Evaluation of school lunch programme at a low-decile primary school in South Auckland

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Abstract

Background: Optimal childhood nutrition is crucial as children experience rapid changes in physical, cognitive and behavioural development. However, increasing number of children is experiencing some form of malnutrition, either over- or under-nutrition. Diet inadequacies during school hours need to be addressed as food choices made during lunchtime are significant contributors to their overall diet. Minimal research has been conducted in New Zealand to assess what children are consuming at schools and whether a school lunch programme will be beneficial in improving nutrition and school outcomes.

Aim: To assess impacts of Feed the Need school lunch programme on children's dietary intakes, attendance and behaviours during school hours, pre-, during and post-programme.

Methods: Primary school children aged 10-11 years (n=77) from a low-decile school in South Auckland completed daily food records during school hours, in pre-, during and post- Feed the Need timeframes. Nutritional breakdown of food records was used to examine children's micro- and macro- nutrients intakes and most commonly consumed food items, across the timeframes. Three recipes from the programme were also analysed to determine their contribution to one-third of a child's daily requirements. Information for attendance and behaviours were obtained from the school records. Children's perception of the programme was examined through five Likert scale items, whereas focus group was conducted with class teachers.

Results: Feed the Need meals were adequate in meeting one-third of children's protein, folate, vitamin A, iron and zinc requirements, based on average contribution of the three meals within a week. During the programme, significant higher intakes of the same nutrients were observed ($p<0.05$). Energy level was inadequate whereas sodium content was elevated in these meals. Confectionery and sweet drinks were most commonly consumed during school hours. Attendance and behaviour conducts remained unaffected by the programme. However it was very well received by the children and teachers.

Conclusion: The programme, upon modifications and improvement of recipes, can be a useful instrument to prevent nutrient deficiencies in childhood. Longitudinal studies are needed to examine long term benefits of adequate childhood nutrition on health and educational outcomes.

Key words: school lunch programme, Feed the Need, childhood nutrition

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Chapter One: Introduction

1.1 Background of research

Children experience rapid changes through their childhood and adolescence and these majorly influence their physical, behavioural, cognitive and social development. Optimal nutrition during these crucial life stages is essential for the maintenance of growth and health (Ministry of Health, 2015d). The food and nutrition guidelines for children and young people ensure optimal growth and also prevention of nutritional deficiencies. It also aims to promote health, while also preventing obesity and diet-related chronic diseases (Ministry of Health, 2015d). However, over the years, childhood nutrition has become a growing worldwide issue, with concerns that more children are experiencing some form of malnutrition (Wong et al., 2015, Poskitt, 2014, Tzioumis and Adair, 2014, Lobstein et al., 2015).

Inadequate consumption of nutrients often results in over- and under- nutrition in children and adolescents. These are now considered the double burden of malnutrition, referring to the co-existence of the two within the same population (Tzioumis and Adair, 2014, World Health Organisation, Lanigan and Singhal, 2009, Wong et al., 2015). The term “child malnutrition” covers the following concepts and theories (Ge and Chang, 2001, World Health Organisation, World Food Programme, 2015, Unicef, 2006):

1. Inadequate nutrition, also known as under-nutrition or protein-energy malnutrition, due to insufficient intake of energy and essential nutrients that are vital for growth and development
2. Over-nutrition, which leads to overweight and obesity, due to excessive consumption of energy
3. Diseases that are derived from micro- nutrient deficiencies, resulting from the insufficient intake of one or more specific micro- nutrients such as vitamin A, folate, and iron.

As mentioned, nutritional issues among young children have received worldwide attention (Wong et al., 2015, Tran et al., 2014, Rito et al., 2013). While figures for all

nutrient deficiencies are unclear in New Zealand, the Ministry of Health suggested that common deficiencies include iron, iodine and selenium (Ministry of Health, 2015d).

An obesity epidemic has been on the rise over the past decades. In 2014, World Health Organisation released findings that 42 million children, aged five and under, were overweight or obese in year 2013; whereas more than 1.9 billion adults, who is of 18 years of age and older, were overweight (World Health Organisation, 2015g). From 1980 to 2013, public health sector saw an increase in percentage of men and women whose body mass index (BMI) was 25kg/m^2 or greater, from 28.8% to 36.9%; and 29.8% to 38.0% respectively (Ng et al., 2014).

In New Zealand, similar trends have been observed: around 30% of the adult population is obese in 2013/14, which equated to approximately over one million individuals (Ministry of Health, 2014). The rates were reported to be more pronounced among children of Maori and Pacific Island heritage and those from deprived neighbourhoods (Ministry of Health, 2014, Ministry of Health, 2015a). This was further supported by increasing epidemiological data showing that energy-dense diets are consumed particularly widely by those in lower socioeconomic areas (Darmon and Drewnowski, 2008). These New Zealand statistical figures, which have been the same trends for the past decade, raise concerns for the inadequate intakes of essential nutrients among these population groups.

Such phenomenon is also observed internationally. A study conducted in Finland, in which 404 children (aged 10 and 11 years) were investigated using food frequency questionnaires to determine their dietary patterns, reported a similar trend (Haapalahti et al., 2003). Findings revealed that higher family socio-economic status was associated with healthier food choices among school children; when compared to those in lower socio-economic status, they reported to consume vegetables more regularly, and did not use high fat milk or butter as much.

The alarming rate in increased childhood under- nutrition and obesity is of concern, and expansion of processed food with marketing strategies targeted at children is a major contributor. The lack of nutritious foods, in addition to the poor food choices,

were found to be prevalent in young children during school hours in New Zealand, and therefore result in diet inadequacy (Dresler-Hawke et al., 2009, Ministry of Health, 2015d).

Inadequacies in children's diets during school hours need to be addressed as the food choices made at lunchtime are believed to contribute significantly to the children's overall diet (Harrison et al., 2013). Inadequate childhood nutrition can have several impacts while transitioning into adulthood, including increased risks of high blood pressure, diabetes and other chronic diseases (Mohd Shariff et al., 2008). There have been suggestions that adult diseases are often results of disruptions during development stages, and they could occur over the early years of a child's life. Over time, such disruptions present a cumulative damage to the health and well-being of individuals (Shonkoff et al., 2009, Campbell et al., 2014). In Helsinki, 13345 men and women, born in 1934-44, were included in a study investigating the effect of maternal obesity and its long term consequences (Eriksson et al., 2014). Maternal BMI was strongly and positively associated with cardiovascular diseases and type 2 diabetes. Such findings are indicative that early prevention in life has greater benefits than modifications of health-related behaviours later in life (Shonkoff et al., 2009).

In New Zealand, researchers investigated lunch boxes of primary school children from the Manawatu region, where six primary schools with a combination of those from both low and high socio-economic areas were included (Dresler-Hawke et al., 2009). The common trend across all schools was that lunch boxes had a high over-representation of foods high in sugar, fat, and salt; and a low representation of fruits and vegetables in their lunches. Another study undertaken in this country reported inadequate nutrient intakes during school hours (Rockell et al., 2011). These dietary patterns were also clearly reflected in the 2002 National Children's Nutrition Survey (CNS2002) (Regan et al., 2008, Rockell et al., 2011), which will be discussed further in literature review.

As schools are the setting where children spend most of their time, such observations have sparked concerns among public health advocates, questioning the nutrition status of school children and the quality of school lunches brought in by children

especially those in lower decile schools. Families from low socioeconomic areas have been associated with an increased risk of developing nutrient deficiencies (which might cause measurable adverse effects on their growth), poorer cognitive and learning development, compromised immunity, and obesity as well as its associated health problems (Nelson, 2000).

The only published study related to school meal provision in NZ was conducted in 2010, where authors aimed to assess the effect of free breakfast provision in decile one to four primary schools throughout New Zealand (Ni Mhurchu et al., 2012). The Maori and Pacific populations made up 34% and 42% of the study populations, respectively, with the remaining NZEO (New Zealand Europeans and Others). Many have dismissed such programme due to the unpromising results produced, in which the programme did not produce significant differences in both school attendance and academic achievement (reading), although there was a significant decrease in hunger among children with free breakfasts.

Benefits of school lunch programmes have been widely discussed in all parts of the world, as it serves to not only tackle under-nutrition, but over-nutrition as well. The National School Lunch Programme (NSLP) in United States of American (USA) has been catering to school children for decades, both partially and fully funded depending on the child's social background as those of lower socioeconomic status receive free meals. Previous studies have shown that the NSLP benefits children's cognitive development (Carter, 2012), reduces food insecurity by 6%, poor health by 33% and obesity by 21% (Gundersen et al., 2012). The NSLP is recognised as critical to help school children improve dietary intake and develop lifelong healthy eating habits (Xue and Wang, 2012). However, NSLP's impacts on the childhood obesity epidemic in U.S. is controversial, with its effectiveness questioned due to the increasing incidence of overweight and obesity in the USA (Campbell et al., 2011). Therefore, it is important to evaluate school lunch meals that are available to children to ensure they meet the recommended nutritional guidelines. Similarly, school meals are strongly advocated by government throughout Europe, especially in the United Kingdom and Finland, where School Food Policies play an important role in providing a balanced meal for children during school hours.

Adequate childhood nutrition is suggested to be beneficial for short- and long- term health outcomes. It has been proposed that through sufficient essential nutrient intakes in school lunches and dinners, it can improve outcomes such as children's school attendance and development of cognitive development (Belot and James, 2011, Ni Mhurchu et al., 2012); however other studies had produced conflicting results (Mcewan, 2013), which will be discussed in greater details in Chapter 2.

1.2 Justification of the research

This research acts as a pilot study for school lunch programme research in New Zealand, which provides as an overview of benefits of such a programme for primary school children. The study was carried out in a decile one primary school in South Auckland. The lower the school's decile rating, the greater its proportion of students is from low socio-economic backgrounds. As previously mentioned, literature has pointed to the importance of nutrition intervention in early childhood as children spend most of their time at schools. Therefore it is important to investigate the types of foods they consume during school hours and also whether their nutrient intakes are meeting the recommended guidelines. In NZ, Maori and Pacific populations face greater inequalities, in comparison with other population groups, which directly impact on their health outcomes. Benefits of breakfast programmes have also been found to be more apparent in deprived areas (Defeyter et al., 2010). Therefore the South Auckland primary school is the optimal setting to carry out our research.

Feed the Need (FtN) is a charitable organisation formed three years ago, with the mission of providing warm nutritious meals for children who are in lower-decile schools in South Auckland, three times a week over the winter months (June – August). The programme was carried out from August to November in 2014, when this research was carried out.

The menu for 2014 consisted of nine recipes, which were rotated over a three-week cycle. Dietetic students from Massey University carried out a nutritional analysis for the lunch menu in 2014 to calculate the meals' contribution to the Nutrient Reference Values (NRVs) for the children. The overall findings indicated that the meals needed further modifications to improve the nutritional values for energy and other essential

nutrients. Detailed findings of the project will be presented and discussed in later chapters.

The **main scope of this project** is to investigate what children from this particular primary school are typically consuming during school hours, and therefore create an analysis of how the Feed the Need programme contributes to the children's nutritional intakes. Using a cross sectional study design, we collected daily food records from the children (Year Five and Six) during school hours, for one week before the programme started (pre- FtN timeframe), during the FtN, and again after the FtN programme had ended (post- FtN timeframe) to be able to assess its impacts on the children's food intakes. Upon entering the data onto a food analysis database, we were then able to investigate the types of foods the children were eating and also compare the differences between children's usual nutritional intakes with and without the FtN lunches that were provided.

The **secondary scope** is to investigate the children's attendance rates, as well as behavioural conducts observed from Positive Behaviour for Learning programme (PB4L), using information provided by the school. PB4L is a programme which aims to improve the wellbeing of children by supporting positive behaviour in situations of needs (Ministry of Education, 2015). In schools, teachers document any inappropriate behaviour from students and create a supportive environment to deal with issues of concern. However, we have noted that school attendance is also likely to be influenced by a combination of factors, such as medical appointments, dental visits, social or family backgrounds; whereas a child's behaviour is unlikely to be an aspect that can be immediately affected by nutrition in the short timeframe when the research was carried out. Children's and teachers' perceived views of the programme will also be examined through questionnaire and focus group.

Therefore this research aims to become an important starting point to further investigate the types of lunch school-age children are constantly exposed to, and also identify how a school lunch programme can help them meet the recommended nutrient intakes during school hours. These results can contribute to the existing literature about how nutrition initiatives in NZ school settings are useful in combating

childhood under- and over- nutrition. International initiatives proven to be successful include school lunch programmes, enforcement of school food policies, or nutrition education and curriculum for school children. This research could then be available to New Zealand Government or the Ministry of Health as a tool for ongoing policy development.

1.3 Aims, objectives, hypotheses

The overall aim of the study is to evaluate the school lunch programme, Feed the Need (FtN), and its impact on school children in a low-decile primary school in South Auckland.

The four objectives are as follows:

a) To determine the contribution of FtN meals to children's daily nutritional requirements

b) To compare the children's nutritional intakes (macro and micro nutrients) during school hours pre-, during and post- the FtN programme

c) To examine the impact of FtN programme on children's attendance and behavioural conducts using the PB4L programme

d) To investigate the teachers' and children's perceived views of the lunch provision

This research tests the following hypotheses:

During the FtN programme, we would observe a greater intake of essential nutrients in the children's diets during school hours, compared to the dietary patterns during school hours pre- and post- FtN programme. Also, by consuming meals from the programme, children would decrease the consumption of highly processed energy-dense food items that would contribute less nutritional value to their diets and further contribute to childhood under- and over- nutrition.

Throughout the weeks of the programme, an improvement in both attendance and behaviour at school may be anticipated. It has been previously noted that absenteeism at the school could be affected by lack of lunch to bring to school (short term) or

health-related illnesses as a result of poor nutrition (long term), as reported by the school principal. Intakes of appropriate nutrition could also have a positive impact on students' behaviours.

When the school trialled Feed the Need programme in 2013 for four weeks, both the children and teachers responded positively (new flavours for children, exposure to unfamiliar foods and consuming more substantial foods). We would predict similar findings in this aspect.

1.4 Structure of thesis

In chapter Two, we will be reviewing the definitions of child malnutrition, the recommended nutritional guideline by New Zealand's Ministry of Health, determinants of health and how they affect those in deprived areas, the importance of adequate nutrition during school hours in both health and educational outcomes, and also school lunch programmes that are available both internationally and within New Zealand. Following that, methodology that we used will be described in Chapter Three. Chapter Four features our results and any supporting statistical analyses. Chapter Five focuses on the discussion and in-depth investigation of the main findings. The final chapter will provide an overall summary of this research study, including its strengths and limitations, together with recommendations and a conclusion.

1.5 Researcher's contribution to the study

Researcher	Contribution
Jennifer Chua	Data collection, data entry, statistical analysis
School staff (Principal, teachers and administrator)	Provided information on school attendance and PB4L
	Collected data on behalf of researcher
Nitasha Walia	Conducted spot check for data entry
Samantha Ansell	Conducted spot check for data entry

Chapter Two: Literature review

In recent times, there are growing global concerns about the welfare of young children and their nutritional status. As non-communicable diseases such as cardiovascular issues become increasingly major burdens on the health sector in both developing and developed countries, it is suggested that the public health sector needs to take preventive measures (Puska, 2002, New Zealand Medical Association, 2014). In United States, prevalence of obesity has tripled over the last three decades (Khan et al., 2014). New Zealand childhood obesity rates reached 10.8% in 2015, which is an equivalent of 85,000 children (Ministry of Health, 2015a). Obesity and diet inadequacies are major concerns as public health efforts and interventions aim to target school settings where children spend a majority of their time at.

This literature review explores childhood nutrition and dietary requirements of children aged 10 to 11 years to achieve the recommended nutrition guidelines, as advised by New Zealand's Ministry of Health, for optimal health. Both under- and over-nutrition, and how they have greater impacts on the population groups from lower socioeconomic areas, are also investigated, with an overview of inequalities experienced by these groups. Current meal patterns of school-age children are explored, as well as the numerous school-based interventions that have been proven effective.

International school lunch programmes and policies that are available will also be discussed. Long term effects of good childhood nutrition, from both health and school outcomes perspective, will be explored; followed by what is currently available in the country and whether there needs to be more effort in addressing childhood malnutrition.

2.1 Childhood nutrition

A healthy childhood is significantly influenced by adequate nutrition (Clark and Fox, 2009). Throughout periods of childhood and adolescence, children experience rapid changes and optimal nutrition during this period is essential for the maintenance of health and well-being (Ministry of Health, 2015d). Children's continuous growth and

development suggest that their dietary requirements can vary significantly to those of adults. In addition, there is clear evidence that establishing good nutrition and lifestyle patterns during childhood and adolescence positively impacts on health outcomes during adulthood.

Deprivation of nutrition during childhood is an increasing issue from a public health perspective (Piernas et al., 2015, Tzioumis and Adair, 2014). According to the World Health Organization, out of the ten leading risks of disease burden in developed countries measured in DALYs (Disability Adjusted Life Years), five of them are commonly associated with nutrition. These include obesity, high cholesterol, high blood pressure, and nutrient deficiencies (Belot and James, 2011). Actions are, therefore, necessary at a young age to prevent major diet-related complications and risk factors, before they reach adulthood (Rush et al., 2014).

2.1.1 Nutrient guidelines and recommendations

To achieve optimal health and growth, children and adolescents are required to consume adequate amount of essential nutrients on a daily basis. New Zealand's Ministry of Health has published the recommended Nutrient Reference Values (NRV) for all of the nutrients for this age group (Ministry of Health, 2015d). As this research focuses on assessing the nutrient adequacy of children as a population group, the Estimated Average Requirement (EAR) will be used to investigate the adequacy of their nutrient intakes. EAR is defined as "*a daily nutrient level estimated to meet the requirements of half the healthy individuals in a particular life stage and gender group*" (Ministry of Health, 2015d). However, as there are currently no EAR values for certain nutrients, other relevant NRVs such as Adequate Intake (AI) will be used instead.

In order to meet their daily nutritional requirements, young children are recommended to consume the right proportions of these four essential food groups: bread and cereals, fruit and vegetables, milk and dairy products, and lean meat, nuts, eggs or other vegetarian protein sources (Ministry of Health, 2015d).

These foods provide a variety of essential nutrients such as energy, protein, iron, calcium, folate, vitamin B12 and other vitamins and minerals. Exploring these guidelines will determine the adequacy of current dietary intakes of the children in our study, when compared to the recommendations. **Table 2.1** summarises the dietary requirements for optimal growth of children aged 10 to 11, and the examples of food sources and the nutrients they provide. These are recommendations based on the latest scientific evidence research and findings (Ministry of Health, 2015d).

Table 2. 1: Essential nutrients and their Nutrient Reference Values, with benefits and functions for growth for boys and girls aged 10-11 years, and the major food sources of each nutrient

Nutrients	Estimated Average Requirements (EAR)		Benefits / Functions	Major food sources
	Boys	Girls		
Energy[1]	8,900 kJ	7,800 kJ	Energy is a macronutrient which is required for growth, metabolic and physiological functions, heat production and muscular activity (Ministry of Health, 2015d).	Energy is mainly generated from ingestion of carbohydrates (breads, cereals, and fruits), fats, and proteins (red meat, chicken, and eggs). Energy is released as these foods are metabolised.
Carbohydrates[1]	262g	229g	Carbohydrates serve as the main source of energy in children's diet. As they are broken down into glucose, it will be used for different cells, tissues and organs.	Wholegrain breads and cereals, fruits or vegetables, and legumes are good sources of dietary carbohydrates.
Protein	31g	24g	Protein is important for building, maintaining and repairing tissues. This is particularly essential during childhood and adolescence to support growth (Ministry of Health, 2015d).	Protein can be sourced from both animal and plant foods. Meat, poultry, fish, eggs, tofu, dairy products, seeds and nuts have high levels in them.

