11 years old on FTN days and non-FTN days, during school hours in a low decile School in South Auckland

	Mean ± SD			Mean ± SD			Mean ± SD		
	Monday during FTN week	Monday during non-FTN week	p-value	Wednesday during FTN week	Wednesday during non-FTN week	p-value	Friday in during FTN week	Friday in during non-FTN week	p-value
Energy (KJ)	3429.1 ± 2078.6	2451.1 ± 1747.6	**0.03**	3622.0 ± 1857.8	2153.3 ± 1153.5	**0.00**	3770.3 ± 2724.3	1914.8 ± 1152.5	**0.01**
Carbohydrate (g)	115.0 ± 69.5	79.6 ± 62.7	**0.02**	92.9 ± 43.4	72.3 ± 42.9	**0.02**	103.8 ± 70.1	55.8 ± 29.5	**0.01**
Carbohydrate (% Energy)	55.59 ± 8.18	54.5 ± 9.73	0.63	45.4 ± 14.2	53.6 ± 13.1	**0.01**	48.3 ± 15.1	52.2 ± 13.6	0.32
Dietary fibre (g)	9.64 ± 4.62	6.24 ± 3.67	**0.00**	10.7 ± 5.05	5.43 ± 3.04	**0.00**	8.23 ± 7.34	5.06 ± 3.41	0.13
Total sugars (g)	48.3 ± 35.3	41.4 ± 46.7	0.44	42.0 ± 38.0	35.0 ± 25.6	0.25	45.1 ± 39.2	21.7 ± 15.7	**0.01**
Protein (g)	29.0 ± 18.1	15.4 ± 12.2	**0.00**	28.1 ± 20.3	11.9 ± 8.40	**0.00**	34.4 ± 28.5	14.0 ± 11.0	**0.01**
Protein (% Energy)	15.0 ± 4.2	10.5 ± 5.53	**0.00**	12.1 ± 4.19	9.53 ± 4.65	**0.00**	14.0 ± 6.16	11.9 ± 7.08	0.36
Total fat (g)	24.8 ± 19.6	22.0 ± 17.1	0.53	42.3 ± 28.4	17.4 ± 10.8	**0.00**	39.3 ± 36.5	19.8 ± 16.3	**0.04**
Fat (% Energy)	26.3 ± 9.34	32.0 ± 11.4	**0.03**	40.9 ± 11.5	31.4 ± 12.5	**0.00**	36.8 ± 11.2	33.9 ± 13.0	0.43
Saturated fat (g)	11.4 ± 8.86	10.4 ± 9.00	0.68	19.5 ± 12.8	7.82 ± 5.07	**0.00**	17.6 ± 17.6	8.37 ± 7.64	**0.04**
Saturated fat (% Energy)	12.0 ± 5.03	14.7 ± 6.61	0.07	18.9 ± 5.66	13.8 ± 6.38	**0.00**	16.7 ± 6.21	13.7 ± 7.7	0.20
Calcium (mg)	420.1 ± 286.2	152.7 ± 137.1	**0.00**	140.3 ± 94.4	166.3 ± 127.1	0.36	144.2 ± 124.4	140.0 ± 126.9	0.92
Iron (mg)	4.36 ± 3.35	2.97 ± 3.01	0.09	4.45 ± 2.65	1.96 ± 1.84	**0.00**	5.34 ± 6.13	2.20 ± 1.96	0.10

Results are presented as mean ± standard deviation for the dietary intake, as categorised by days during the FTN week and non-FTN week, of the children. Findings only present dietary intake during FTN days of FTN week (Monday, Wednesday and Friday) and their respective days during non-FTN week. P-values were calculated using dependent t-tests with a <0.05g significance.

Table 9: Comparison of nutrient intake of children aged 9-11 years old between non-FTN days, during school hours in a Low decile School in South Auckland