Nutrients	Estimated Average Requirements (EAR)		Benefits / Functions	Major food sources
	Boys	Girls		
Total Fat[1]	89.0g	75.6g	There are several classifications of fatty acids, namely saturated, trans, monounsaturated and polyunsaturated (including omega 3 and omega 6). Both mono- and poly- unsaturated fats are also known as the 'good fats', which have the potential to lower total and LDL cholesterol (Ministry of Health, 2015d). Saturated and trans fats will be discussed further under "Effects of over- nutrition".	Examples of mono- and poly- unsaturated fats are nuts, almonds, avocados, oils (except coconut oil). Fish, fish oils, poultry and eggs are also main sources. Although these types of fats contain better nutritional properties, the proportion consumed still need to be limited due to their high energy levels.
Iron	6 mg		The role of iron is to produce haemoglobin in the blood, which is responsible to carry oxygen (New Zealand Nutrition Foundation, 2015). Needs are higher during rapid growth such as early childhood and growth spurts. It is important to prevent anaemia, fatigue, impaired immune function, and certain cognitive learning effects (Ministry of Health, 2015d).	Sources of haem iron (with higher bioavailability) include red meat and shellfish, whereas non-haem iron (with lower bioavailability) is found in breads and cereals, nuts and fruit, vegetables, and legumes.

Nutrients	Estimated Average Requirements (EAR)		Benefits / Functions	Major food sources
	Boys	Girls		
Calcium	800 mg	1000 mg	Maintaining adequate calcium intake during childhood and adolescence is necessary for the development of peak bone mass, which may be important in reducing the risk of fractures and osteoporosis later in life (Greer and Krebs, 2006).	Dairy products such as milk and milk products (cheese and yoghurt), and calcium-fortified milk alternatives are excellent sources. It can also be found in non-dairy products such as canned fish with bones, legumes, nuts and seeds, dark green leafy vegetables and fortified breakfast cereals.
Dietary fibre[2]	24 g	20 g	Dietary fibre promotes healthy bowel functions. Soluble fibre reduces risk of cardiovascular disease as it lowers blood cholesterol level (Bazzano, 2008, New Zealand Nutrition Foundation, 2015). Soluble fibre absorbs fluid and softens bowel contents. It also improves blood glucose levels. Insoluble fibre is a 'bulking agent' to make bowel movements regular.	Soluble fibre sources include oats, legumes, broccoli, carrots, kumara, apples, pears, stone and berry fruit; whereas wholegrain breads and cereals, corn, fruits and vegetables are insoluble options. Adequate fluid intake is also recommended when eating high fibre foods.

Nutrients	Estimated Average Requirements (EAR)		Benefits / Functions	Major food sources
	Boys	Girls		
Folate	250 µg		Requirement for folate is highest during growth. As it is involved in the synthesis of DNA and proteins, its inadequacy will impair immune function and cause macrocytic anaemia (Ministry of Health, 2015d).	Dark-green leafy vegetables (broccoli, spinach, brussel sprouts), citrus fruit, fortified breads and cereals are major folate sources.
Vitamin A	445 µg	420 µg	Vitamin A incorporates retinol and beta-carotene (which acts as a precursor for vitamin A). It is required for immune function and regulation of cell growth (Ministry of Health, 2015d).	Meat, eggs, milk products, and oily fish are in retinol form; colourful vegetables (carrots, pumpkins, kumara), and dark-green leafy vegetables (spinach, silver beet) are in beta-carotene form.
Vitamin D	5.0 µg		As vitamin D promotes calcium absorption and bone health, an inadequacy of the vitamin can cause abnormal bone formation (Kaganov et al., 2015).	The main source is exposure to sunlight (Ministry of Health, 2015d). Dietary intake alone is insufficient to achieve adequacy; but main sources include salmon, sardines, eggs and other fortified foods.

Nutrients	Estimated Average Requirements (EAR)		Benefits / Functions	Major food sources
	Boys	Girls		
Vitamin B12	1.5 µg		Vitamin B12 is important for production and maintenance of healthy blood and nerve cells (New Zealand Nutrition Foundation, 2015). Both folate and vitamin B12 are involved in production of red blood cells and the functioning of human's genetic material.	Animal products are rich in vitamin B12. For vegetarians, eggs and milk products or any other fortified foods can be the alternatives although not at a high level (Ministry of Health, 2015d).
Selenium	40 µg		It has a vital role in thyroid hormone metabolism and antioxidant defence (Ministry of Health, 2015d), as well as regulation of blood pressure and maintenance of immune system (New Zealand Nutrition Foundation, 2015).	Fish, eggs, nuts (especially Brazil nuts), and cereals are the common foods with appropriate content of selenium.
Iodine	75 µg		Iodine is an essential component of thyroid hormones, which play a critical role in maintaining the body's metabolic rate and in normal growth and development. It is also involved in cognitive development (Kaganov et al., 2015).	The main sources of iodine in NZ are of marine origin - including seaweed, seafood and fish - along with dairy products and eggs. Most breads in NZ are fortified with iodine (New Zealand Nutrition Foundation, 2015).

Nutrients	Estimated Average Requirements (EAR)		Benefits / Functions	Major food sources
	Boys	Girls		
Zinc	5 mg		Zinc is essential to promote optimal cognitive and immune functions, as well as to support both growth and development (Ministry of Health, 2015d).	Protein sources such as seafood (fish and shellfish), lean meat and poultry are sources of good bioavailability. Others include nuts, legumes and wholegrain products (Ministry of Health, 2015d).

[$]NRV reported as EAR for children 10-11 years old, unless specified otherwise

[1]References values determined from the mean intakes of children 7-10 years (energy) and 9-14 years (carbohydrate, sugar and fat) (Clinical Trials Research Unit and Synovate. 2010. A National Survey of Children and Young People's Physical Activity and Dietary Behaviours in New Zealand: 2008/09: Key findings. Wellington: Ministry of Health).

[2]Adequate Intake (AI) levels recommended for children 10-11years old (Ministry of Health, 2015d)

2.1.2 Effects of over-nutrition

Appropriate childhood nutrition is essential due to both immediate and long term consequences of diet inadequacies. The consequences are not only limited to malnutrition in childhood, but it potentially causes more complications in the long run, which can result in diabetes epidemic as well as potential decline in life expectancy for the population (Mohd Shariff et al., 2008, Rush et al., 2012).

Foods that are of poorer nutritional quality, if consumed at a high level, can contribute to problems of excess energy intake, inadequate intake of essential nutrients and childhood obesity (Ministry of Health, 2015d). This has led to ongoing research that addresses the rise of overweight and obesity as it remains a major issue for children in many countries (Choumenkovitch et al., 2013, De Bock et al., 2012, Rito et al., 2013, Madden et al., 2013). Based on data from the National Health and Nutrition Examination Survey 2005 – 2006, a cross sectional analysis in United States identified the top dietary sources of energy, fats and sugars for children aged two to eighteen year-olds, (Reedy and Krebs-Smith, 2010). They were grain desserts, pizza and soda, with 577.4kJ/day, 569.0kJ/day and 493.7kJ/day respectively. The study also reported that approximately 40% of total energy consumed was in the form of empty calories, which incorporated both solid fat and added sugars.

Excessive consumption of the following nutrients has been linked to negative health outcomes:

(a) Energy – An over-consumption of energy has derived mainly from “empty calories”. This is defined as the “sum of energy from solid fats and added sugars” (Reedy and Krebs-Smith, 2010). Empty calories, also known as high fat/sugar/salt foods (HFSS) such as cream-filled biscuits, potato crisps, sweetened beverages and confectionery contribute very little nutritional value to the children’s diets and are often associated with their increased risk of being overweight and obese (Ministry of Health, 2015d). Although additional energy is required to fuel the growth of young children, level and sources of intake should be monitored.

(b) Sodium – Sodium or salt is found not only in breads, cereals and certain dairy products, but its level can be immensely high in manufactured foods, such as pies and potato crisps. The Adequate Intake (AI) for sodium in age group of 9 to 13 years old is 400 – 800mg (Ministry of Health, 2015d). High sodium intake has been repeatedly proven to be a major risk factor for high blood pressure, which can result in multiple cardiovascular diseases in adulthood (Ministry of Health, 2015d).

(c) Fats, especially saturated and trans fats – Saturated and trans fats are mainly found in butter, full-cream milk, meat, highly processed products such as pies, biscuits and pastries (Ministry of Health, 2015d). Children can establish atherosclerosis during the early years of their lives, and this results in cardiovascular diseases later in adulthood (Daniels and Greer, 2008). Therefore, the types and amount of fats consumed during childhood should be well monitored, as cardiovascular diseases remain as the leading cause of death in New Zealand (Ministry of Health, 2015d).

(d) Carbohydrates and sugars – Sugary drinks and refined cereals are major contributors of carbohydrates and sugars for young children (Ministry of Health, 2015d). Majority of sugary items sold in convenience shops around school areas contain high levels of artificial flavours and added colourings. It has been suggested that excessive added sugar intake could cause attention deficit hyperactivity disorders (ADHD) (Johnson et al., 2011). This causes children to experience a lack of attention and tolerance, as well as excessive motor activity (Mahan et al., 2012). Increased incidence of dental caries is also a major concern.

2.1.3 Nutrients inadequacy and the associated deficiencies

The over-consumption of certain nutrients is likely to replace the intakes of other essential nutrients with more nutritional value. These inadequate intakes, which often result in nutrient deficiencies, are precursors to multiple diseases that impact morbidity and mortality (Sorhaindo and Feinstein, 2006). World Food Programme recognised the following four deficiencies among the top ten leading causes of death through disease (World Food Programme, 2015):

1. Iron deficiency – as this has been recognised as the most common nutrient disorder for those under two years of age, such deficiency is reported to have long term consequences such as delayed development and poorer performance in late childhood leading into early adolescence (Mahan et al., 2012). Other possible consequences include increased risk of infection and impaired psychological development (Ministry of Health, 2015d). However, the 2002 National Children's Nutrition Survey (CNS2002) found that the prevalence of iron deficiency was fairly low among children in New Zealand (Ministry of Health, 2015d). New surveys may be needed to determine the most current prevalence, as small studies have shown up to 24 percent of children may be iron deficient (World Health Organisation).
2. Vitamin A deficiency – Research in New Zealand has reported the prevalence of vitamin A deficiency to be 10% in those aged between five and fourteen, and it is considerably higher for Pacific children and young people (Ministry of Health, 2015d). As it is responsible to maintain vision, blindness can occur as a result of its deficiency. Other consequences are one's reduced ability to see in dim light, impaired immunity, and increased risk of infection (Ministry of Health, 2015d).
3. Iodine deficiency – Soils in New Zealand are low in iodine, resulting in low iodine content in foods grown locally. Mild iodine deficiency can have an impact on one's hearing, mental development and IQ level (Ministry of Health, 2015d). A more severe form of iodine deficiency can result in goitre (swelling of the thyroid gland in the neck with associated lethargy) and hypothyroidism (caused by insufficient production of the thyroid hormone by the thyroid gland) (New Zealand Nutrition Foundation, 2015).
4. Zinc deficiency – Zinc is essential for growth and development. Marginal zinc deficiencies occur most commonly in low-income groups and also those who consume unbalanced diets that are deficient in fat and in proteins of animal origin (Taras, 2005). This puts them at higher risks of impaired growth, poor immunity and cognitive functions (Ministry of Health, 2015d). In New Zealand, the prevalence of zinc deficiency was found to be highest in Pacific children, followed by Maori children and then New Zealand European and others (NZEO) (Gibson et al., 2011).

2.2 Malnutrition in children

As mentioned in Chapter One, the double burden of malnutrition is when under- and over- nutrition co-exist within a population. Child malnutrition has become a rising concern in both low- and middle- income countries (Poskitt, 2014, Wong et al., 2015), as rapid rise in childhood obesity parallels the continuingly growing levels of under-nutrition (Lobstein et al., 2015, Tzioumis and Adair, 2014). The prevailing under-nutrition and increasing over-nutrition, such as that in both the urban and rural communities in Malaysia, often justify the great need to provide health and nutrition interventions to children and adolescents (Mohd Shariff et al., 2008).

The phenomenon of under- and over- nutrition was observed by a study conducted in Colombia. With the data from 2005 Colombian Demographic and Health Survey and 2005 Colombian census, the authors explored the association between individual or household characteristics and malnutrition in 30779 children (Garcia et al., 2013). Cross-sectional data revealed that children in poorer households were almost five times more likely to be stunted, while those from richer households were 1.3 to 2.8 times more likely to be overweight.

Data from the CNS2002 in New Zealand revealed similar patterns; in which urban boys and girls aged five to fifteen years were 1.3 and 1.4 times more likely to be overweight than those in rural areas, respectively (Hodgkin et al., 2010). The authors cited another study in New Zealand, which found children in rural areas to have lower body fat percentage in five year-olds, and smaller waist circumferences and body mass index in ten year-olds, when compared to those in urban areas. Studies cited in the same article also reported similar trends in Turkey, China and Brazil (Hodgkin et al., 2010).

Such findings are strengthened by a large study conducted in China, in which two to twelve year-old children participated in the 2009-2011 China Health and Nutrition Survey (Piernas et al., 2015). After comparing their dietary intakes with the 2013 Chinese Dietary Recommended Intakes, it was found that among seven to twelve year-old children, approximately 21% were underweight and 19% were overweight or obese in 2011. Children from higher socioeconomic status were more overweight and obese, as they had significantly higher intakes of daily energy. However, they also consumed

most macro- and micro- nutrients compared to those from lower socioeconomic status (Piernas et al., 2015).

On the other hand, recent data available for NZ that was published in the Annual Update of Key Results 2013/14: New Zealand Health Survey on the health of our children had a different finding (Ministry of Health, 2014). Children of Pacific background, from lower socio-economic areas, are 3.2 times as likely to be obese as non- Pacific children. However, there were no significant changes in rates since 2011/12. Obesity rates were positively related to socioeconomic deprivation; the obesity rate for children living in the most deprived areas is 2.7 times the rate in the least deprived areas, after adjusting for age, sex and ethnic differences (Ministry of Health, 2014). In United States, disadvantaged children living in rural areas are said to be disproportionately at increased risk for overweight and obesity with prevalence rates reaching nearly 50% (Choumenkovitch et al., 2013). These findings are strong evidence that both under- and over- nutrition could be major issues for all socio-economic classes, regardless of status, in both developing and developed countries.

World Health Organisation has attributed childhood malnutrition to the lack of access to highly nutritious foods (World Health Organisation, 2015e). The ideal foods for children should provide an adequate amount of energy, vitamin and minerals, proteins, fibre and good balance of fats. However, in NZ, manufactured foods high in fat, salt and sugar often appear to be more affordable than foods of higher nutritional value (Ministry of Health, 2015d). These foods have been heavily marketed and produced to suit children's tastes, and packaged and sold as "appropriate snacks for children and young people' (Utter et al., 2007, Swinburn et al., 2011).

The 2006/07 Health Survey indicated that children had a great intake of these foods (Ministry of Health, 2015d). Data is currently limited for younger children in NZ, but a huge proportion of older children are found to be highly exposed to these foods. A high percentage of male teenagers consumed juice/fruit drink (44%) and soft drinks (53%) at least three times per week. Similar patterns were observed in female teenagers, with 49% consuming juice or fruit drinks and 40% have soft drinks at least

three times per week. At the same frequency, confectionery consumption was high in both males and females, 35% and 43% respectively.

Therefore, poor food choices among children have resulted in different outcomes of malnutrition (under- and over- nutrition). These are often influenced by several determinants of health, which will be discussed further in the following section.

2.2.1 Determinants of health in low decile areas

The overall health of children, including their nutritional status, is greatly influenced by several factors. These include their social and economic environment, their physical environment, individual behaviours or characteristics as well as genetic susceptibility (World Health Organisation, 2015a).

These factors often act collectively to influence the health outcomes of children. The following points summarise how each factor influences a child's health and nutrition outcomes.

1. A family's lower income and social status are linked to worse nutrition and health outcomes, as a result of lack of access to healthcare due to its affordability (World Health Organisation, 2015a). However, as mentioned previously, higher social status can also be associated with higher prevalence of over- nutrition in certain communities.
2. Low levels of education are linked with poor health (which derives from poor knowledge), more stress and lower self-confidence (World Health Organisation, 2015a). In the long run, higher levels of education and knowledge also lead to better employment and work conditions through an increase in overall understanding and literacy of how to improve own health through their actions (Mikkonen and Raphael, 2010). Education or knowledge alone, however, is argued to not be sufficient to promote better health (Warren et al., 2008)
3. A child's physical environment is also an important determinant of health and nutrition. The processed food industry is constantly deterring the public health efforts in implementing food policies for promotion of health eating (Swinburn et al., 2015). School children are often surrounded by convenience stores and

tuck shops that sell cheap and highly flavourful foods. Vending machines, snack bars and school canteens have also been associated with higher consumption of fat and sweetened beverages, and decreased consumption of fruits and vegetables (Nansel et al., 2010). Recent literature shows that if interventions are focused on enriching children's physical environments, there can be significant impacts on numerous outcomes in their lives (Campbell et al., 2014). In particular, a school environment which is supportive of healthy eating is essential to combat heavy marketing of unhealthy food. Modifications within and outside the school food environment can promote a positive impact on eating behaviours and this often requires more policy changes at a national level (Driessen et al., 2014).

4. There have also been suggestions that maternal health during pregnancy plays an important role in determining the health status of young children. A study by Eriksson et al observed that maternal BMI was found to be positively associated with the following health outcomes of their offspring: death, cancer and stroke. CVD and type 2 diabetes outcomes were found to have the strongest association with maternal BMI (Eriksson et al., 2014).
5. Great social support from families, friends and communities is also associated with better health and nutrition outcomes. Culture, which involves traditions and the beliefs of the family and community, could also have an impact on children's overall health (World Health Organisation, 2015a). However, despite social support, it can remain challenging to improve the health of Maori or People of Pacific if they continue to experience limited access to education and health care.

2.2.2 Health status of Maori and Pacific populations

In New Zealand, the existing inequalities between NZEO and Maori or Pacific groups have persisted over a long period of time. Both socioeconomic and geographical inequalities appear to be very significant in determining children's nutritional status. The poorer segment of the population in New Zealand, often consisting of Maori and Pacific groups, is at a higher risk of malnutrition (Rush et al., 2012, Utter et al., 2007). Previous results from the 1997 NZ National Nutrition Survey (NNS97) found that there

was a significant relationship between living in the most deprived areas of the country and inadequate intakes of zinc, vitamin A, riboflavin, folate, dietary fibre, calcium, vegetables and fruit (Russell et al., 1999). A majority of these findings remain unchanged as of recently; Pacific children, particularly those aged 11–14 years, are said to be at higher risk of inadequate intakes of similar nutrients: vitamin A, folate, calcium and also selenium (Ministry of Health, 2015d).

Inequalities experienced in early life can have an impact on a child later in adulthood, by taking a cumulative toll on his or her health. Such inequalities are particularly impactful on those of lower socioeconomic status. The NNS97 and 2002 National Children's Nutrition Survey (CNS2002) found that lower socioeconomic households are more likely to report to be unable to afford foods for better diets, and the variety of foods eaten was limited by money as reported by almost half of Maori (Ministry of Health, 2006a).

These findings were well reflected in the findings of the 2008/09 New Zealand adult nutrition survey (with a focus on Maori nutrition), which was released in 2012 (Ministry of Health, 2012). It was found that Maori males and females consumed a higher percentage of energy, and this was mainly sourced from total fat, saturated fat and monounsaturated fat (Ministry of Health, 2012). Their dietary habits indicated that the population group was more likely to choose full fat milk and consume fast food and soft drinks (more than three times per week). They were also less likely to have the recommended five servings of fruit and vegetables, compared to non-Maori population groups (Ministry of Health, 2012). As children have limited influence over what they consume in home setting, they are inclined to consume the same foods as their parents and form similar dietary habits at a young age as they are still learning to develop them (De Bock et al., 2012).

A secondary analysis, conducted using the data collected from the CNS2002, revealed that about half of the children surveyed (58%) purchased either some, or most of their food from the school canteen (Utter et al., 2007). They also reported that among the younger canteen users, they were more likely to be of Maori or Pacific background and from more economically disadvantaged areas (Utter et al., 2007). They were

significantly more likely to consume carbonated drinks five or more times, sweet treats four or more times and sausage rolls or pies three or more times in a week. The same analyses also reported that school canteen use was associated with poor dietary patterns (e.g. lower intakes of vegetables and fruit, and higher intakes of foods high in fat and/or sugar) and higher BMI.

Obesity rates among the 2-14 years old of different population groups in New Zealand were demonstrated in **Figure 2.1** below:

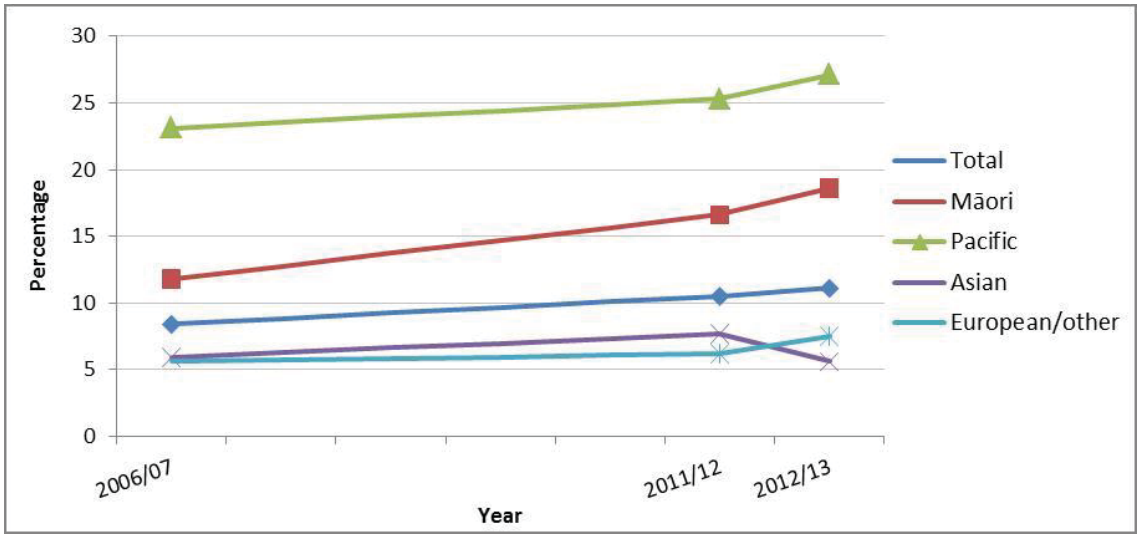

Figure 2. 1: Obesity rates among 2-14 year-old children in New Zealand from 2006 – 2013.

*Obesity rates on upward trend for all groups, other than Asian, with Maori and Pacific children having the highest percentages of obesity.

(Source: Associate Professor Louise Signal: Action needed to halt New Zealand's obesity epidemic: Themes from Big Food Symposium - https://blogs.otago.ac.nz/pubhealthexpert/2014/02/19/action-needed-to-halt-new-zealands-obesity-epidemic-themes-from-big-food-symposium/)

Both overweight and obesity rates, defined by body mass indexes, were also found to have increased to 40% in Maori and 60% in Pacific children, compared to 24% in NZEO (Rush et al., 2012). Higher rates are also found in more deprived areas, and in girls, compared to boys, from ten years of age (Rush et al., 2012). These statistical findings highlight the persisting inequities for Maori as well as Pacific populations and continue to identify the challenges and barriers to improve their health outcomes, and also decrease other health co-morbidities.

2.3 Meal patterns during school hours

The food choices made during school lunchtime are believed to make a significant contribution to the children's overall diet (Harrison et al., 2013). However, limited data is available in New Zealand regarding children's usual dietary intake during school hours. Data from CNS2002 suggest that children's morning snacks are often of poor nutritional quality (Regan et al., 2008). The authors found that the most commonly consumed foods in the morning from nine to eleven were: potato chips, corn snacks, popcorn and other snacks (29%); fruit, including dried fruit and roll-ups (22%); and biscuits, crackers, and muesli bars (21%). A typical single snack item could supply an average of 6-14% of a day's recommended calories, fat, sugar, and sodium, or even 56-169% for some (Lucan et al., 2010). These findings suggest that morning snacks are an important contributor of children's energy intakes and are likely to contribute fewer other important nutrients.

The same analysis revealed that lunch provided approximately 20% of daily energy, protein, fat and carbohydrate intake, and approximately 15% of daily calcium, iron and vitamin A intake (Regan et al., 2008). The analysis also found that nearly all children (94%) had something to eat at lunch during school hours. Foods commonly consumed at lunch time (between 12 and 2 pm) included: sandwiches (by 44% of children); fruit including dried fruit and roll-ups (36%); biscuits, muesli bars and crackers (16%); potato chips, corn snacks, popcorn and other snacks (16%); and sweetened drinks (16%) (Regan et al., 2008).In 2004, a survey was conducted to assess foods available in 200 primary school canteens throughout New Zealand and the findings revealed that the most common foods were pies (79%), juice (57%) and sausage rolls (54.5%), with pies being the most purchased items (>55000 per week) (Carter and Swinburn, 2004). This dietary pattern is not surprising, as snack foods in canteens and convenience shops contribute to an obesogenic environment that promotes diet-related diseases, particularly for children of low-income and minority groups (Lucan et al., 2010). Although the sources of these foods were unknown, a cross sectional study carried out in the country in 2009 investigating 927 school lunch boxes of primary school children, indicated similar findings (Dresler-Hawke et al., 2009). Photographs of children's lunch boxes were taken in the morning and the unconsumed items in the bins were

observed after lunch. These lunchboxes showed an over-representation of fatty and sugary food items (23.8% and 22.2% respectively) and an under-representation of fruit and vegetables (8.2%) (Dresler-Hawke et al., 2009). Other essential food groups such as milk or dairy products and protein were below 10% of foods in the lunch boxes. The study found that over 80% of unconsumed foods were sandwiches, fruit and dairy, which contained more nutritional value than the energy-dense foods.

With data from CNS2002, 2572 children consumed different proportions of certain food groups depending on whether it was a school day or non-school day (Rockell et al., 2011). The authors also revealed that more children, aged 5-14 years, consumed snack bars, sandwiches, snack foods, biscuits, and fruits on school days compared to non-school days. Mean cholesterol was found to be higher on non-school days, while dietary fibre and carbohydrate were higher on school days.

In United Kingdom, such eating pattern was evident in a study observing 79 secondary schools, where 5695 students were included. Researchers visited the schools over lunchtimes to document the types of foods and beverages that were offered at schools and consumed each day (Nelson et al., 2004). The study found that the most commonly served food items (at least four days a week) were baked goods such as muffins and cakes (95% of schools), sandwiches and soft drinks (92%), and fruits (91%). Authors Belot and James (2011) cited that children were more likely to choose desserts, cakes, biscuits and ice cream (78% of pupils), as seen in the study by Nelson et al. Higher fat main dishes were chosen by nearly 53% of students, compared to 29% who chose lower fat main dishes; similarly, 48% of students chose chips and other potatoes, in comparison to potatoes not cooked in oil or fat (25%) (Belot and James, 2011).

Besides the types of food items consumed during school hours, children's meal patterns also play an important role in creating a balanced eating habit among young children. Research has found that irregular meal consumption was associated to a low intake of fruit and vegetables among adolescents (Pedersen et al., 2012).

Below are the important findings of meal patterns obtained from NZ based studies, as highlighted by Ministry of Health in their latest edition of nutrition guidelines for young New Zealanders (Ministry of Health, 2015d):

i. Missing breakfasts or other meals during the day could have a negative impact on children's cognitive function, academic performance, school attendance, psychological function and mood.
ii. Most young children (90%) have at least something to eat for lunch at school. Only around 66% of young people eat lunch on four or more school days.
iii. Nearly half of 12-18 year olds purchase their lunch from convenience stores or canteens. This behaviour is very likely to carry on throughout the rest of their school years as habits are established from a young age.
iv. Lunch meals provide children with their daily energy when levels may be decreasing around mid-day.

Lunch meals consumed at school are a significant contributor of energy and nutrients, providing between 25% and 33% of daily energy intakes among primary school children, (Ministry of Health, 2015d, Ruxton et al., 1996, Barton, 2000). Hence improvements in school lunches are suggested to have an impact on overall diet, potentially leading to improved health outcomes through an increased intake of essential nutrients (Harrison et al., 2013).

2.3.1 The importance of appropriate nutrition in school setting

Ongoing research indicate that the school food environment determines the quantity and quality of children's diets during school hours (Bartrina and Pérez-Rodrigo, 2006). This is because children spend the majority of their weekdays in schools and their daily energy intakes are estimated to range between 19% to 50% while at schools (Nansel et al., 2010). Therefore, the prolonged and comprehensive contact schools have with children allows the education and promotion of healthy eating and active lifestyles to be considered the most effective when planted in this setting (Nansel et al., 2010, Rito et al., 2013, Tran et al., 2014, Driessen et al., 2014, Damsgaard et al., 2014).

Nutrition education, in which children learn to adapt to eating and nutrition-related behaviour for health and well-being, has been proven to be one of the most effective means to tackle the unhealthy eating patterns, as well as increase knowledge and practical skills (Mohd Shariff et al., 2008). This is due to the stimulation component that has an effect on the cognitive functions of the child (Nores and Barnett, 2010). Therefore, an intervention involving education as one of the components in schools is beneficial.

One of the common theories reported to eliminate the burden of childhood malnutrition is sustained exposure to nutritious food (Mcewan, 2013). Furthermore, researchers have claimed that in order to promote better health, approaches have to be extended beyond the preparation of a healthy school meal for the children. Important elements to be considered for provision of school meals include students' needs, preferences and experiences; supportive atmosphere and positive environment which constitutes school food policies and service style of the meals; and variety of high-quality foods of appropriate portion size which consist of adequate nutrients that meets the recommendations (Bartrina and Pérez-Rodrigo, 2006).

A research study recruited 335 primary school students from a south-western state of Malaysia (168 in intervention, 167 in control), and examined their knowledge, attitude and practices of dietary behaviours (Mohd Shariff et al., 2008). The intervention group received nutrition education intervention, including practical hands-on activities, video presentations and exhibitions, for six weeks while control group had the standard Health and Physical Education curriculum. There were significant increases in the post intervention mean scores of knowledge (2.17 vs. 0.47), attitude (1.40 vs. 0.32) and practice (0.87 vs. -0.10) items for the intervention group, when compared to the control group (Mohd Shariff et al., 2008). There was a significant correlation between change in children's nutrition knowledge and changes in their practices and attitudes, which was maintained after adjusting for confounders.

Similar findings were detected in a study investigating the short-term impacts of a nutritional intervention in 377 German pre-school children (De Bock et al., 2012). By carrying out a cluster-randomised study design, a six-month intervention was

administered once weekly by a nutrition expert, whereby children were educated on meal preparation and activities to increase their knowledge of nutrition. At the end of the intervention, children's fruits and vegetables intakes were reported to have significantly increased, however with no change in consumption of sugary drinks or anthropometric measurement (De Bock et al., 2012).

Another study in Minneapolis metropolitan area shows school environment to be an optimal setting to influence young children's food choices and increase their knowledge about importance of nutrition (Burgess-Champoux et al., 2008). The intervention group (67 students, mean age of ten years) received modified canteen menus, classroom curriculum on Social Cognitive Theory, and family oriented activities which allowed the involvement of parents. The consumption of whole grain products had increased during lunch meals, with refined grain consumption decreasing. As the availability of whole grain increased, children in the intervention group were more capable in identifying these products, compared to control group. This indicated that the availability of healthy food groups at schools may have increased the intake of these foods; with potential health and weight maintenance benefits in the long run (Burgess-Champoux et al., 2008, Choumenkovitch et al., 2013).

These findings are indicative that interventions at an early age have the ability to modify children's poor dietary habits. In conjunction with nutrition education, provision of school meals or healthy school environment was also found to be an effective way of promoting higher intakes of essential nutrients among school-age children.

An observation was carried out in South West England, involving 621 seven year-old primary school children. In the study, authors compared the nutrient intakes between those who consumed school meals and those with packed lunches (Rogers et al., 2007). Subjects were chosen from the Avon Longitudinal Study of Parents and Children (ALSPAC), a prospective study of 14,541 pregnancies recruited from all pregnancies in the three Bristol-based District Health Authorities. Food diaries for two weekdays and one weekend day were completed by carer prior to visiting the clinic for analysis. If children consumed school dinners, portion size information was obtained from the

catering services. By analysing 3-day unweighted food records, it was found that both types of meals did not meet the dietary guidelines. It was concluded that even though both meals needed improvement as they were not in favour of dietary guidelines, the school meals were more favourable compared to packed lunches, as they were more nutritionally adequate (Rogers et al., 2007).

In 2007, another cross sectional survey was carried out in 54 English primary schools, where 2709 children between six and eight years old completed 24-hour estimated food diary. A comparison between school meals and packed lunches was also conducted (Evans et al., 2015). On average, children consuming a packed lunch were found to consume 11g more sugars and 101mg more sodium. There was also lower intake of vegetables throughout the day. Conversely, children consuming a school meal, on average, had more protein, fibre and zinc, 4.0g, 0.9g, and 0.4mg respectively. The energy consumed was similar between the two groups. Compared to children having a school meal, children taking a packed lunch to school consumed a diet of lower quality within the day. Authors concluded that such findings support the introduction of policies that increase uptake of school meals (Evans et al., 2015).

Authors carrying out a cross sectional study in Norfolk, United Kingdom, acknowledged the importance of foods consumed at schools and their impacts on the children's diets. They assessed the differences in dietary intakes of children consuming school meals and packed lunches (Harrison et al., 2013). "School meals" were defined as meals prepared and provided by the school, whereas "packed lunches" were brought in from home. 4-day food diaries were used to determine intakes of 1626 primary school children, aged nine to ten years old. Significant differences were observed between the two groups, with food choices among school meal eaters generally more in line with School Food Trust standards (Harrison et al., 2013). School meal eaters obtained a higher percentage of energy from protein and had an overall diet lower in energy dense foods.

Also within United Kingdom, a registered dietitian introduced the implementation of changes to a school kitchen's menu, for children aged between 12 and 16 in London (Madden et al., 2013). It involved the substitution of high fat and sugar food items (e.g.

thicker steakhouse chips on two of the four days standard chips were served, bacon was trimmed, reduced fat mayonnaise and cheese were used, most snacks remained on sale), as well as increase of fruit and vegetables options (e.g. a bowl of salad made available for free during intervention). A total of 378 lunches were observed and evaluated in 180 children pre-intervention and 198 children post-intervention. The intervention was found to have improved the mean fat and saturated fat intakes significantly and also encouraged a higher fruit and vegetable intake (Madden et al., 2013). Although the means did not meet the recommended guidelines, the results still showed the benefits of a kitchen-based intervention at schools to improve children's nutritional status.

In summary, these studies involved a large number of participants. It was evident that each study's findings reflected the types of foods children were consuming during school hours and their food choices were less likely to be of adequate nutrition, when compared to provision of school meals. School meal programmes with an education component are suggested to act as a medium to meet the children's nutritional requirements.

2.4 Short- and long- term benefits of adequate childhood nutrition

Adequate childhood nutrition is beneficial not only for the immediate effects it has on both physical and mental aspects of a child's health, but also for the health consequences later in life (Sorhaindo and Feinstein, 2006). There is now increasingly stronger evidence to suggest that nutrition and growth in early life, which has become a predictor of adult health, affect the development of adulthood chronic disease (Lanigan and Singhal, 2009). Second to tobacco in preventable deaths, poor diet and physical inactivity are accountable for an approximate of 365000 deaths in the United States annually. These result in US$110–129 billion in both direct and indirect health care costs per year (Nansel et al., 2010).

Therefore, by promoting healthy dietary intakes and adequate nutrition at a young age, behaviour in lifestyle choices can be formed over the course of childhood, and is ultimately very likely to affect their life style choices as an adult (Warren et al., 2008, Sorhaindo and Feinstein, 2006).

2.4.1 Nutrition and health

Emerging evidence has suggested that healthy eating during school hours may help to prevent the development of metabolic syndrome (MetS), type 2 diabetes, cardiovascular diseases and its associated co-morbidities, as well as mortality (Damsgaard et al., 2014). Association between diet inadequacy and deficiency diseases (scurvy, beriberi and stunting in children) should also be considered. Evidence has been emerging to support the short- and long- term benefits of nutrition for health outcomes of young children.

2.4.1.1 Short term benefits

As previously discussed, school meals appear to contain more nutritional value than children's packed lunches. In 1112 adolescents aged 13 to 16 years across England and Wales, significant differences have been observed in some cardiovascular risk factors (systolic blood pressure, ratio of total cholesterol to HDL cholesterol, plasma glucose, serum insulin, serum folate) between those usually eating school meals and those eating packed lunches (Whincup et al., 2005). Although school meal eaters had no

significantly lower anthropometric markers, they did have significantly lower mean levels of systolic blood pressure, ratio of total cholesterol to high density lipoprotein (HDL) cholesterol and glucose and an overall slightly lower cardiovascular risk profiles compared to packed lunch eaters.

The Healthy Kids, Smart Kids programme was implemented in one of the elementary schools in Georgia in 1999 in response to the principal's growing concerns about the high obesity rates, and children's frequent visits to the school nurses for general health issues. The school also observed students' lack of attention in a classroom setting (Nansel et al., 2010). The programme involved a multidisciplinary approach, including teachers, parents, cafeteria manager and several grocery store managers. Changes were then made to the menus by modifying high fat and sugary food items such as burger, pizzas, cookies, chips; and introducing wholegrain breads, pot pies, and baked potatoes and so on. Besides nutrition, physical education curriculum was reviewed to incorporate health classes into the students' school curriculum (Nansel et al., 2010). The authors then used data from 1995 to 2006 to reveal that after the programmes started in 1999, there had been a downward trend in the number of referrals for nurses, disciplinary and counselling per 100 students, as shown in **Figure 2.2**. Findings were observed with a p-value of less than 0.05, which indicated significant differences.

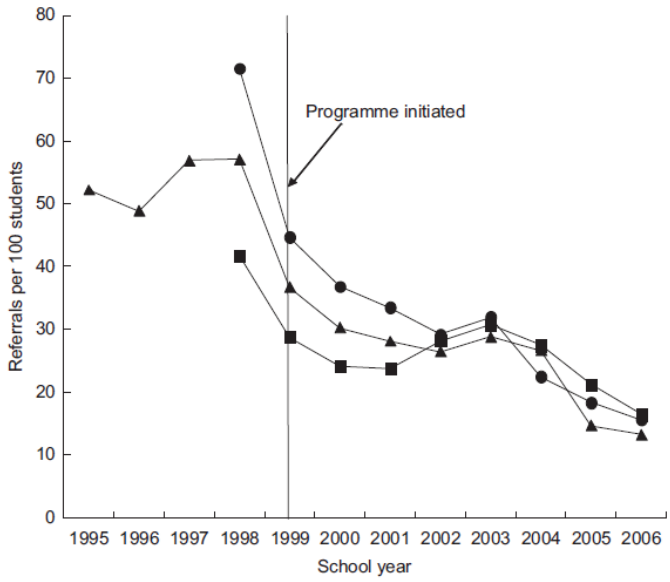

Figure 2. 2: Number of referrals for nurses, disciplinary and counselling per 100 students.