	Mean ± SD			Mean ± SD		
	Tuesday (FTN week)	Tuesday (non-FTN week)	p value	Thursday (FTN week)	Thursday (non-FTN week)	p value
Energy (kJ)	2245.6 ± 1275.2	2389.0 ± 1292.2	0.62	3225.3 ± 1996.1	2843.1 ± 1974.9	0.30
Carbohydrate (g)	77.3 ± 51.0	72.4 ± 42.9	0.65	99.7 ± 59.9	85.6 ± 55.6	0.19
Carbohydrate (% Energy)	54.9 ± 13.4	50.0 ± 11.1	0.12	52.0 ± 8.40	51.8 ± 8.68	0.92
Dietary fibre (g)	6.11 ± 7.84	4.80 ± 3.62	0.45	6.33 ± 3.42	5.53 ± 2.90	0.33
Total sugars (g)	41.8 ± 38.9	40.9 ± 32.1	0.91	52.7 ± 36.2	38.6 ± 27.7	**0.02**
Protein (g)	13.6 ± 11.1	17.3 ± 11.0	0.13	21.2 ± 14.2	22.8 ± 21.3	0.66
Protein (% Energy)	10.7 ± 5.31	12.7 ± 5.38	0.10	12.1 ± 4.81	13.6 ± 6.39	0.19
Total fat (g)	17.7 ± 12.4	22.5 ± 15.2	0.14	30.7 ± 24.8	26.6 ± 23.1	0.34
Fat (% Energy)	30.7 ± 13.8	34.3 ± 12.6	0.28	33.3 ± 9.99	32.3 ± 10.9	0.63
Saturated fat (g)	8.07 ± 6.24	11.3 ± 8.59	0.07	14.9 ± 13.0	12.5 ± 12.4	0.30
Saturated fat (% Energy)	14.2 ± 7.22	16.9 ± 7.16	0.15	15.7 ± 6.52	14.6 ± 6.35	0.38
Calcium (mg)	183.8 ± 100.3	312.2 ± 198.1	**0.00**	387.3 ± 240.2	334.0 ± 263.5	0.44
Iron (mg)	2.12 ± 3.03	1.83 ± 1.48	0.67	2.50 ± 1.70	2.32 ± 2.26	0.71

Results are presented as mean ± standard deviation for the dietary intake, as categorised by days during the FTN week and non-FTN week, of the children. Findings only present dietary intake during non-FTN days of FTN week (Tuesday and Thursday) and their respective days during non-FTN week. P-values were calculated using dependent t-tests with a <0.05g significance.

Table 10: Dietary analysis of FTN recipes.

Day	Monday				Wednesday				Friday	
Soup	Butternut and Bacon soup		Butternut soup		Cowboy Casserole		Vegetarian Casserole		Sloppy Joes	
Nutrient	Per serving (345g)	Per 100g	Per serving (336.67g)	Per 100g	Per serving (281.63g)	Per 100g	Per serving (150g)	Per 100g	Per serving (270g)	Per 100g
Energy (KJ)	791.4	229.4	670.0	199.0	2429.6	862.7	427.0	284.7	1684.3	623.8
Carbohydrate (g)	30.4	8.80	30.3	8.99	19.7	6.99	15.9	10.6	15.9	5.88
Carbohydrate (% Energy)	52.9	52.9	62.5	62.5	13.5	13.5	61.3	61.3	15.5	15.5
Dietary fibre (g)	2.89	0.84	2.89	0.86	7.49	2.66	5.66	3.77	5.66	2.10
Total sugars (g)	16.9	4.91	16.9	5.02	7.40	2.63	8.13	5.42	8.13	3.01
Protein (g)	12.7	3.67	11.6	3.44	27.3	9.68	5.25	3.50	28.3	10.5
Protein (% Energy)	27.2	27.2	29.4	29.4	19.1	19.1	20.9	20.9	28.5	28.5
Total fat (g)	3.18	0.92	0.41	0.12	42.6	15.1	0.61	0.41	24.0	8.89
Fat (% Energy)	14.9	14.	2.24	2.24	64.9	64.9	5.30	5.30	52.8	52.8
Saturated fat (g)	1.29	0.37	0.17	0.05	19.5	6.92	0.01	0.01	10.9	4.03
Saturated fat (% Energy)	6.01	6.01	0.91	0.91	29.7	29.7	0.12	0.12	23.9	23.9
Calcium (mg)	333.3	96.6	332.7	98.8	48.6	17.3	46.3	30.9	52.3	19.4
Iron (mg)	0.64	0.18	0.55	0.16	4.00	1.42	1.22	0.81	4.90	1.81

The table above presents the nutritional analysis of meals, per serving and per 100 grams, offered to all children during FTN days of FTN week (Monday, Wednesday and Friday).

Table 11: Ingredients list for FTN recipes.

Butternut and Bacon soup	Butternut Soup	Cowboy Casserole	Vegetarian Casserole	Sloppy Joes
Onions	Onions	Beef sausages	Baked beans	Beef mince
Carrots	Carrots	Onions	Onions	Baked beans
Potatoes	Potatoes	Potatoes	Worcestershire sauce	Onions
Butternut	Butternut	Baked beans	Tomato sauce	Worcestershire sauce
Pork	Vegetable stock	Tomato puree		Tomato sauce
Meat stock	Milk powder			
Milk powder				

The table above presents the ingredients used during preparatin of each FTN meal during FTN week.