*Healthy Kids. Smart Kids programme. Downward trend was observed for all referrals after the initiation of programme (Source: Nansel et al 2010, p.119)

Project Energize was launched in Hamilton, Waikato (NZ) to improve nutrition and physical activity levels to reduce cardiovascular risk factors in primary school children. Its effectiveness was investigated from 2004 to 2006, by comparing schools with and without "Energizers", who were either graduates or teachers assigned to coordinate the programme in the school setting (Rush et al., 2012). The children had their anthropometric measurements (height, weight, body fat, blood pressure) taken at baseline, and measurements were repeated two years later. Apart from the physical activity sessions, foods like pies and biscuits were removed from school canteen, and filled rolls, fruit and low-fat yoghurt were added. Education on sugary drinks, healthy lunches and snacks on budget was also incorporated into the programme. Schools participating in Project Energize were found to have reduced body fat accumulation in younger children, and a decreased rate of systolic blood pressure rise in older children over the two years' period (Rush et al., 2012). The outcomes were further investigated in 2011, where authors found prevalence of obesity and overweight among younger and older children was lower by 31% and 15%, respectively (Rush et al., 2014). Lower BMI and higher physical fitness level were also observed. In the long run, Project Energize is suggested to have the potential in reducing risk of obesity and type 2 diabetes; through a combination of better nutrient intakes and physical activity.

Research has also examined the relationship between whole-grain intakes and BMI z-score in 792 rural children attending 3rd to 6th grade in California, Mississippi, Kentucky and South Carolina in the United States (Choumenkovitch et al., 2013). The CHANGE (Creating Healthy, Active and Nurturing Growing-Up Environment) study was an intervention based on the prevention of obesity in rural communities in the four mentioned states. Students were classified according to their intakes of either: <1 serving/day, 1 to 1.5 servings/day, and >1.5 servings/day of whole grain products. Only 1.9% of participants (n=15) were in the highest whole grain intake category (approximately half of the recommendation). Overall, children in the highest intake category had a 40% lower risk of being obese (p=0.02), compared with those who consumed <1 serving/day. Most common foods include breakfast cereals, popcorn and wholegrain bread. The article also cited several other studies that examined the same relationship, but all observed conflicting results (Choumenkovitch et al., 2013).

To further explore the relationship between provision of school meals and cardio-metabolic markers and body composition, 834 Danish children aged 8-11 years were provided with freshly prepared lunch meals in the intervention group and compared with the control group for 3 months (Damsgaard et al., 2014). The children received meals that were high in vegetable, fish and fibre. At the conclusion of the study, the school meals provided undesired effects for the MetS score (p=1.00), waist circumference (increase of 0.5cm) and HDL-concentration (decrease of 0.02mmol/L); however, small improvements were found for mean arterial pressure, triglyceride concentrations and insulin resistance, with BMI z-score remained unaffected.

This is further strengthened by a literature review conducted by NZ's Canterbury District Health Board, which found many observational and experimental studies (mainly conducted in United States of America and United Kingdom) showed positive effects for adolescents who participated in their schools breakfast programmes (Canterbury District Health Board, 2014). Greater intakes of essential macro- and micro- nutrients, more positive dietary habits, and better anthropometric and cardio-metabolic (total and low lipoprotein (LDL) cholesterol, lower percentage of body fat) measurements were among the health outcomes.

2.4.1.2 Long term health implications

In addition to the short term benefits of childhood nutrition, more research has emerged to explore the long term implications. Despite high-quality early childhood programmes showing considerable benefits in reducing crime, raising incomes and promoting education, little is known about their benefits for adult health (Campbell et al., 2014).

The association between body mass indexes (BMI) of childhood levels and adult levels has been researched over the years. A cohort study was conducted based on observations in 2610 children aged between two and 17 years, with a mean follow-up of 17.6 years (Freedman et al., 2005). It was carried out in Louisiana between 1973 and 1996. The participants' skinfold thickness and BMI-for-age were measured during childhood and adulthood. It was found that both measurements were associated with

adult adiposity, as those who had BMI-for-age equal to or greater than the 95th percentile were four times more likely to be overweight adults.

In 2008, the Alberta Project Promoting active Living and healthy Eating in Schools (APPLE), a school health programme, started in ten elementary schools in the Canadian province of Alberta (Tran et al., 2014). A full-time School Health Facilitator in each school organised cooking clubs, walk-to-school days, community gardens and lunch and snack programmes. Authors modelled growth rates of BMI using longitudinal data from the National Population Health Survey collected between 1996 and 2008. It was previously published that grade five students (between ten and eleven years of age) attending APPLE schools had a reduced prevalence of obesity of 2.2% between 2008 and 2010, compared to 2.8% of grade fivers in control schools. It was therefore suggested that if the programme was scaled up, Alberta could potentially save $33 to $82 million per year in healthcare costs, or $150 to $330 million per year for Canada (Tran et al., 2014).

The human capital diagram, as demonstrated by Martorell (1999), shows that by improving child nutrition, human capital can be enhanced and therefore increased productivity leading to growth in economy. When that occurs, investments can be made to promote better health, education and nutrition (Martorell, 1999). Therefore, more research is needed to investigate long term effects of adequate childhood nutrition, e.g. 10 to 20 year follow up on those who have participated in a school lunch programmes as this will further strengthen the association between childhood nutrition and long term health implications.

2.4.2 Nutrition and educational outcomes

Other than health outcomes, childhood nutrition has also been linked to educational outcomes among children at schools: in areas of growth and development, their learning and academic achievement, school attendance, attention and concentration during lessons as well as their behaviours and social interactions with teachers and other children. It was suggested that both content and quality of the food eaten during childhood, including contents of their school lunch boxes, is often related to developmental, cognitive and behavioural outcomes which is important for health,

well-being, and specific experiences, such as school life (Darnton-Hill et al., 2004, Feinstein et al., 2008, Dresler-Hawke et al., 2009). When children's behaviour, concentration and cognitive abilities are compromised, it has an immediate effect on their ability to attend school (Belot and James, 2011).

Adequate childhood nutrition is said to be able to affect student learning in the following ways (Mcewan, 2013, Belot and James, 2011):

1. There has been research which shows that short-term attention and memory are adversely impacted when breakfast is skipped. Previous trials have suggested that even "empty calories" instead of a morning fast can have a positive impact on the short-term functioning among children (Pollitt, Cueto, & Jacoby, 1998). Energy sources contribute to more effective work during the school day, therefore children could produce sustained gains in test scores.
2. Sustained exposure to nutritious food could prevent malnutrition. A poor diet increases children's susceptibility to illnesses. In contrast, adequate nutrition could affect learning through increased attendance in schools, overall cognitive development, and improved academic achievement.
3. If in-school meals are available, this could induce parents to enrol their children in school, enrol earlier or encourage regular attendance. Some families might choose to transfer their children to a treated school.

The New Zealand literature review on breakfast consumption also found that there is a positive and consistent relationship between nutrition and academic outcomes in the long term (Canterbury District Health Board, 2014). Better nutrient intakes created more positive mood outcome. This is consistent with the findings indicating that better nourished girls were more attentive and more involved in class, and boys had improved classroom behaviour and increased activity levels (Bundy et al., 2006). An increase of 0.1 standard deviation (SD) in arithmetic and language tests is associated with one z-score increase in height for age (Bundy et al., 2006). This supports the necessity to advocate for nutrition initiatives in early stages of lives as an approach to improve children's academic achievement (Glewwe et al., 2001). In addition, there are also potentially long-term economic benefits of early childhood nutrition (Grosse and

Roy, 2008), including substantial increases in wages among men in the long run by improving early childhood nutrition (Hoddinott et al., 2008).

Table 2.2 below explores a summary of some of the main findings in existing literature, assessing the relationships between nutrition and different aspects of educational outcomes:

Table 2. 2: Details of studies investigating associations between childhood nutrition and educational outcomes

Author	Experimental Design	Main findings
(Alaimo et al., 2001)	Authors reviewed the consequences of food insufficiency in American school-aged children, by using data from National Health and Nutrition Examination Survey (NHANES III). The measures included academic, cognitive, and psychosocial outcomes.	Children aged six to 11 years of age, who were categorised as food-insufficient, had significantly lower arithmetic scores, higher possibility to have repeated a grade, have seen a psychologist, and also difficulty getting along with other children. Consequences were found to be similar when those in food-insufficient category were in their teen years.
(Sigfúsdóttir et al., 2007)	The authors aimed to investigate the relationship between selected health behaviours and academic achievement in 5810 Icelandic school children, aged 14 and 15 years old. Students self-reported their average grades, BMI, poor diet patterns, intake of fruit and vegetables, and physical activity levels.	Students who have BMIs in the 85th percentile or above had significantly lower self-esteem, poorer grades (in Icelandic, English, Danish and Maths) and higher depressive mood. They also reported parents with lower education, reported less physical activity and ate less nutritiously than those with lower BMIs ($P < 0.01$). The correlation between BMI and grades is of modest strength.
(Feinstein et al., 2008)	By using data from Avon Longitudinal Study of Parents and Children (ALSPAC), authors investigated the impact of dietary intake at multiple time points in childhood on their school attainment. The three indicators of school attainment included: ages 4-5 entry assessments to school, 6-7 Key Stage 1 national tests, and 10-11 Key Stage 2 national tests.	Higher intake of 'junk food' pattern at age three was associated with lower scores in KS2 tests (significant but small). Measures of early diets (junk food vs health conscious vs traditional dietary patterns) were more predictive of school success than later measures of diet, suggesting nutrition might have a diminishing role in attainment as children grow older.

Author	Experimental Design	Main findings
(Nansel et al., 2010)	Using school records from year 1995 to 2006, authors examined the effect of Healthy Kids Smart Kids programme, which involved a major change of the school menus (↓ HFSS foods, ↑ fruits and vegetables and wholegrain products), and compliance of nutritional guidelines for food brought from home.	Upon the implementation of the programme, there had been an upward trend in the standardised test scores (increase of approximately 20 percentile in six years within the programme starting). The amount of referrals (nurses, counselling and disciplinary) was observed to be on a significant downward trend.
(Belot and James, 2011)	In Greenwich (2004), chef Jamie Oliver launched "Feed Me Better" campaign in which low-budget processed meals at school were switched to healthier options. Education outcomes such as test scores and attendance were assessed, before and after the reform, in primary school children. The analysis was performed on data collected from 2002 to 2007.	With neighbouring areas as control group, the study found that those involved in the campaign had higher proportion of children reaching level 5 or above (increased by 3% points in Maths, 6% points in English and 8% points in Science). Authorised absences (defined as absences related to sickness) dropped by an approximate of 14% on average.
(Mcewan, 2013)	JUNAEB is an agency in Chile, which provides higher-calorie meals to school in lower socioeconomic areas. This study evaluates such programme on education outcomes of primary school students, including test scores, enrolment and attendance.	Authors found no evidence that the additional calories had any impact on the outcome measures. Suggestions were made that the focus should be on the nutritional content of school meals, rather than the energy content.

2.4.3 Nutrition and psychosocial and behavioural outcomes

Childhood is the critical period for the psychological growth and development, and promoting mental health during this period is essential to their health and well-being (Kulkarni et al., 2015). Positive physical and mental development during childhood is dependent on adequate nutritional intake. However, evidence has established that the quality of children's dietary patterns has deteriorated significantly in recent decades. A decline in children's diet quality, with the simultaneous increase in the prevalence of depression among children, has led to an interest in the possible role of nutrition in the development of depressive symptoms (Kulkarni et al., 2015).

Research has suggested that malnourished children or children who consume unhealthy diets display a number of behaviours that can potentially interfere with children's school performance. These include irritability, apathy and lower self-esteem (Sigfúsdóttir et al., 2007). Behavioural problems could also spill over to other pupils in the class through peer effects. The research in this area is however limited (Belot and James, 2011).

In New Zealand, the relationship between diet quality and mental health has been researched in 4249 adolescents in South Auckland, where a cross sectional study was designed to collect their responses from self-reported dietary questionnaires. Mental health was assessed by emotional subscale of PedsQL (Pediatric Quality of Life) instrument (Kulkarni et al., 2015). There was a significant association between eating a healthy diet with improved emotional health, and between eating an unhealthy diet with greater emotional distress. However, all participants were from low decile schools in low socio-economic areas, where other factors such as social background could be confounders.

In the United Kingdom, by randomly assigning 146 students from six primary schools in Sheffield to a 12-week intervention or a 12-week control group, authors explored the relationship between nutrition and children's behaviour through the improvement of school lunch meals and dining environment in the intervention school (Golley et al., 2010). Measures of concentration and disruption in class were observed. Teacher-pupil

engagement in the intervention school was found to be 3.4 times higher compared to the control school. However, pupil-pupil behaviour was not as anticipated. This suggests for a further research, as no clear evidence could be drawn from the study (Golley et al., 2010) .

As children have the tendency to consume processed foods with added sugars, the additives could have adverse effects on them. Artificial colouring and additives were found to increase hyperactivity in three year-old and eight or nine year-old children in the general population (Mccann et al., 2007). Furthermore, a meta-analysis of five well-designed studies established a relationship between diet and anti-social and criminal behaviour, in particular the omega-3 fatty acid which decreased hostility and aggression (Benton, 2007). The author also included three well-designed trials, which showed that with mineral and vitamin supplementation, incidence rates of violent behaviour, and also non-violent anti-social behaviour, were reduced.

Other than behaviours, research has also considered the potential relationship between diet and depressive symptoms. A random sample of 5003 Chinese adolescents, aged 11 to 16 years, was studied to assess the association between dietary patterns ('snack', 'animal food' and 'traditional') and risk of depression and anxiety symptoms (Weng et al., 2012). Self-reported FFQ and depression/anxiety assessments revealed that adolescents in the highest quartile of snack dietary pattern scores had higher risk of psychological symptoms, whereas those in traditional dietary pattern category had the opposite effect.

A similar study was conducted on 7114 Australian adolescents, aged between ten and 14 years. The study, known as the Australian Healthy Neighbourhood Study, used a dietary questionnaire to measure depression rate of the participants, with adjustments made for age, socioeconomic status, family conflict and BMI among others (Jacka et al., 2010). Compared with the lowest quintile of unhealthy diet score, adjusted odds ratio for depressive symptoms across the increasing quintiles were: Q2=1.03, Q3=1.22, Q4=1.29 and Q5=1.79. Both study findings suggested there was an association between the quality of diet consumed and early onset of depression among adolescents.

Similar findings were found in 3846 Iranian adults, aged 20 to 55 years, in which Western and fast food dietary patterns were associated with increased odds of psychological distress, compared to a lacto-vegetarian diet which was found to have protective effects with depression in women (Hosseinzadeh et al., 2015). Although the study was conducted in adults, it was an implication of how dietary patterns could potentially affect one's psychological behaviour. In summary, the role of adequate nutrition in the development of child's behaviour and cognitive function should not be dismissed as it is potentially one of the major factors influencing their social behaviours.

2.5 International school meal programmes

School lunch programmes have been regulated to provide nutritious meals to eligible school children, although there has been opposition that these meals have not always been associated with health benefits (Madden et al., 2013). Despite the lack of a Government-funded school lunch programme in New Zealand, they are considered to be very relevant in the other parts of the world, especially throughout United States and in Europe, particularly United Kingdom.

2.5.1 United States

The existing Food and Nutrition Service advocates for schools and childcare centres to provide healthy meals for their children, in order to achieve both health and social equity (Bhatia et al., 2011). It facilitates several programmes, including the National School Lunch Programme (NSLP), the School Breakfast Programme, the Child and Adult Care Food Programme, the Summer Food Service Programme, the Fresh Fruit and Vegetable Programme, and the Special Milk Programme (Food and Nutrition Service, 2015).

NSLP operates as a federally assisted meal programme in more than 90 000 public and non-profit private schools. It provides millions of children with low-cost or free lunches, meeting their nutritional requirements (Burgess-Champoux et al., 2008, Ishdorj and Higgins, 2015). In Georgia, the relationship between NSLP and academic achievement of fifth grade students in 1285 elementary schools was investigated (Houston et al., 2013). Authors revealed that the higher the percentage of children

receiving lunches from NSLP, the lower the percentage of children meeting standards on both reading and maths sections of the assessment. This confirmed the existing inverse association between poverty and achievement test scores.

However, with its cost-effectiveness questioned and potential contributor to United States' increasing obesity rates, its impacts on school children in the country have still remained inconclusive (Campbell et al., 2011). Multiple studies have been carried out to examine children's nutritional and educational outcomes after participating in the programme.

A study was designed to investigate the nutritional quality of US public school children's diet when they participated in the NSLP (Clark and Fox, 2009). With a large sample size of 2314 participants from grades 1 through 12 in 287 schools, propensity score matching was used to assess the prevalence of inadequate and excessive intakes and their usual nutrient intakes were compared with the Dietary Reference Intakes as well as the Dietary Guidelines for Americans 2005. The results revealed that 80% of the public school students had excessive intakes of saturated fat and 92% excessive sodium. Participation in NSLP had an overall reduced prevalence of nutrient inadequacy, but increased prevalence of excessive sodium intakes (Clark and Fox, 2009).

Authors cited a study that found NSLP contributed to an increased consumption of essential nutrients (vitamin B12, zinc, riboflavin, calcium, phosphorus, dietary fibre and magnesium), other than vitamin C and consumption of added sugars was decreased. However, consistent with many studies, participation also led to an overall intake of total and saturated fat (Gleason and Suitor, 2003).

An observational study was conducted on three schools in rural Virginia, after the implementation of the 2012 – 2013 NSLP standards. Records were taken on both packed and school lunches for five consecutive days, and all 1314 lunches observed in that week were then analysed for their individual macro and micro nutrients (Farris et al., 2014). When packed lunches were compared to school lunches, energy, saturated

fat, sugar, iron and vitamin C were found to be significantly higher in packed lunches whereas sodium, fibre, vitamin A, calcium and protein were lower.

NHANES 1999 – 2008 was used to evaluate the dietary quality of NSLP participants and non-participants, in school children aged between five and 19 years (Xue and Wang, 2012). NSLP participation was positively and significantly associated with dietary quality and total fruit consumption. Calories from solid fat, alcohol and added sugar were not higher for NSLP participants (Xue and Wang, 2012). Consuming NSLP meals was associated with increased BMI-Z score by 0.1; however the effect disappeared after correction was performed.

Another study utilised datasets from several surveys to analyse the outcomes of NSLP (Hinrichs, 2010). The first survey was the funding and participation in NSLP by state (1947-1973), second was the five National Health Interview Surveys conducted between 1976-1980, which provided information on health outcomes and demographic control variables, and finally the third one is 5% sample of the 1980 Census (Hinrichs, 2010). The first and second were merged to estimate effects of participation on health, whereas first and third were merged for effects on educational attainment. Overall, participation in the programme generated few health benefits in the long term but educational attainment was found to be substantial (Hinrichs, 2010).

In summary, ongoing research is needed to determine the association between NSLP participation and health and educational outcomes due to conflicting results. Further improvements of the menu should be considered to address the elevated energy, fat and sodium intakes among participants.

2.5.2 United Kingdom and Europe

Throughout Europe, many countries have school food policies to assist schools in providing nutritionally balanced meals, which would also incorporate the general eating culture of each country. Other than that, programmes are also available in most European countries, such as the School Milk Programme which distributes milk, cheese, yoghurt and fermented milk products.

European Union provides guidelines to ensure children consume a balanced meal during school hours. A report was released in 2014, detailing the School Food Policies (SFP) available in all 30 countries (EU28 plus Norway and Switzerland) (Bonsmann et al., 2014). More than 90% of the SFP have food-based standards to ensure the school menus are balanced, 76% incorporate portion size guidelines, and 68% have nutrient-based standards for lunches.

There are numerous objectives for SFP in the EU28, plus Norway and Switzerland. Most schools (97%) have 'improve child nutrition' as one of their main school food policies, with 'learn healthy habits' as the secondary objective. 'Reduce/prevent obesity' and 'reduce/prevent malnutrition' are adopted by 88% and 65% of schools, respectively (Bonsmann et al., 2014).

Schools in England are restricted in providing foods high in salt, sugars and fat (e.g. no more than two portions of deep-fried foods in a week) and nutrient-rich foods are promoted (e.g. daily availability of fruit and vegetables) (European Food Information Council, 2015). The lunch meals and beverages provided in the school setting are to meet the guidelines set for 14 nutrients.

Below are the summary points of programmes in other European countries:

Being the first country in the world to commence free school meals, Finland's lunch programme, which is available to all students, is well regulated. It is required to ensure lunches meet one third of students' daily nutritional requirements (Finnish National Board of Education, 2008). The World Health Organisation's guide for Europe provides guidelines on the 'plate model', which determines the main food groups to be offered, and the number of servings of each. A plate of meal will be displayed during the self-service meal time to guide the children to portion half a plate with vegetables, quarter of a plate with potatoes, rice or pasta and quarter of a plate of meat, fish or vegetarian options. Milk and fruits are also available for the children (Finnish National Board of Education, 2008).

In France, portion sizes of school lunches are determined by the type of dish and also the age group that it is being served to (European Food Information Council, 2015). In

their 20-meal cycle, the meals are well regulated by nutritional standards. Each meal has to consist of a main dish (protein sources such as meat, fish, eggs, or cheese), a dairy product and a side dish. Cooked vegetables must be in at least ten meals, pulses, starchy foods or cereals in ten meals, and a fresh fruit dessert is to be in at least eight of them.

Food-based standards for lunch meals in Germany require a minimum menu cycle of four weeks (20 days), with a vegetarian choice offered daily. Students' allergies, intolerances and preferences are also considered in the menu development. Out of the 20 days, fruits and dairy products should be served on a minimum of eight days; fish minimum of four days; red meat maximum of eight days, deep fried/bread crumbed products maximum of four days (European Commission, 2011).

In Denmark, confectionary such as sweet treats, potato crisps, and carbonated beverages are not to be served on school premises (European Commission, 2012). Out of five meals per week, at least two meals should have carbohydrates (rice, pasta, potatoes), and at least one meal should be fish-based. Children, who are over ten years of age, are also recommended to have between 200g to 300g of fruits and vegetables daily.

2.6 New Zealand

At present, there is no Government-funded school lunch programme available in New Zealand. However, the provision of food in school settings is common. There are numerous initiatives run by the Ministry of Health and several charitable organisations to encourage health-promoting schools and improve the nutritional status and well-being of children during school hours.

Fruit in Schools programme is a Government initiative which is targeted at a number of primary schools in lower socioeconomic areas (Ministry of Health, 2006b). Its main aim is to enhance the learning of school children by emphasising on healthy eating and physical activity. In order to promote the 5-plus servings a day of fruits and vegetables, fresh fruits are delivered to low decile schools throughout the nation. It promotes health through a whole school approach and is currently in its eleventh year, ensuring

primary school children of the less advantaged groups are meeting their recommended intakes.

KidsCan, a charitable trust, was founded ten years ago and is currently supporting 449 low decile schools throughout the country (Kidscan, 2015). Their programmes include Food for Kids, Shoes for Kids, Raincoats for Kids and Health for Kids, which aim to provide the basics for children. Yoghurt, baked beans, loaves of bread, jelly pottles and healthy snack bars are among the food items provided by the initiative. Fonterra has also been delivering milk to 73% of primary school kids around the country throughout the academic year (Fonterra, 2015). The school children receive one pack of 200ml Anchor milk on a daily basis, which is estimated to meet 30% of their daily calcium requirement.

Sanitarium, in partnership with Fonterra and Ministry of Social Development, has launched the KickStart Breakfast, which is the only school breakfast programme available in the country (Kickstart, 2015). Formed in 2009, the programme provides Weet-Bix cereal and milk to help the schools participate in their own breakfast clubs, which help to create an encouraging environment to improve the children's social skills. Currently over 800 schools are involved in the programme, which equates to 100,000 breakfasts being served each week.

Feed the Need is a charitable trust, with a mission to serve warm nutritious meals to decile one and two primary schools in South Auckland. The programme targets high-need communities and currently focuses on winter, as young children's health is said to be most vulnerable in the coldest time of the year. The winter boost programme provides a variety of casseroles and stews, sometimes with bread rolls, for all children at the participating schools. At the present, their resources allow the lunch provision to six primary schools in South Auckland region.

Chapter Three: Methodology

3.1 Study design

The Feed the Need (FtN) programme was designed to provide warm nutritious meals three times a week (Mondays, Tuesdays and Fridays) for students in low-decile primary schools in South Auckland, New Zealand, for ten weeks over the winter months. In 2014 when data for this research project were collected, available funding allowed lunch provisions for two schools.

This study was conducted in one of those schools, a decile one school predominantly serving children from families of lower socioeconomic status. The school accommodates students from year one to six, aged approximately between five and eleven years. All students were entitled to the free lunches, however students were able to purchase their lunches from the school canteen or convenience shops, or bring their lunch from home.

A cross sectional study design was used to assess the nutritional quality of all the consumed lunches regardless of whether they were provided by FtN, and also the effects of the programme on student attendance and behaviour. Specifically, this study examined the impact of the programme on students in year five and six as these students were considered more likely to exercise greater autonomy over their lunch choices and would be able to respond in an appropriate manner. There were three combined year five and six classes in the school which were included in the study. All of the children from these classes (n=77) were included in the data collection process, whether or not they participated in the FtN programme. Additionally, at the completion of the FtN programme, students were asked to provide their perceptions of the lunch programme through a questionnaire**,** and the three class teachers participated in a focus group to explore their insights of the programme**.**

3.2 Ethical Approval

Ethical approval for this research was obtained from the Massey University Human Ethics Committee (MUHEC). An application of low-risk research notification was submitted and approved in June 2014. Following discussions with the principal and

senior staff of the school, students to be involved were notified by the school on behalf of the research team.

3.3 Measures

3.3.1 Nutritional analysis of FtN recipes

FtN recipes were designed by the organisation and its purpose was providing warm nutritious meals for hungry school children. To determine whether one serving size of the meal was adequate to contribute to the nutritional requirements of the school children (10-11 years old) during school hours, energy, macronutrients, and selected vitamins and minerals were examined. The 17 nutrients assessed in this study were total energy, protein, total fat, saturated fat, carbohydrate, sugars, dietary fibre, vitamin D, vitamin B12, total folate, vitamin A, sodium, calcium, iron, selenium, iodine and zinc.

On average, a serving size of FtN meals consisted of 200g of soup or casserole, and some of the meals were also served with an 80g wholemeal bread roll and a 10g margarine pack. During the week that food records were collected, the recipes for the three meals provided were obtained from the FtN kitchen (see Appendix A) and were assessed for nutritional content. The three recipes assessed included butternut and bacon soup, hearty beef stew and Sloppy Joes. Nutrient compositions of the three meals were analysed using FoodWorks (version 7, Xyris Software (Australia) Pty Ltd) then compared with one-third of the children's nutritional requirements recommended by the Ministry of Health Nutrient Reference Values (Ministry of Health, 2015d). The comparison was conducted in context of one nutritious meal contributes 33% of a child's daily requirements (breakfast, lunch and dinner). However, it is also important to acknowledge children often have other meal times, such as morning tea and afternoon tea.

3.3.2 Dietary intake assessment of food consumption during school hours

Children's food consumption and nutrient intakes at school were investigated at three timeframes during the study: before, during and after the FtN programme was completed. The collection of daily food records was conducted during school meal times. This enabled the researcher to compare the children's nutrient intakes across

the three timeframes and to determine how the programme had affected their nutrient intakes, as well as overall food group consumption.

The Daily Food Record method was a record of what the children consumed for each meal time. After morning tea and lunch, they documented the type, brand, flavour and also weight of the food item that was consumed (see Appendix B and C). The purpose of this method was to determine children's total dietary intake at school and also to assess the nutritional quality of the intake in proportion to their diet during school hours. Previous studies have shown that children aged eight and above have increased ability to self-report dietary intake (Livingstone and Robson, 2000, Warren et al., 2003). Therefore this method was deemed the most appropriate. Its perceived limitation will be discussed in later chapter.

The method was tested in July 2014 to determine whether children could use it accurately. A copy of a 'portion sizes' booklet and weighing scales were distributed to the three class teachers in charge in the event that the children needed assistance in determining the size or the weight of their food items. As a result of the classes' different schedules, the food records were completed either after each meal time (morning tea and lunch time) or at the end of the day. Prior to the start of data collection in August, the procedure was practised with the teachers to emphasize the importance of the accuracy and consistency of data collected.

The children's food records were collected for an entire week during three timeframes: in the week before the programme started (known as pre- FtN timeframe), the fourth week of the programme (during FtN timeframe), and the week after it had ended (post- FtN timeframe). Post- FtN timeframe determined if the children resumed their regular dietary intakes when the meal provision ended. In each timeframe, a total of 385 food records were anticipated, as each of the 77 students would complete five days' worth of food records.

Guidance and assistance on the completion of food records was offered to the children by the researcher, class teachers, or senior classmates who were more able to complete the data collection on their own. On the individual food record, children wrote either their first name or initials, with the date. All the forms were either

checked by the teachers or researcher, whenever plausible, to ensure the forms were completed to a satisfactory standard, that writing was easily understood and that both morning teas and lunches were included. The students or class teachers were approached to obtain any clarification for the food records. If a child had missed a meal, the relevant part of the recording sheet was left blank.

3.3.3 Attendance

Attendance data of the three classes were requested from the school in order to compare the rates across the three timeframes. Attendance (presence or absence) was entered in a class register by the class teacher twice a day (morning and afternoon).

3.3.4 Positive Behaviour for Learning (PB4L)

The school had recently adopted a Ministry of Education programme called Positive Behaviour for Learning (PB4L), where details of all behaviour misconducts noted by teachers were recorded in a specific form (see Appendix D). For each incident, the following details were noted:

- Minor behaviours: Defiance/disrespect, property misuse, disruption, inappropriate language, inappropriate physical contact, late to class
- Major behaviours: Defiance/disrespect, property misuse, physical aggression, dishonesty, harassment/bullying, verbal assaults
- Location and motivations of incident
- Teacher or senior management consequences

Class teachers or teachers on duty were required to report any incidents that were of concern, and the school would then utilise the opportunities to help students deal with the issues. Its principles were focused on changing the environment to create positivity, rather than changing the students. This study explored the possibility that the school lunch programme would contribute to lowered rates of misbehaviour at schools.

For comparisons to be made across the timeframes, these data were also obtained from school records. The PB4L data were then categorised according to the terms and weeks in which the incident occurred.

3.3.5 Perception of FtN programme

3.3.5.1 Children's perceived views of FtN programme

In the week following the conclusion of FtN programme, the children were approached by the researcher with the support of teachers during class time to complete the questionnaire relating to the school lunch programme. This ensured a higher response rate, with the researcher present in each class. The questionnaire contained five Likert scale items as well as three open-ended questions about aspects of the programme. A scaling system was chosen as the preferred method as an easy and direct way for children. The items were read aloud to all the children in the class and responses were recorded on paper by children independently.

The questionnaire consisted of the following five items:

1. I enjoyed the variety of the food.
2. I loved the taste of the food.
3. I liked eating with the rest of my class.
4. I looked forward to lunch time more on days where there was Feed the Need lunch.
5. Feed the Need programme should continue.

All five questions were accompanied by six choices: 1 = Strongly disagree, 2 = Moderately disagree, 3 = Disagree, 4 = Agree, 5 = Moderately agree and 6 = Strongly agree. Children were encouraged to circle the option that best expressed their opinions. The questionnaire also included three open questions, asking the children "what you thought the best part about the programme was?", "which meal was your favourite?" and "which meal was your least favourite?". At the end of the questionnaire, they were also given the option to add in further comments about the programme if they wanted to.

3.3.5.2 Focus group with teachers

As a result of informal discussions with the school about the FtN lunch programme, a decision was made to include a focus group with the three class teachers at the school. The focus group has been used as a tool in qualitative research for several decades, as

it provides researchers with a more open and in-depth understanding of the respondents' views, particularly as they interact with each other (Bobby, 1977, Morgan, 1996). It is also recognised as a less intimidating method for researchers to interact more directly with participants (Kitzinger, 1995). In the current context, it allowed the researcher to assess whether the views of the three classroom teachers were shared amongst each other.

The focus group was conducted with the three year five and six teachers at the immediate conclusion of the programme in November 2014. This ensured that they had a clear memory of the programme and their perceptions and views of it. Under the guidance of Professor Michael Townsend, Massey University, seven questions were developed for the teachers to help determine their observations during and after FtN, and also provide an overall impression of how they thought the programme might have benefited the students. Even though the ethnic breakdown of the participants was not included in the study, engagement with Maori within the school community was crucial. One of the teachers involved in the study was undertaking the Maori class and curriculum. This added value to the discussion as it provided a glimpse of the culture within the school and also the impact of such programme on the population group.

The focus group discussion was completed in approximately thirty minutes. The following questions guided the discussion, though the free-flowing nature of the discussion meant that there was no fixed order as some questions were discussed without the question being asked, and some earlier responses were revisited in light of later discussions.

1. How do you feel about the programme overall?
2. What has been the main advantage from Feed the Need programme?
3. Were there any disadvantages?
4. Do you think it has affected their attendance?
5. How about reducing the behavioural misconducts?
6. What do you think were the roles of the meals?
7. What feedback have you gotten from the parents, if any?

Prior to the focus group beginning, all teachers granted permission for the discussion to be recorded. The recording was then transcribed and common themes were extracted from the discussion. Findings from this focus group could also be used to support or strengthen relevant results from the statistical analyses.

3.4 Data handling and data analysis

3.4.1 Nutritional analysis of FtN recipes

To assess whether one serving portion of FtN meals met the children's nutritional requirement, the individual nutrient reference values (NRV) for both boys and girls were divided by a third to obtain the required amount of each nutrient that one meal (lunch) should provide (33.3% of the daily recommendations). Comparisons were then made to determine which nutrients were adequate or deficient in the lunch meals. The mean nutrient contribution of the three meals was also calculated.

The ingredients of each meal recipe were entered into FoodWorks, a nutrient analysis software programme. The New Zealand – Diet and Recipe Analysis, Abridged Version, was used for the data entry as it contained a complete dataset for fifty nutrients, including both macro- and micro- nutrients and had New Zealand-specific foods and nutrient amounts. The nutritional breakdown of each FtN recipe was used to compare with the children's NRVs to determine if it contributed to a third of their nutritional requirements. Their individual nutritional breakdowns were then documented.

3.4.2 Dietary intake assessment of food consumption during school hours

Prior to data entry, all 77 children were given a specific ID code to ensure privacy of each participant. Upon collation of all the food records, missing data from each class was documented in an Excel spreadsheet. Throughout the three timeframes of data collection, missing data were due to relief teachers not being aware of the complete data collection process, as well as a number of students who did not complete the food records due to non-compliances, commitments away from school such as sports events, or being absent from school.

After checking for accuracy, the food records were finalised and entered into FoodWorks. While entering food records, assumptions and decisions had to be made

for certain food items. This was mostly due to some foods not being in the database, or lack of specific data provided by the students. In most instances, food items with the closest nutritional values were used to substitute original item listed on the children's food records. A few particular food items consumed by students had been purchased from dairies and bakeries, which made it difficult to determine the real nutritional values. Web searches were used to identify these uncommon products and items with the closest nutritional value were entered. Other uncommon food items were also searched for in supermarkets or convenience stores within the school proximity in order to identify what they were. Furthermore, when weight was not noted in the food records, a standardised weight or serving size was used (which was measured at the beginning of data collection, e.g. fruits). A list of assumptions and decisions was kept during the food record entry to ensure consistency throughout the process (see Appendix E).

Over the course of data entry, the FoodWorks file for each participant was checked multiple times with reference to the paper copy to ensure accuracy and consistency of data entered. A spot-check of the food records was then conducted by two first-year dietetic students to re-check for consistency and mistakes. Upon checking, five inconsistencies were found in the ninety food records checked, indicating a discrepancy rate of 6%. Discrepancies were resolved through mutual discussion with the spot-checkers. For example, it was agreed that butter was entered instead of jam; 250ml of flavoured drink was entered as 250 cups. When checks were completed, the nutritional break-down were then exported from FoodWorks into SPSS for further analysis. Subsequently, all entered data were then sorted, and different aspects of the food records were broken down to be analysed for the following outcomes of measurement:

i. Contribution of FtN meals to children's nutritional requirements
ii. Overall comparison of nutrient intakes, for pre-, during and post- FtN
iii. Comparison of FtN days vs non FtN days in a week
iv. Food groups consumption, with most commonly consumed food items in each group

For each of the three timeframes, all food items that were consumed were categorised into one of these eight food groups– four essential food groups and four non-essential food groups (which include foods high in sugar, salt and fat). The eight food groups were breads and cereals; fruits and vegetables; milk and dairy products; meat, legumes, nuts and eggs; crackers, chips, and crisps; biscuits, confectionery and sweet drinks; other processed foods (such as sausage rolls, pies, pizzas, ham) and spreads, sauces, dressings. Percentages were then calculated accordingly to determine which food group was consumed more regularly. The weights of the most commonly consumed foods in each category were also collated.

Data from pre- FtN timeframe were treated as baseline data to observe what the children usually ate during school hours. The second data collection (during FtN timeframe) was observed as how the programme contributed to their nutrient intakes and possibly replaced their usual food consumption, and lastly data from third timeframe (post FtN) determined if the children resumed or changed their normal eating habits.

The study aimed to investigate the overall nutrient intakes as a whole population, rather than individual intakes. Each student's mean intakes for all 17 nutrients for the week were calculated to obtain the overall average intake of all students. As previously mentioned, not every student had completed food records every day of data collection. For each timeframe, a student's mean nutrient intake was calculated by dividing their total nutrient intake in that week by the number of days they had completed the food records, to obtain their average intake. For example, if the total energy intake for student A was 3200 kJ and she had only completed four days of food records that particular week, her mean energy intake for the week would be 800 kJ per day; if student B's total energy intake was 650 kJ and completed only 1 day of food record, her mean intake would be calculated as 650 kJ per day, for the week. For each nutrient, datasets for pre-, during and post- FtN were combined in order to test the significance of differences between the three time frames.

Justification of using mean and 95% CI

After assessing the data for normality, it was found that the datasets for each nutrient were skewed and not normally distributed based on Shapiro-Wilk tests, level of significance, as well as Q-Q plots. Therefore, all the values for each timeframe were log transformed. However, as datasets for vitamin D and vitamin B12 also contained zeroes (and therefore could not be transformed), a log formula with a constant (log (x + 0.001)) was used for these two nutrients. A small constant value of 0.001 was chosen as the original values for both vitamins were relatively small values, and the constant was then subtracted from the back-transformed values. After the data was back-transformed in Microsoft Excel, they were then re-tested for normality.

Also, as the sample size for each timeframe could be considered 'large' (i.e. greater than 40), this allowed the use of central limit theorem (CLT), which is applicable when sample means are said to be approximately normal for sufficiently large sample sizes even when the original populations are non-normal. Therefore, the findings were reported as geometric mean with 95% confidence intervals. The nutrient intakes for the three timeframes also needed to be reported in the same measure of central tendency in order to carry out the comparisons.