Table 12: Incidences of consumption for the most commonly consumed food items from the dairy during the feed the need week and non-feed the need week:

Food item	Incidence of consumption during the FTN week	Incidence of consumption during the non-FTN week
Crisps	37	32
Biscuits	17	19
Cookies	12	11
Corn snacks	17	16
Doughnut	8	4
Pie	14	25

The table above reports the foods that were consumed the most by all children, during the FTN week and the non-FTN week. In addition, the number of times these food items were consumed is also presented above.

Focus group key themes – school staff:

Gratitude and appreciation

Staff in Session A exhibited a sense of gratitude for the food programme being offered to the children at Manurewa South school.

"*It's the best thing, for our children*" (session A, staff 1)

"*It's great to have the opportunity to have these offered to our school for our children. So we absolutely appreciate what's coming in…"* (session A, staff 1)

They additionally displayed a sense of appreciation for these programmes. In their perceptions the programmes filled a need for example, kisdcan decreased the need of bread.

"…its specific to the kids who need it." (session A, staff 3) "the variety this year. They've added a bun this year too" (session A, staff 1)

The teachers further appreciated being provided utensils from feed the need. "…less downtime trying to find them…" (session A, staff 3)

Positive changes in behavior of children

The staff perceived that the food programmes allow improved food exposure to the children. "*we found with the bread, that we get peanut butter and honey, children absolutely love the honey. Its very expensive to buy in this market, they love the honey, its their favourite thing*." (session A, staff 2)

"*…and some of them have never had that before so its opening the children up to a different type of food*." (session A, staff 1)

"*its getting them to try things they haven't tried before like we had pineapple, we have the summer fruit…we used to have grapes…cherry tomatoes…"* (session A, staff 1, 2 and 3)

The staff perceived that a social environment was created in the classroom as a result of food from feed the need coming in. It allowed development and education of new skills in regards to protocols. Feed the need especially allowed education of manners at the table.

"*you also notice with our children too, that a lot of our children are walking around with food and its like I think they do this at home that they just have their meal and carry on around and now they're sitting at the table*." (session A, Staff 1)

The children additionally learn to clean up after eating at their table. The staff expressed how they believed the food programmes allowed the children to sit and eat meals together. They were additionally taught in regards to patience and calmness while waiting for meals to arrive.

"*the thing I also like is the responsibility that the children have dealing with waste as well they have to recycle the cartons, they have to fold the cartons…"* (session A, staff 3) "*…milk in schools...that's very hard to get on that because of the waiting list…well its given them another responsibility, they've gotta collect, they've gotta recycle every bit and they've gotta put it back in the recycle bin….*" (session A, staff 1)

Improved attendance as the teachers believed there is no longer an excuse for the children to not show up to school "*…some of our children stay away cos they have no food, so we make it clear to the parents that that's not a reason for them to keep their children home, so its encouraged less attendance issues with having that on board*." (session A, staff 2) "*well it gives them something warm in their tummy for winter and again it's a attendance thing as well…its something warm and filling and nutritious*." (session A, staff 1)

Parental support

The staff felt that the food programme provide a great deal of parental and familial support and provide meals in times of greatest need.

"*…the winter months seem to be the neediest months for the families…the parents appreciate it, that there is something for their children…something hot in their tummy*" (session A, staff 1)

"*provides them a warm meal…*" (session A, staff 3)

"*that their children are being fed…they're getting a hot meal…bread…"* (session A, staff 1)

It extends into the home environment where the children are able to take leftovers home or educate their families. In specific the staff highlighted the usefulness of bread and fruit provided to school.

"*…and I think they go home and talk about it too saying oh I told mum about this one today it was really nice…I didn't like this one, you know*." (session A, staff 1)

"*fruit…its good cus they take it home and goes towards your meal, towards the stew."* (session A, staff 1)

They additionally highlighted that the programmes were appreciated by the parents.

"*…and the parents hey? 95% of the parents appreciate it*." (session A, staff 1)

Negative perceptions

Majority of the discussion in regards to the food programme was positive however the staff indicated their dislike for limited timeframe of feed the need. They also highlighted how the programmes can make the parents realize how deprived their children are.

"*he said to me…does that we are really really hard up?...No it just means we are really lucky."* (session A, staff 1)

They also showed concern of future absence of the food programme.