Upon reporting the mean intakes for each nutrient, tests were carried out to determine if there were any statistically significant differences between the 'during FtN' timeframe and the other two timeframes. As conducting multiple t-tests between the timeframes could result in increased chance of type 1 error ('false positive'), one-way repeated measures ANOVA test was used to obtain an overall difference for each nutrient, and where the difference occurred, if any.

ANOVAs with repeated measures are susceptible to the violation of the assumption of sphericity (equal variances of differences between all combinations of related groups) when used to determine significant differences. The violation of sphericity causes the ANOVA test to become too liberal, i.e. an increase in the Type I error. Greenhouse-Geisser correction was used to combat the violation of sphericity.

When comparisons were made between FtN days and non- FtN days within a week, the paired t-test was used to compare nutrient intakes within the week, with degree of freedom of 68.

3.4.3 Attendance

A total of 72 students were included in this analysis. These were students who were present for all three school terms. Five students on the class roll were excluded from this analysis because of prolonged absenteeism at any given point in time, for unidentified reasons as there was no indication of them being absent (i.e. their roll was left blank). Using the same ID codes for each student, the number of days they were absent for each week were recorded to be analysed in SPSS.

Calculation of attendance was performed for the ten weeks prior to programme, the eleven weeks when the programme was running and the five weeks after the programme had finished (which marked the end of the school year). For each of the three time periods, the total number of school days was recorded, as well as the days absent for each student. The total numbers of school days for pre-, during and post-FtN were 49, 54 and 25 days, respectively. Students' attendance was compared across the three timeframes.

3.4.4 Positive Behaviour for Learning (PB4L)

Due to unforeseen circumstances, the school was unable to provide data for the entire duration of the study. However, PB4L data was available for the three weeks before the programme started, and for the first three weeks that the programme was running. Therefore, comparisons were made between these two periods.

3.4.5 Perception of FtN programme

For the data analysis of the children's questionnaire, graphs were used to show the frequency of the responses children provided for each item. The three negative responses (strongly disagree, moderately disagree, disagree) were categorised into "Disagree", whereas the three positive responses (strongly agree, moderately agree, agree) were categorised into "Agree". The total score for each item was calculated to obtain the means, which reflected the overall perception of those who participated in

the programme. The main themes from the teachers' focus group were used to support and strengthen the findings of the study.

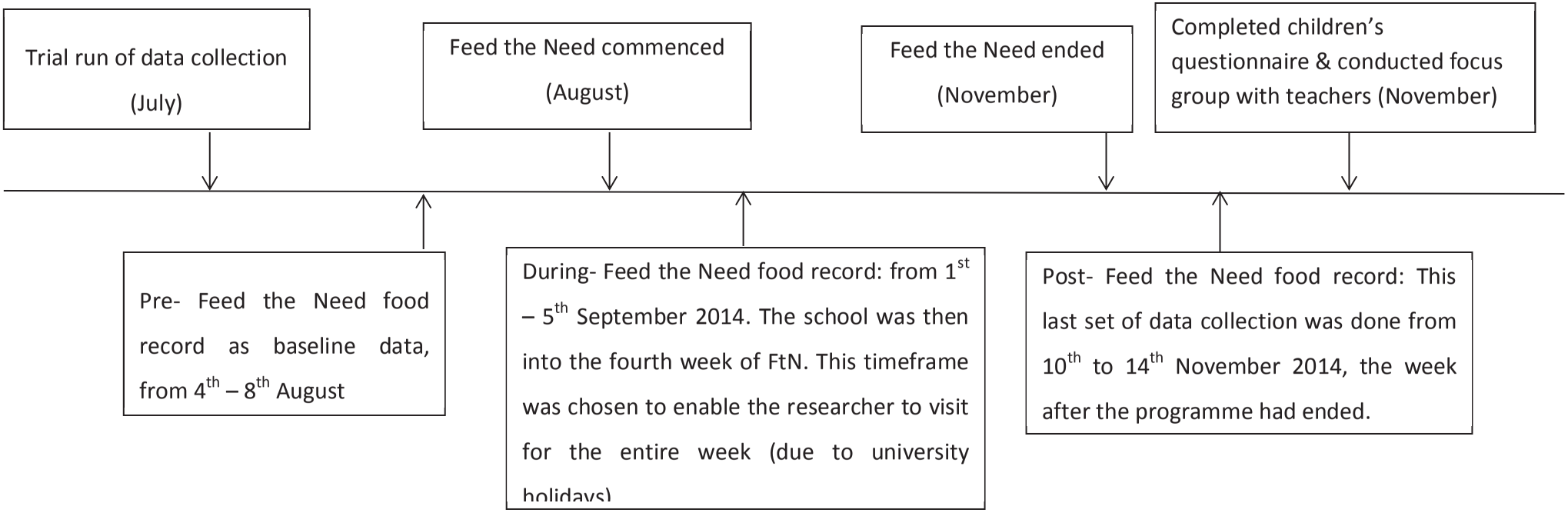

Figure 3. 1: Timeline of data collection process, from July to November 2014

Chapter Four: Results

This study was conducted in 77 children aged between 10 and 11 years from a low decile school in South Auckland. Participants completed food records for their daily food consumption at school during three different timeframes (pre- FtN, during FtN and post- FtN), as well as questionnaires for students and a focus group with three teachers regarding their perceptions of the lunch programme. Data for school attendance and behaviour misconducts at school were obtained from school records. The results from this study will be presented in this chapter. The characteristics of the participants are presented first, followed by the nutritional analysis of FtN meals and their adequacy in meeting one-third of the children's nutritional requirements. Children's nutrient intakes are then presented, describing the differences in intakes pre-, during and post- FtN programme; followed by most commonly consumed food items and food groups. Attendance and PB4L findings are briefly described, and finally, children's responses to the programme and teachers' perceived views are presented.

4.1 Characteristics of participants

A total of 77 year five and six students were included in the study, whether or not they participated in the FtN programme. **Table 4.1** summarises the numbers and genders of the participants from year five and six that were involved:

Table 4. 1: Total number of children participating in the study according to gender and school year (%) (n=77)

Year	Boys (n=40)	Girls (n=37)
5	20 (50.0%)	17 (45.9%)
6	20 (50.0%)	20 (54.1%)

No demographic information was collected from the students. As not all students were compliant in completing food records, the total food records collected were 251, 286 and 300 for pre-, during and post- FtN, respectively, compared to the expected 385 food records in each timeframe.

4.2 Nutritional analysis of FtN meals

The nutritional breakdown of each FtN meal was important in determining the meals' adequacy in helping children meet their nutritional requirements during school hours. The results from Feed the Need project carried out by Massey University Dietetics students in 2014 suggested that required levels of energy, carbohydrate, calcium and selenium were not met for both boys and girls in all of the meals. All meals, however, met or exceeded at least 50% of one-third of protein and iron NRVs (see Appendix F for full analysis on all meals).

In this study, the nutrients assessed for the meals were total energy, protein, total fat, saturated fat, carbohydrate, sugars, dietary fibre, vitamin D, vitamin B12, total folate, vitamin A, sodium, calcium, iron, selenium, iodine and zinc. **Table 4.2** illustrates how much one serving size of each of the three meals (butternut and bacon soup, hearty beef stew and Sloppy Joes) contributed to a child's diet when compared to one-third of their nutritional requirements.

Table 4. 2: Nutritional analysis of FtN meals and their contribution to a third of the nutritional requirements of children aged between 10-11 years

Nutrients	1/3 of NRV		FtN meals (per serving size)			Average nutrient contribution of the three meals	Differences between dietary requirements and FtN contribution
	Boys (B)	Girls (G)	Butternut and Bacon Soup (200g) with wholemeal roll (80g) & margarine (10g)	Hearty Beef Stew (200g)	Sloppy Joes (200g) with wholemeal roll (80g) & margarine (10g)		
Energy (kJ)[1]	2937.0	2574.0	1762.2	641.8	1992.5	1465.5	-1471.5 (B), -1108.5 (G)
Protein (g)	10.2	7.9	11.3	13.7	29.7	18.2	+8.0g (B), +10.3g (G)
Total fat (g)[1]	29.4	24.9	16.4	5.4	17.4	13.1	-16.3 g (B), -11.8 g (G)
Saturated fat (g)[1]	≤ 9.2	≤ 8.0	4.7	1.4	5.9	4.0	-5.2 g (B), -4.0 g (G)
Carbohydrate (g)[1]	86.5	75.6	53.8	11.4	46.9	37.4	-49.1g (B), -38.2g (G)
- Sugars (g)[1]	≤ 17.2	≤ 15.1	8.7	4.0	7.6	6.8	-10.4 g (B), -8.3 g (G)
Dietary fibre (g)[2]	7.9	6.6	8.5	2.9	8.7	6.7	-1.2g (B), +0.1g (G)
Vitamin D (µg)	1.7		0.0	0.0	0.0	0.0	-1.7µg

Vitamin B12 (µg)	0.5	0.0	2.2	1.3	1.2	+0.7 µg
Total folate (µg)	83.3	114.0	22.6	113.2	83.3	0 µg
Vitamin A (RE)	148.3 140.0	729.5	544.6	327.3	533.8	+385.5 RE (B), +393.8 RE (G)
Sodium (mg)[2]	133.3 – 266.7	624.3	136.7	791.9	517.6	+250.9-384.3 mg
Calcium (mg)	266.7 333.3	82.7	32.4	90.3	68.4	-176.4 mg (B), -264.9 mg (G)
Iron (mg)	2.0	2.1	1.7	4.6	2.8	+0.8 mg
Selenium (µg)	13.3	3.8	3.4	8.1	5.1	-8.2 µg
Iodine (µg)	25.0	16.4	11.3	10.4	12.7	-12.3 µg
Zinc (mg)	1.7	0.5	3.2	4.4	2.7	+1.0 mg

NRV = Nutrient Reference Values, EAR = Estimated Average Requirements, FtN = Feed the Need

[$]NRV reported as EAR for children 10-11 years old, unless specified otherwise

[1]References values determined from the mean intakes of children 7-10 years (energy) and 9-14 years (carbohydrate, sugar and fat) (Clinical Trials Research Unit and Synovate. 2010. A National Survey of Children and Young People's Physical Activity and Dietary Behaviours in New Zealand: 2008/09: Key findings. Wellington: Ministry of Health).

[2]Adequate Intake (AI) levels recommended for children 10-11years old (Ministry of Health, 2015d)

[#]1/3 of NRV obtained by dividing the nutrient's NRV value (as seen in Table 2.1) by 3; average nutrient contribution of FtN meals = total from all 3 meals divided by 3

A serving size of any one of the three meals did not meet a third of the requirements for both boys and girls for the following nutrients: energy (providing between 22%-77% of requirements), carbohydrate (13%-71%), vitamin D (providing 0.0%), calcium (10%-31%), and selenium (26%-61%), with hearty beef stew as the lowest contributor for all nutrients. Iodine level was also low in three meals, providing between 42%-66% of requirement, with Sloppy Joes the lowest contributor. Content of sodium was above the Adequate Intake (AI) level of 133.3 – 266.7mg in all three meals, which indicated excessive salt content. A serving size of butternut soup or Sloppy Joes reached over 600mg of sodium, which indicated over 200% of the upper end of Adequate Intake (AI) recommendation for one meal.

The two meals higher in sodium level were also meals that were served with a wholemeal roll. Despite the high sodium, they contained higher level of dietary fibre as well, compared to hearty beef stew. Butternut and bacon soup, which did not contain any natural meat sources, had the lowest amount of zinc as well as vitamin B12, providing only 29.4% and 0.0% of requirements, respectively. Both nutrients were found to be adequate in hearty beef stew and Sloppy Joes, contributing twice the level of recommendations. While hearty beef stew was significantly low in folate and iron levels, they were adequate in the other two meals.

On the other hand, total fat, saturated fat and sugars were all within the recommended range for all three meals. The contents of protein and vitamin A were also well above the recommended guidelines, providing the children with more than 100% of a third of their daily requirements.

4.3 Comparison of nutrient intakes across the three timeframes

To determine the impacts of FtN meals on children's dietary patterns, a comparison was made across the three timeframes (pre- FtN, during FtN and post- FtN) for the different nutrient intakes. **Table 4.3** illustrates the mean scores of the nutrients for each timeframe.

Table 4. 3: Comparison of children's nutrient intakes pre-, during and post- FtN school lunch programme with one-third of their nutritional requirements

Nutrients	1/3 of NRV		Pre FtN (n = 70)	During FtN (n = 72)	Post FtN (n = 73)	p-value
	Boys	Girls				
Energy (kJ)[1]	2937.0	2574.0	620.27	627.48	497.57	0.419
			[547.69, 702.48]	[560.19, 702.86]	[433.38, 571.26]	
Protein (g)	10.2	7.9	3.40	4.82	2.71	*0.011*[b]
			[2.86, 4.04]	[4.20, 5.53]	[2.24, 3.28]	
Total fat (g)[1]	29.4	24.9	5.40	5.46	4.24	0.580
			[4.65, 6.28]	[4.84, 6.17]	[3.45, 5.20]	
Saturated fat (g)[1]	≤ 9.2	≤ 8.0	2.29	2.12	1.72	0.377
			[1.95, 2.69]	[1.86, 2.41]	[1.36, 2.17]	
Carbohydrate (g)[1]	86.5	75.6	19.96	19.06	15.79	0.314
			[17.64, 22.59]	[16.90, 21.49]	[13.98, 17.85]	
- Sugars (g)[1]	≤ 17.2	≤ 15.1	8.15	6.41	6.54	*0.030*[a]
			[6.88, 9.64]	[5.44, 7.55]	[5.67, 7.53]	
Dietary fibre (g)[2]	7.9	6.6	1.53	1.90	1.29	0.431
			[1.33, 1.75]	[1.69, 2.15]	[1.12, 1.49]	
Vitamin D (µg)	1.7		0.11	0.07	0.08	*0.022* [a]

Nutrients	1/3 of NRV		Pre FtN (n = 70)	During FtN (n = 72)	Post FtN (n = 73)	p-value
	Boys	Girls				
			[0.07, 0.14]	[0.05, 0.09]	[0.06, 0.10]	
Vitamin B12 (µg)	0.5		0.09	0.19	0.12	0.157
			[0.06, 0.11]	[0.14, 0.24]	[0.05, 0.20]	
Total folate (µg)	83.3		11.59	19.38	8.97	*<0.001*[a, b]
			[9.95, 13.49]	[16.89, 22.25]	[7.75, 10.39]	
Vitamin A (µg)	148.3	140.0	19.73	60.79	15.72	*<0.001*[a, b]
			[15.87, 24.53]	[55.38, 88.90]	[12.04, 20.54]	
Sodium (mg)[2]	133.3 – 266.7		171.74	200.55	122.74	0.058
			[144.72, 203.81]	[175.78, 228.80]	[95.17, 158.31]	
Calcium (mg)	266.7	333.3	35.65	30.77	21.23	*0.004*[c]
			[30.33, 41.90]	[26.40, 35.87]	[17.93, 25.13]	
Iron (mg)	2.0		0.49	0.71	0.40	*0.001*[a, b]
			[0.42, 0.57]	[0.62, 0.81]	[0.34, 0.48]	
Selenium (µg)	13.3		2.03	2.12	1.56	0.108
			[1.67, 2.47]	[1.79, 2.51]	[1.27, 1.92]	
Iodine (µg)	25.0		1.53	2.48	1.16	*0.002*[b]

Nutrients	1/3 of NRV		Pre FtN (n = 70)	During FtN (n = 72)	Post FtN (n = 73)	p-value
	Boys	Girls				
			[1.24, 1.89]	[2.12, 2.91]	[0.94, 1.44]	
Zinc (mg)	1.7		0.39	0.72	0.34	*<0.001*[a, b]
			[0.33, 0.46]	[0.62, 0.83]	[0.28, 0.40]	

NRV = Nutrient Reference Values' FtN = Feed the Need, EAR = Estimated Average Requirements

[^] Values expressed as means with 95% CI for normally-distributed data; population mean of 77 students who completed the food records over 5 days in each timeframe

[$]NRV reported as EAR for children 10-11 years old, unless specified otherwise (Ministry of Health, 2015d)

[1]References values determined from the mean intakes of children 7-10 years (energy) and 9-14 years (carbohydrate, sugar and fat) (Clinical Trials Research Unit and Synovate. 2010. A National Survey of Children and Young People's Physical Activity and Dietary Behaviours in New Zealand: 2008/09: Key findings. Wellington: Ministry of Health).

[2]Adequate Intake (AI) levels recommended for children 10-11years old (Ministry of Health, 2015d)

One way-ANOVA test determined the p-values, comparing the three timeframes for statistically significant differences ($p<0.05$). Post hoc tests using Bonferroni correction determined where the difference occurred with denotations of a, b and c; a=significance between pre- FtN and during FtN, b=significance between during FtN and post- FtN, c=significance between pre- FtN and post FtN

In the pre- FtN timeframe, the children's normal dietary intakes during school hours were assessed. The results suggested that none of the requirements of the essential nutrients were met, with all of the nutrient intakes failing to reach half of the NRV recommendations. Mean sodium intake for the sample population was still within the AI recommendation range. Additionally, the mean intakes of total fat, saturated fat and sugars were also not over the recommended thresholds.

When FtN meals were provided in the 'during' timeframe, increasing trends of nutrient intakes were observed for total energy, protein, dietary fibre, vitamin B12, folate, vitamin A, iron, selenium, iodine and zinc when compared to the first timeframe; nevertheless, one-third of the daily recommendations were still not met. Total fat and sodium were also higher during FtN timeframe. Mean scores of all nutrients, except for sugars and vitamin D, decreased further in the post-FtN timeframe.

One-way ANOVA repeated measures determined that the mean scores for vitamin D and sugars between pre- FtN and during FtN timeframes were significantly different. A significant difference was also found between during FtN and post- FtN timeframes for protein and iodine. Lastly, folate, vitamin A, iron and zinc intakes were observed to have a significant increase from pre- FtN to during FtN timeframe, and significant decreases from the during FtN timeframe to the post- FtN timeframe. A Greenhouse-Geisser correction was used for all nutrients as they violated assumption of sphericity, except sugars and iron.

4.4 Comparison of FtN days vs non FtN days within a week

Using the data collected from the second timeframe (during FtN), investigations were also carried out comparing days with FtN meals (Monday, Tuesday, Friday) and days without FtN meals (Wednesday, Thursday) exclusively, to further assess the impact of FtN meals on children's nutrient intakes within a week. The nutritional data for the week was split into the two categories to be analysed (FtN days vs non- FtN days). **Table 4.4** reports the mean intakes of each nutrient for each category and whether there were statistically significant differences between the two sets of days.

Table 4. 4: Comparison of nutrient intakes within the second timeframe (during FtN week), on days with FtN meals (Monday, Tuesday and Friday) and days without the meals (Wednesday and Thursday)

Nutrients	1/3 of NRV		FtN days (n=69)	Non- FtN days (n=69)	p-value
	Boys	Girls			
Energy (kJ)[1]	2937.0	2574.0	1069.74	1247.70	*0.005*
			[958.97, 1193.29]	[1062.21, 1465.59]	
Protein (g)	10.2	7.9	9.19	6.29	0.463
			[8.05, 10.49]	[4.90, 8.07]	
Total fat (g)[1]	29.4	24.9	9.32	10.58	*0.001*
			[8.34, 10.40]	[8.61, 13.01]	
Saturated fat (g)[1]	≤ 9.2	≤ 8.0	3.41	4.22	*<0.001*
			[3.02, 3.84]	[3.31, 5.37]	
Carbohydrate (g)[1]	86.5	75.6	31.48	39.23	*0.002*
			[27.95, 35.45]	[33.36, 46.13]	
Sugars (g)[1]	≤ 17.2	≤ 15.1	9.45	12.55	*0.001*
			[8.00, 11.16]	[9.61, 16.39]	
Dietary fibre (g)[2]	7.9	6.6	3.54	2.88	0.401
			[3.15, 3.98]	[2.39, 3.47]	

Nutrients	1/3 of NRV		FtN days (n=69)	Non- FtN days (n=69)	p-value
	Boys	Girls			
Vitamin D (µg)	1.7		0.10	0.18	0.212
			[0.05, 0.15]	[0.12, 0.24]	
Vitamin B12 (µg)	0.5		0.35	0.21	*0.001*
			[0.27, 0.46]	[0.12, 0.30]	
Total folate (µg)	83.3		37.19	24.11	0.866
			[32.50, 42.57]	[18.72, 31.06]	
Vitamin A (µg)	148.3	140.0	136.51	22.51	*<0.001*
			[104.76, 177.89]	[15.26, 33.19]	
Sodium $(mg)^2$	133.3 – 266.7		349.86	327.35	0.459
			[306.31, 399.60]	[253.27, 423.10]	
Calcium (mg)	266.7	333.3	50.29	57.52	0.084
			[43.29, 58.43]	[46.88, 70.56]	
Iron (mg)	2.0		1.36	0.94	0.336
			[1.19, 1.56]	[0.75, 1.17]	

Nutrients	1/3 of NRV		FtN days (n=69)	Non- FtN days (n=69)	p-value
	Boys	Girls			
Selenium (µg)	13.3		3.67	3.12	0.998
			[3.08, 4.37]	[2.33, 4.19]	
Iodine (µg)	25.0		5.17	2.08	*<0.001*
			[4.42, 6.05]	[1.68, 2.59]	
Zinc (mg)	1.7		1.47	0.75	*0.018**
			[1.28, 1.69]	[0.58, 0.96]	

NRV = Nutrient Reference Values' FtN = Feed the Need, EAR = Estimated Average Requirements

^Values expressed as means with 95% CI for normally-distributed data; population mean of 69 students who completed the food records during FtN week

$NRV reported as EAR for children 10-11 years old, unless specified otherwise (Ministry of Health, 2015d)

[1]References values determined from the mean intakes of children 7-10 years (energy) and 9-14 years (carbohydrate, sugar and fat) (Clinical Trials Research Unit and Synovate. 2010. A National Survey of Children and Young People's Physical Activity and Dietary Behaviours in New Zealand: 2008/09: Key findings. Wellington: Ministry of Health).

[2]Adequate Intake (AI) levels (Ministry of Health, 2015d)

*Paired t-tests were conducted to compare the nutrient intakes of children on FtN days (n=3) vs non FtN days (n=2), with significance level of <0.05.

During the week when FtN meals were provided, our results revealed that intakes of nine nutrients' were significantly different between the two sets of days. On FtN days, mean intakes of energy, total fat, saturated fat, carbohydrates and sugars were lower; whereas vitamin B12, vitamin A, iodine and zinc intakes were higher. Consistent with results from the overall comparisons in previous section, sodium intake was also higher on FtN days compared to non- FtN days.

4.5 Food group consumption and most commonly consumed food items in each group

Food records collected were also used to further investigate the types of foods these children were consuming the most at school, and the food groups these food items belonged to. In order to compare the consumption of each particular food item across the three timeframes, the total weight consumed was divided by the total number of students who reported having consumed the item, and then by five days. This enable us to report the average intake of the food in g/person/day for that particular week. **Figure 4.1** describes the types of food items that were most commonly consumed by children in pre- FtN timeframe, and each of these food items was categorised into the eight food groups accordingly.

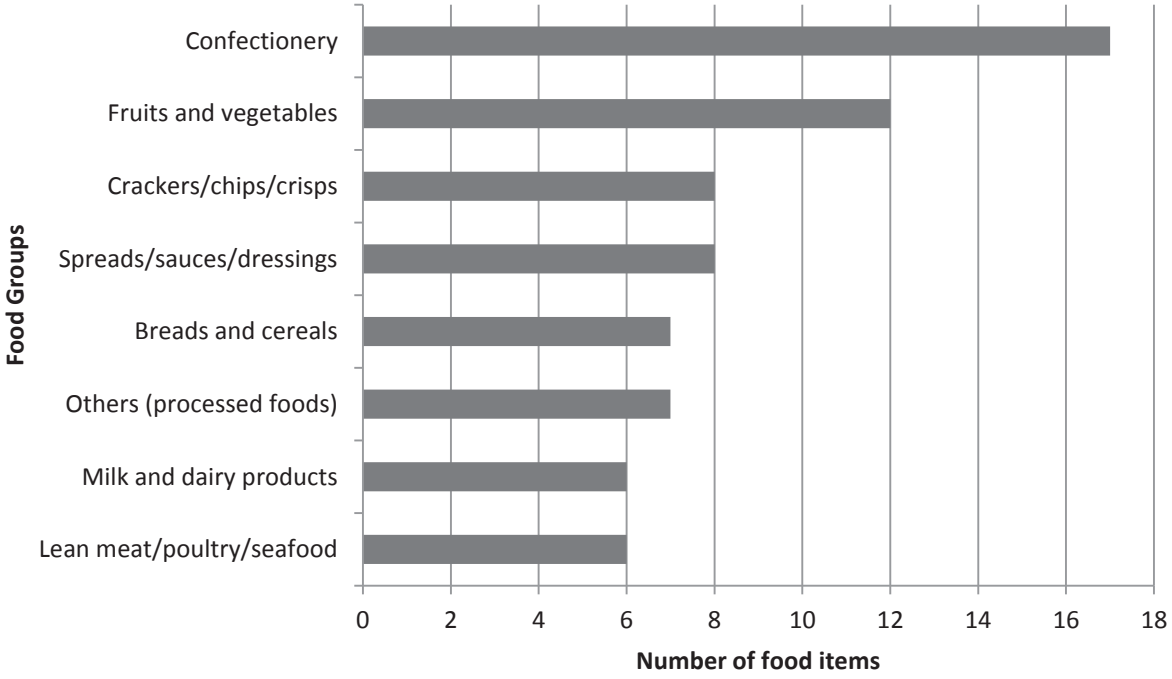

Figure 4. 1: Food items (n=71) consumed by children in the pre- FtN timeframe and the categorisation of these items into relevant food groups

There was low consumption of the four essential four groups – with fruit and vegetables (F&V) intakes highest at 16.9% (12 out of 71 items). Reporting by weight consumed/person/day, there were 58.5g/person/d of F&V consumed – with fresh fruits such as apples, bananas and kiwifruits most frequently reported. Bread & cereals, milk & dairy products and meat & proteins constituted below 10% of the types of foods consumed.

White bread was the most popular item in the breads and cereals category, with 33.8g/person/d consumed, as reported by 51 students; as compared to wholegrain bread at 24.9g/person/d reported by 8 students. Of the 71 types of foods, six belonged to the milk and dairy products category (yoghurt, flavoured milk, dairy food, Up&Go, cheese and cream), with a total consumption of 6606.3g by 42 students in the week, averaging at 31.5g/person/d.

Confectionery and sweet drinks accounted for 23.9% of the types of foods consumed (17 out of 71). Considering weight or portion size, cakes were the most consumed in the category (25.7g/person/d), followed by biscuits (15.9g/person/d), fruit rolls (10.0g/person/d) and bars (8.6g/person/d). Oreos and chocolate chip biscuits were recorded most regularly. Sweet drinks and juices were also highly consumed at 87.6ml/person/d.

Crisps or crackers, corn snacks of all sorts, or processed foods which included sausage rolls, pies, ham and pizzas made up 20.0% of the food types. The consumption of these foods averaged at 25.3g/person/d.

During the FtN timeframe, each of the three FtN meals was broken down into their individual ingredients, and were then categorised accordingly as well. **Figure 4.2** describes the types of food items that were most commonly consumed by children in during FtN timeframe:

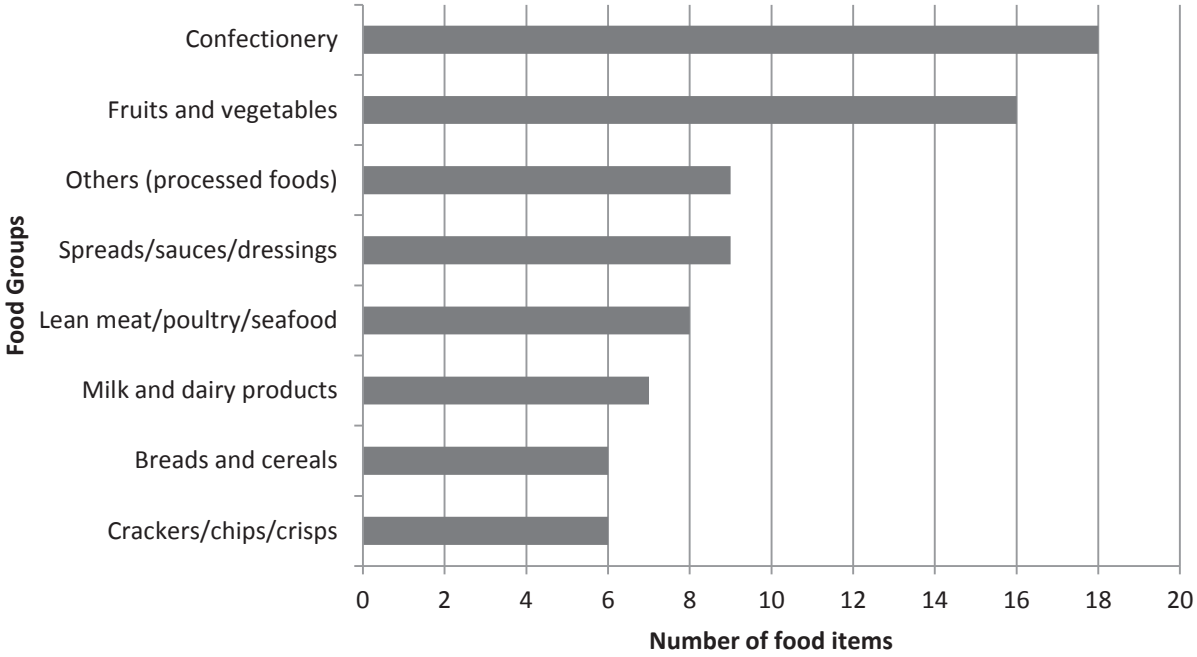

Figure 4. 2: Food items (n=79) consumed by children during FtN timeframe and the categorisation of these items into relevant food groups

Among the 79 food items consumed during FtN timeframe, 20.3% belonged to the F&V category. On average, F&V consumption averaged at 80.8g/person/d as reported by 67 students, as compared to 58.5g/person/d in first timeframe. Butternut, carrots and onions from FtN meals contributed to a greater intake of vegetables in this week.

In breads and cereals category, bread remained the most popular foods among the children. A total amount of 9602.9g of wholegrain/wholemeal bread was consumed by 62 students (31.0g/person/d), compared to 6990.2g of white bread by 48 students (29.1g/person/d). Up & Go was the most popular item in the dairy group (86ml/person/d consumed).

Confectionery and sweet drinks still made up 23.9% of food groups consumed (18 out of 79). In terms of weight, biscuits were the most consumed (16.6g/person/d), followed by cakes (47.2g/person/d), and fruit rolls (11.6g/person/d). Sweet drinks and juices remained highly consumed at 89.9ml/person/d. Total consumption of crisps, crackers and corn snacks decreased to 5271.0g by 61 students (17.3g/person/d).

Figure 4.3 describes the types of food items that were most commonly consumed by children in post- FtN timeframe:

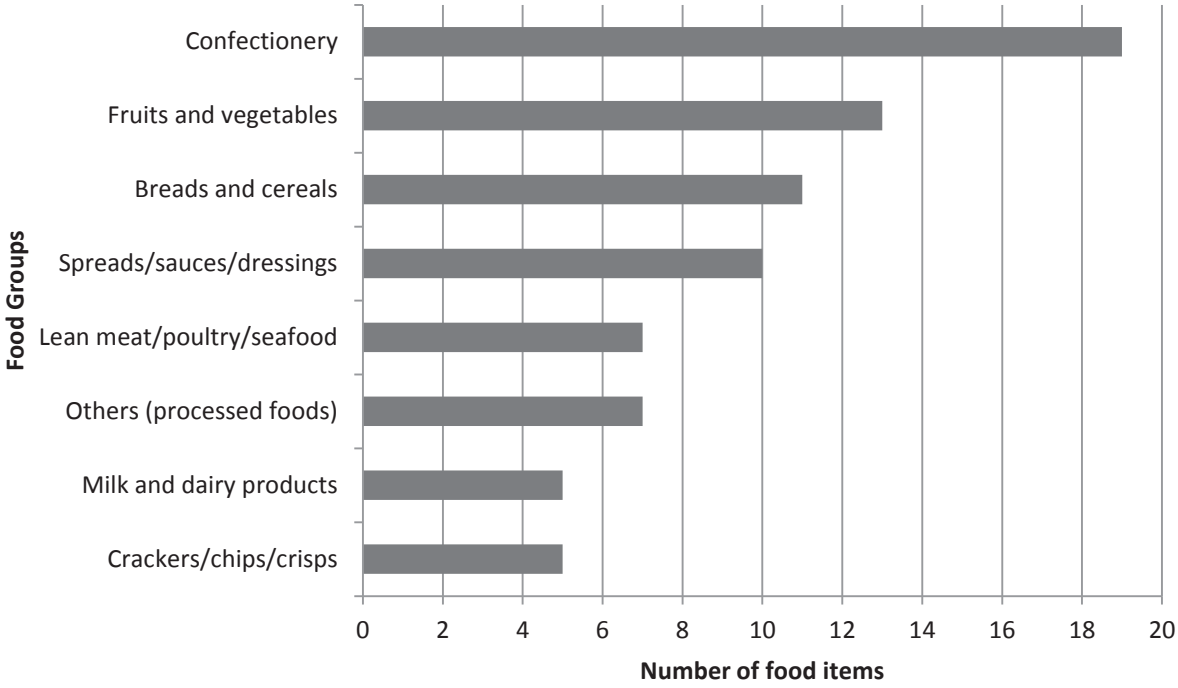

Figure 4. 3: Food items (n=77) consumed by children post- FtN timeframe and the categorisation of these items into relevant food groups

Among the 77 food items in post- FtN timeframe, 36 of them belonged to the essential food groups. 13 were of fruit and vegetables category (16.9%), a decreased intake at 56.4g/person/d compared to the during FtN timeframe; followed by 11 in breads and cereals category (14.3%); whereas milk & dairy products and meat & proteins both remained under 10%, same outcome as pre- FtN timeframe.

White bread resumed as the most popular item in breads and cereals category, with 8564.4g reported by 44 students (38.9g/person/d), compared to wholegrain bread at 580.1g (38.7g/person/d) as reported by only 3 students.

Confectionery and sweet drinks were accountable for 24.7% of food items consumed in the week. In this category, cakes remained most consumed by weight (26.4g/person/d), biscuits (18.0g/person/d), fruit rolls (10.8g/person/d) and bars (9.2g/person/d). Sweet drinks and juices were also highly consumed by 28 students (87.2ml/person/d). Crisps, crackers and corn snacks of all sorts (averaged at

25.4g/person/d by 59 students) and processed foods made up approximately a total of 19.5% of consumption.

In brief, the types of food items consumed across the three timeframes remained consistent, however the total weights consumed for certain food items were different. This was evident in the week when FtN meals were provided, as the overall weight of energy-dense foods appeared to be lower compared to the pre- and post- FtN timeframe. However, for certain items such as biscuits, baked goods, muesli bars and fruit rolls, the g/person/d consumed remained similar throughout the three timeframes despite significant drops in overall weight during FtN week. Overall, confectionery remained as the largest proportion of food items consumed during school hours with more than three quarters of students reporting intakes across the timeframes.

4.6 Attendance

This analysis explored the possibility that the nutritional benefits of the FtN programme may reduce the number of absences from school due to ill health. The rates of absenteeism for 72 students were expressed in percentages [(Days absent/Total number of school days) * 100%]. Tests of normality showed that the data for the three timeframes were normally distributed. Therefore, means and standard deviations (SD) were used. The mean ± SD percentages of absenteeism were 10.6 (9.2), 12.4 (10.5) and 11.8 (13.7) for pre- FtN, during FtN and post- FtN timeframes, respectively.

In brief, children had a higher rate of absenteeism during FtN- timeframe. On average a child was absent approximately five out of 49 days in pre- FtN timeframe, seven out of 54 days during FtN, and three out of 25 days in post- FtN timeframe. A one-way analysis of variance revealed no significant differences in absenteeism between any of the three timeframes.

4.7 Positive Behaviour for Learning (PB4L)

This analysis explored the possibility that the nutritional benefits of the FtN programme may reduce the number of formally recorded incidences of misconduct during school hours. For the three classrooms involved in the study, there were 15 reported incidents of misconduct for the three weeks prior to FtN and 7 reported incidents during the first three weeks of the programme. This reduction in reported misconduct during the programme was significant (*binomial p* = 0.067). However, this finding is to be treated with caution due to the relatively low frequency of reported misconduct.

As the school could not supply the data for the post- FtN timeframe, it was not possible to determine whether the incidents continued to decrease, stabilised, or reverted back to pre- FtN levels. Furthermore, although all formal reports were for serious misconduct requiring some intervention by a teacher or a consequence for the student, the brief nature of the reports was not sufficiently detailed to enable a distinction to be drawn between 'serious' and 'very serious' incidents.

4.8 Perceptions towards programme

Following the programme all children were asked to complete a 5-item Likert-format questionnaire on their perceived views about the programme. A total of 63 children returned the questionnaire. Missing questionnaires were a result of children being absent from their classes at the time. The majority of children completed the questionnaire by answering all five of the items; a small percentage of children failed to indicate all items. However this was a low frequency behaviour, and this was identified and treated as missing data. The responses for each item were demonstrated in **Figure 4.4**.

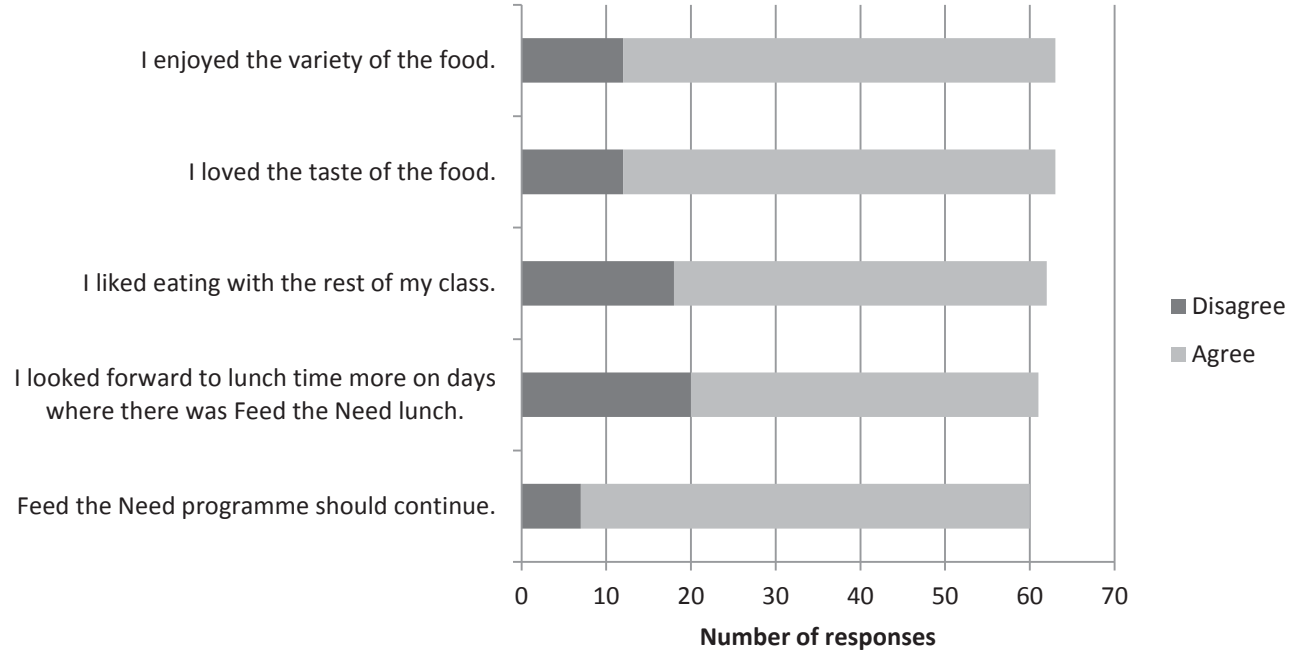

Figure 4. 4: Children's perception of the FtN programme

*"Disagree" includes "strongly disagree", "moderately disagree" and "disagree"; "Agree" includes "strongly agree", "moderately agree" and "agree".