"So I suppose we gotta tick all the boxes otherwise they may think the need is not there" (session A, staff 1)

"…and we hope it doesn't stop." (session A, staff 1)

Focus group key themes – children:

Gratitude and appreciation for food programmes provided.

Students in Session B demonstrated a deeply held appreciation for the multiple different food programmes that were provided to their school. They understood that programmes placed in their school environment were very selective, and that not every school in the South Auckland region got the same opportunity as them, and for that they were grateful.

"*It makes me feel lucky …there is only a minimum of schools that get all these things*" (session B, girl 1).

The students held the perception that they were privileged to be chosen for such food programmes.

"*It makes me feel appreciative to have all of these things because not a lot of schools get things; I'm glad that our school got chosen to have these things*" (session B, girl 2).

Positive contributions to student wellbeing.

Students demonstrated that school food programmes provided positively affects them beyond physical wellbeing, but also contributes to emotional wellbeing as well. The students remarked firstly on how the food provided to their school gives them full tummies, and physically makes them feel full, but also expanded to say that the foods help to give them a more sustained energy source to help them play, and keep active, with a more specific focus on protein sources.

"*It makes your brain wake up again…it gives you healthy bones…we need that for play and swimming*" (session B, girl 2).

The students had a good understanding of nutrition and how the different foods programmes such as Feed the Need are providing a more quality lunch source them some of the food originally provided to them, such as the school canteen.

"…the brownie is full of sugar and makes you hyperactive…we use up the energy in like a minute, and then we get tired, and have a sore stomach" (session B, girl2 and boy 1).

Further, the students demonstrated how the provision of a regular lunch source from Feed the Need helps to provide a sense of food security for those children who live in a more deprived household. They provided insight as to how having the minimal of things in life can affect you emotionally, and how Feed the Need helps to fill that gap, and provide more to the children then just a hot meal. The children demonstrate the perception that knowing that such food programmes are out there, provides a sense of food security and safety, knowing that they will not go without.

"*they are so joyful…after all those years of having a minimum of things, they get free things that will help them throughout life*" (session B, girl 1).

The importance of Manurewa food culture.

The students demonstrated a strong food culture within their school environment which expanded into talking about waste control, and the growth of produce from their own land. The children commented on the fact that their school gardens were not being utilised to their full capacity, with fruits and vegetables being grown going to waste. They demonstrated a deep sense of frustration towards this, wanting their garden to be used to its full potential to help to feed the school. Furthermore, the children commented on the Feed the Need school lunches, and how a lot of these meals are not eaten. They stated that these meals weren't going to 'waste', as a select few children have the ability to take these foods home to their families. However, some did comment that they didn't like the concept that students weren't appreciating and hence, eating meals provided.

"*I feel stink because I don't want to let food go to waste…some people in the world don't even get food, we need to be respectful for the food we get*" (session B, girl 3).

Finally, the children demonstrated a strong connection between food waste and how this impacts on the environment. They were extremely proud of their environmental waste and recycling programme that was implemented on school grounds. They believed that it helped to provide and clean image for the school, which gained respect from their local community and surrounding sister and brother school.

"*when other schools come to our school they think we are clean*" (session B, girl 2) "*we want them to know we are clean and responsible*" (session B, boy 2).

Negative perceptions

The students in general did not have many negative comments to say about the quality food being provided through different programmes available. There was however a major concern demonstrated amongst students when it came to the intermittent nature of the programmes provided. The children demonstrated that they didn't like Feed the Need only coming in the winter months, and wanted food provision throughout the whole year.

"*what I don't like about these programmes is that we don't get to have them every day*" (session B, girl 2).

The students seemed to demonstrate an underlying unease and anxiety to the inconsistent nature of the many different food programmes that were coming and leaving their school environment.

Furthermore, the students demonstrated a small amount of Neophobia, where they didn't like certain foods and meals that were being provided by different food programmes because they were not foods that they were used to.

"*I don't like the sausage because it's not cooked how I like it to be cooked at home*" (session B, girl 3).

This also demonstrates the relevance of food culture in this student population, where it is important that foods provided to students are culturally and socially relevant.

Appendix C: Materials used

Self-administered food record template used by children during data collection:

Name:

Age:

Gender:

Year (circle): 5 or 6

Ethnicity (circle): New Zealand European / Maori / Pacific Island / Asian / Other:_____

Please fill out with as much detail as you can! Remember to include anything you drink throughout the day as well.

Time	What did you eat?	Amount eaten *For example:* *1 small red apple* *2 slices of white bread* *1 trim milk box (250mL)* *1 subway with ham* *1 sandwich with 1 slice of ham and 1 slice of cheese*	Brand *For example:* *Meadowlea Edam Cheese* *Tip Top Bread*	Where did it come from? For example: -Home -Dairy -School (please specify e.g. Kidscan, Feed the Need etc.) -Other (please specify)
Morning Tea	Did you have breakfast at school? What did you have?			

	Name_____	Class_____		
Time	**What did you eat?**	**Amount eaten** ***For example:*** ***1 small red apple*** ***2 slices of white bread*** ***1 trim milk box (250mL)*** ***1 subway with ham*** ***1 sandwich with 1 slice of ham and 1 slice of cheese***	**Brand** ***For example:*** ***Meadowlea Edam Cheese*** ***Tip Top Bread***	**Where did it come from?** **For example:** **-Home** **-Dairy** **-School** **(please specify e.g. Kidscan, Feed the Need etc.)** **-Other (please specify)**
Lunch				

Moderator Guide for focus group – Teachers:

The aim of this session is to undertake a focus group with two teachers and the receptionist, who are involved in the processes that provide food to the children, to understand the perceived benefits of the food programmes at school.

OVERVIEW

- The discussion was centred on the school food programs offered at the school, over a timeframe of 45 minutes.
- Emphasis was on informal chat to gather thoughts, feelings and beliefs in relation to the food programmes and their perceived benefits.
- The session was audio-recorded, with permission from participants, to ensure accuracy of information collected.
- The teachers and receptionist were thanked for volunteering their time and ensured confidentiality.

INTRODUCTION

Outline of school food programmes:

1. Feed the Need – hot meals that come to school on Mondays, Wednesdays and Fridays only during term 3 of school.
2. Milk in schools – provide cartons of milk on Tuesday and Thursday
3. Fruit in schools – provide fruits for the children everyday
4. Bread in schools – provide 2 trays of bread loafs per week
5. Kidscan – provide muesli bars and fruit pottles
6. Breakfast programme
7. School lunches on Thursday (subway)

QUESTIONS

1. Refer to the food programmes (1-5) highlighted above

   Do these programmes in your view provide any benefits?

   Probes - thoughts, feelings, opinion

   Which of these programmes would you say provide the most benefit for the children? **Probes – health, behaviour, thoughts, feelings**

2. How does Feed the Need complement the other programmes?

   Probes – how does it fit in?

3. What do you like about it?

4. What do you dislike about it?

5. How could FTN do better?

6. How might the parents perceive benefits?

   Probes – health, behaviour, thoughts, feelings

7. Which programmes might the parents perceive to be providing the greatest benefits?

8. What changes, if any, have you noticed in the classroom as a result of the programmes?

   Probes: behaviour, attendance

9. How do you perceive the sustainability of these programmes? Feed the need? In your school?

   Probes – financially, advantages vs disadvantages

10. How do you perceive the sustainability of feed the need in other schools? (Value of feed the need relative to other programmes)

    Probes – financially, advantages vs disadvantages

Moderator Guide for focus group – Children:

Introduction – aim of interview 'perceived benefits of foods coming into the classroom'.

OVERVIEW

- 1-hour session around food provided at school: Milk, Fruit, Muesli Bars and Fruit Yoghurt Pottles, Breakfast Club, and Subway lunches (**get children to write in different colours on paper)**
- Thoughts, feelings, and beliefs, bodily feelings (**get children to write in different colours on paper)**
- We are here for a casual chat amongst ourselves and there is no right or wrong answer, I just want to know what it's like to be you!
- We will be recording this session as not to miss any important bits.
- Ensure confidentiality – no names will be used when we write about it

QUESTION GUIDE

1. When thinking back to the different food programs on offer at your school, what do you like about the foods coming into the classroom?

2. What don't you like about foods coming into the classroom?

3. Of the different foods coming into the classroom, what is your favourite?
probe, want to know details about the different programs

4. What do you like about the hot winter meals coming in?
Are there any other things that you like about it
probe, how it makes you feel, how it makes you act?

5.What about anything you dislike about it?

6. What foods would you like to see coming into the classroom?

probe, hot/cold/healthy/unhealthy

7. How do you feel about packaged foods in the classroom?

8. How do you feel about foods coming into the classroom being leftover?
What about if they are going to waste?

9. What do you think advantages would be to children in other schools having food in the classroom?

10. How do you think it might help the students?