A total of 51 students answered positively to the first item, indicating they agreed that they enjoyed the variety of the meals provided by FtN programme. This provided an overall mean of 4.4 ± 1.6 for this item. Similarly, 51 students agreed that the meals were to their tastes. The other 12 responses disagreed with the question proposed. Overall mean for the item was 4.4 ± 1.6.

Around two-thirds of the students (n=44) responded positively when asked about students consuming lunch meals as a class. A higher number of students disagreed with the statement, with an overall mean of 4.0 ± 1.7 obtained. In assessing whether students looked forward to FtN days more than normal school days, 41 students answered either "agree", "moderately agree" or "strongly agree" and 20 students had somewhat disagreed. The item's mean was 3.9 ± 1.7.

When asked if FtN should continue in the following year, 53 students agreed to it (34 "strongly agreed"), providing a mean of 4.9 ± 1.6, highest value out of the five items.

4.8.1 Children's preferences of meals and additional comments

The menu for 2014 included hearty beef stew, cowboy casserole, winter lamb stew, warming beef goulash, and winter sausage casserole, and meals that were served with a wholemeal roll and butter were butternut and bacon soup, Sloppy Joe's, pumpkin soup, and Italian beef & vegetable soup. Pumpkin soup appeared to be the most liked meal (36.8%); whereas Sloppy Joes was the least favourite (28.3%).

Getting free soup and buns was the top comment from the students across the three classes, claiming it was the best part of the programme. The provision of wholemeal bread rolls and margarine was also most of the students' favourite part. As we hypothesised that children's responses would match the findings from the previous year, children did generally love the meals and expressed gratitude and appreciation towards the FtN programme for the meal provision, with comments such as "thank you so much" and "delicious and wonderful". Two negative comments were received regarding the taste of the meals and the overall perception of the programme. There were three additional comments regarding the meals not being culturally appropriate, therefore they did not have the opportunity to taste them and recommended the addition of vegetarian options for the future. Overall, the majority of the comments (>90%) were positive and FtN was well-received by the school children.

4.8.2 Feedback from the teachers

Following the programme, teachers from the three classrooms participated in a focus group to discuss the programme. Findings from the focus group appeared to be consistent with the results of the study. The teachers felt that the programme had been extremely well-received by students. However, cultural diversity should be considered if the programme continues, as some children did not get to experience the meals due to their dietary restrictions; lack of meal options was thus the only limitation. Although students became more selective towards the end of the programme, they still consumed the food. Teachers felt that the main advantage for the programme was that students received nutritious meals which exposed them to flavours they may have never tried before. It was also suggested by the teachers to

keep the programme within the term or winter, as there were more leftovers on warm days.

The teachers also reported receiving a number of comments from parents. While most of these comments were favourable, such as being appreciative of the programme and were thankful for 'leftovers' that were brought home, some parents who provided lunch for their own children questioned the need for the school to provide food.

The conclusion from the focus group suggested that there was a high awareness regarding the amount of non-nutritious foods the children were eating during school hours. The teachers also recognized the constant efforts needed to acknowledge that the school is a health promoting school.

Chapter Five: Discussion

The main aim of the study was to evaluate the impacts the Feed the Need (FtN) programme had on children from a low-decile primary school in South Auckland. Limited research has been conducted in New Zealand to assess what children are eating during school hours, or whether they can benefit from a school lunch programme. With international studies showing poor food choices during school hours and also conflicting findings about benefits of school meal programmes, this study aims to contribute to existing New Zealand literature about childhood nutrition and to assess whether initiatives at an early stage of life is necessary to ensure immediate and future benefits, in terms of health and education outcomes. Our results show children had low intakes of essential food groups, such as fruits & vegetables and milk & dairy products during school hours. There was also high consumption of energy-dense foods (e.g. confectionary and highly processed foods). FtN meals were found to contribute significant amounts of certain essential nutrients such as Vitamin A, protein and folate. Therefore, children were more able to meet their nutritional requirements as suggested by New Zealand's Ministry of Health. Although rates of absenteeism and behavioural misconducts did not appear to be affected throughout the programme, several explanations for such findings will be discussed. The programme was generally well-received, with more than 70% of children enjoying the taste and variety of meals provided, and majority of responses (88.3%) agreeing for FtN to return for the following year.

5.1 Profile of participants

A total of 77 students from a decile one primary school in South Auckland, aged between ten and eleven, participated in the study. They were enrolled as year five and six students in 2014. The proportions of participants were 51.9% boys and 48.1% girls. Teachers from the three classes involved were interviewed in a focus group at the end of the programme.

5.2 Nutritional analysis of FtN meals

The nutritional analysis of the recipes showed common trends throughout the menu which, if addressed, will improve the nutritional quality of the meals provided to the

children. Our results suggested that through a standard serving size of these FtN meals (butternut and bacon soup, hearty beef stew and Sloppy Joes), children were more able to meet their target for certain essential nutrients, such as protein and vitamin A which provided over 100% of their one-third requirements in each of the meals. As our findings revealed that children did not consume adequate nutrition whilst at school for a third of their day, constant exposure and consumption of the FtN meals could have a long term role in preventing consequences of major deficiencies, such as impaired growth and immunity (Ministry of Health, 2015d). However, their dietary intakes outside school hours remain unclear.

Our findings have been relatively consistent with other studies discussed in Chapter Two, which show that lunch programmes such as the NSLP in U.S.A. promoted higher intakes of essential nutrients. However, NSLP meals were also found to contain high energy, fat and sodium levels. In certain FtN meals, ingredients such as baked beans, bacon, wholemeal roll and salt contributed to elevated sodium level (more than 200% of children's Adequate Intake recommendations). The use of lower cost ingredients was more feasible for bulk production of the meals, and also contributed to heightened taste of the meals. A high sodium intake is positively associated with increased blood pressure, which can lead to cardiovascular disease in later life (Ministry of Health, 2015d). As a recommendation, sodium in the meals can be reduced by using water or freshly made stock flavoured with small amounts of iodised salt or herbs and spices. Additionally, baked beans could be replaced with rinsed and drained reduced salt varieties. Legumes, kidney beans or chickpeas are also feasible options and they will increase folate and dietary fibre levels in these meals.

The opposite was observed for the energy levels in FtN meals, which were inadequate. Low energy level in these meals could be due to the lack of wholemeal bread roll with the hearty beef stew, and possibly an inadequate serving size of the meal (200g) as some children were observed to consume more than one portion. Low level of energy for hearty beef stew could be addressed by incorporating a serving size from the bread and cereal food group. These additions will significantly improve the energy, carbohydrate and fibre contents of the meal; as energy is arguably one of the most important components of the meals by providing necessary resources for bodily

functions for concentration, movement and growth (Ministry of Health, 2015d). Energy may be increased for all three meals without necessarily increasing the volume, by adding energy-dense fortificants (milk powder, potato flakes, or cheese). Some of these fortificants would also further increase the protein content, as well as the calcium level which was found to be significantly low in the meals.

It is worth noting that other recipes of FtN programme were not evaluated in this study, therefore these findings were not applicable to all FtN meals. Additionally, it can also be challenging for one lunch meal to provide the recommended levels of all essential nutrients. Therefore it is important to calculate nutrient contribution over the three recipes within the week, rather than individual recipe analyses. This will be of assistance when adjusting recipes to improve the content of particular nutrients for the following year.

5.3 Comparison of nutrient intakes across the three timeframes

Due to the inconsistency of children consuming FtN lunches and completing their daily food records, it was challenging to determine the true impact of the FtN meals by solely comparing the nutrient intakes across the timeframes. Also, due to the warmer weather when some of these data were collected, some children had appeared to be less receptive towards certain meals. It is also important to note that this population mean is not a clear indication of the participants' individual nutritional status. However, FtN did promote an overall positive effect on the children's dietary patterns. The nutrient intakes from both morning tea and lunch were assessed across the three timeframes and intakes of protein, dietary fibre, vitamin B12, folate, vitamin A, iron, selenium, iodine and zinc were greater when meals were provided.

Our findings of the improvements in protein, vitamin A, iron and zinc intakes confirmed our hypothesis that nutrient intakes would improve during FtN timeframe. One of the explanations for the significant increase in intakes of those nutrients is the increased consumption of wholegrain products and meat sources during FtN timeframe. Such a finding is of great importance because children of Maori and Pacific backgrounds are at higher risk of nutrient deficiencies. The National Children's Nutrition Survey 2002 (CNS2002) shows that girls, especially of Maori and Pacific

background, aged between 11 and 14 years, are likely to be deficient in iron (Ministry of Health, 2015d). Other NZ findings showed those in deprived areas had inadequate intakes of vitamin A, folate and dietary fibre (Ministry of Health, 2015d, Russell et al., 1999). Zinc deficiency was also more prevalent in Maori and Pacific children compared to the NZEO children (Gibson et al., 2011). Along with the reduced likelihood of children in deprived areas receiving an adequate diet at home, they are also unlikely to meet their nutritional requirements as a survey found they are less likely to consume breakfasts compared to NZEO children (Ministry of Health, 2015a). Therefore, it is crucial to sustain these improvements of nutrients in the long run, as adequate protein and iron levels in these meals are essential for the growth of new tissues, normal neurological functions and transport of oxygen around the body (Ministry of Health, 2015d).

There appeared to be no differences in total and saturated fats intakes across the three timeframes. It could be an indication that FtN lunches were not successful in replacing other poorer food choices, when provided only three days a week. The CNS2002 found that potatoes, kumara and taro (including crisps and chips) were the largest contributors to total fat in children's diet (Ministry of Health, 2003). When meals were no longer provided in post- FtN timeframe, children resumed their regular consumption of crisps and processed foods, as supported by a study which observed the weaning effect of fruit intakes among school children when fruits were no longer provided in a school setting (Ransley et al., 2007).

Furthermore, in our study, compared to children's daily energy requirement of 7800 – 8900 kJ, the mean energy consumed from morning tea and lunch was significantly low (ranged between 497.6 – 627.48kJ) due to the lack of substantial lunch items. Although energy-dense processed foods were consumed regularly across the three timeframes, they were not consumed excessively (e.g. 15g of potato crisps or 12g of fruit roll on any one occasion). Therefore energy intake was low, and fat and sugar intakes were not over the recommended threshold. School meal programme participation has been associated with an increased prevalence of excessive sodium intakes, as evidenced by this study's findings, despite a lower prevalence of nutrient inadequacy (Clark and Fox, 2009). As previously discussed, sodium level was elevated in FtN meals. Subsequently,

a higher sodium intake was observed in during FtN timeframe. However, it was not significantly different compared to the other two timeframes. This indicated that emphasis should not only be on modifications of FtN menu, but also the highly processed foods children consume during school hours.

Our findings for dietary fibre and protein intakes were consistent with a study conducted on English children's diets, where intakes of the two nutrients increased when consuming school lunches (Evans et al., 2015). In our study, mean dietary fibre intake was marginally higher during the FtN timeframe but there was no significant difference in dietary fibre intake across the timeframes. A possible explanation was that children consumed adequate amount of fresh fruits on normal school days through the Fruit in School programme, and that provided the children with a similar amount of fibre. However, question still remains if FtN meals replaced intakes of fruits if mean dietary fibre intakes remained similar across the timeframes. Additionally, the selenium level in New Zealand soil is generally low (Ministry of Health, 2015d). Therefore it may be hard to obtain adequate amounts through dietary intake, which is typical of any New Zealand diet. Also, the low zinc intake could create concerns for malnutrition as prevalence of zinc deficiency was already highest among Pacific Islanders and Maori populations (Gibson et al., 2011).

Overall, despite the outliers that might have impacted on the overall mean intakes, children's food records did reveal that most children had very little food for lunches – e.g. a bag of 15g crisps, 12g of fruit roll, a pack of Oreo biscuits, fresh fruits, or a sandwich with Nutella or jam. The low consumption of food at school and also the lack of substantial nutritious food were very well reflected in the nutrient intakes.

5.4 Comparison of FtN days vs non FtN days within a week

When comparisons were made between FtN days and non- FtN days within a week, high sources of meat, carrots and butternut in FtN meals contributed significantly more vitamin B12, vitamin A, iodine and zinc, which were consistent with the findings from the overall comparison. We observed greater mean values in the comparison within a week, than overall comparison of the three timeframes. This was because overall comparison observed a whole week of food intakes with combination of days

with and without FtN meals – therefore low consumption of foods in the non- FtN days decreased the overall mean intakes in the timeframe; whereas this comparison investigated exclusively the days with and days without FtN.

These consistent findings suggested that children's usual food items were of poorer nutritional quality and did not contain appropriate amounts of these nutrients. These are consistent with research that show school meals provide better nutrition compared to children's packed lunches (Evans et al., 2015, Rogers et al., 2007, Harrison et al., 2013). Implication of our findings has suggested a greater concern for under-nutrition among children in low-decile primary school, as a result of inadequate food intakes and low consumption of essential food groups.

Nutrition education and parental role in school meal programmes

Children's eating patterns have remained of poor nutritional quality post- FtN. The healthier eating patterns during FtN were not maintained, with essential nutrient intakes resuming to baseline or decreasing further for some. The mean reduction in children meeting recommended guidelines post- FtN timeframe is difficult to explain but may be related partly to research suggesting any intervention to alter children's eating patterns is unlikely to be effective without any effort to increase their awareness for a need to change (Huon et al., 1996). Changing dietary habits is expected to be a long and difficult process, which would possibly only have effects after a long time (Belot and James, 2011, Wang and Stewart, 2013). A lack of desire to have better dietary patterns can be a huge barrier for these children.

Nutrition education is proven to increase children's knowledge as well as modify their dietary habits (Mohd Shariff et al., 2008). Parental involvement, behaviour curriculum in classroom settings and support from the food industry are also proposed to be incorporated in a school-based nutrition intervention to create a multi-factorial approach (Story et al., 2000). Other than the need for education, other barriers to healthy eating include the absence of parental involvement at home to advocate for healthy food options (Williden et al., 2006). Poor feeding practices within the household, such as offering poor food choices and not ensuring that the child receives

adequate nutritious food, often result in childhood malnutrition (World Health Organisation, 2015e).

As reflected by our results, the short duration of the lunch programme might not have been effective to significantly modify children's dietary patterns as the children resumed their usual eating habits post- FtN. This reflected either their unresponsiveness towards healthy eating or their lack of knowledge and will to maintain healthier eating patterns. Therefore, further initiatives may be needed to prevent the diminishing of such effect from nutrition programmes in school setting (Ransley et al., 2007).

5.5 Food group consumption and most commonly consumed food items in each group

The analysis of food group consumption provided information regarding the types of foods children most commonly consumed at school, and whether these food items belonged to the four essential food groups (breads and cereals, fruits and vegetables, milk and milk products and meat and other protein sources).

Snack packs, bought at school or convenience stores, were consumed most frequently among the children. All four items in the packs, which were chocolate chip cookies, raisins, popcorn and a flavoured drink, contributed to the high sugar intakes as all items belonged to confectionery and sweet drinks category. The low cost of $2.50 appeared to be both affordable and attractive as it suited the children's preferences for sweet foods (Drewnowski et al., 2012). It is universal and evident among children that they possess heightened preference for sweet-tasting foods and beverages during childhood (Ventura and Mennella, 2011). As the weather got warmer throughout the three timeframes, it was not surprising to observe an increasing trend in total consumption of sweet drinks and juices.

Most commonly consumed food items in this research study were consistent with the other findings in NZ settings: with foods high in sugar and salt among the top items children ate during school hours (Dresler-Hawke et al., 2009, Ministry of Health, 2015d). Snack foods and biscuits were highly consumed by NZ children during school

hours (Regan et al., 2008, Dresler-Hawke et al., 2009), which were evident in our findings. Another outcome duplicated in our results was that both dairy and protein groups constituted below 10% of overall food group consumption. We observed similar results as CNS 2002, which revealed foods most commonly consumed between 12pm to 2pm included sandwiches, fruit, biscuits and crackers, corn snacks and sweet drinks (Regan et al., 2008). This implies that children's dietary patterns have remained similar in the past years. NZ Ministry of Health had recommended suitable snacks such as fruit, yoghurt, nuts and milk (Ministry of Health, 2015d). Although the children did consume these items, the amount was inadequate to meet nutritional guidelines.

These results suggest that children are more prone to choose foods high in sugar and fat, as more than half of the foods consumed during school hours did not fit into the four essential food groups. Even though we hypothesised better nutrient intakes during FtN timeframe, it did not, however, replace the consumption of these foods when meals were only provided three times a week. These findings support the need for continuing efforts to reduce empty calorie intake among children, aimed not just at fast-food restaurants, but also at stores and school environments (Poti et al., 2014).

Although children were consuming similar foods during FtN week, the total weight of fruit rolls, chips and corn snacks consumption had decreased, with the justification being children consumed significantly lower amounts of poor food choices on FtN days, as they were eating the meals provided. The researcher's observation also revealed that these items were not brought to school as frequently on FtN days, as evident by the decrease in the number of students who reported consumption of these items. Our results could be more substantial if FtN meals were provided the whole week to determine if they would fully replace other options.

Overall intakes of fruit and vegetables also increased dramatically during the FtN provision of food, due to greater intakes of carrots, butternut and onions from the meals. Provision of a prepared meal during lunchtime is said to reduce snacking frequency (Bower and Sandall, 2002). Although sources of the food items were not investigated in this research, it was observed by the researcher that the fruits consumed (mainly bananas, apples, oranges and kiwifruit) during the three timeframes

were provided by the Fruits in Schools programme. This shows the effectiveness of food provision at schools, to increase fruit and vegetable intakes of low socio-economic group children, especially those who do not normally eat fruit (Ashfield-Watt et al., 2009). National interventions in the United Kingdom promoted increases of fruit intakes; as consumption increased when children were supplied with a free piece of fruit on school days and decreased when they were not eligible for the scheme (Ransley et al., 2007). Authors also found that vegetable intakes were difficult to achieve during school hours, as reflected in our findings.

These findings support the fact that the majority of packed lunches of primary school students contain foods of poor nutritional values, especially in public schools. Mother's educational status and parents' occupations are important determinants of the nutritional contents of lunch packs (Ugochukwu et al., 2014). The results imply that if a school lunch programme is not feasible, future research should address policies, interventions, and programmes to educate parents about nutritional content of packed lunches (Evans et al., 2010). However, the lack of more recent national data regarding children's dietary patterns means it is difficult to determine if the findings from the present study are generalizable across the country.

5.6 Attendance

Health benefits of a nutritious lunch are suggested to reduce a child's absence caused by minor illnesses. In prior discussions with the school, it was also suggested that some parents chose to keep their children at home when they were unable to provide their child with a prepared lunch, or to provide funds to purchase a lunch.

Based on our findings, the FtN programme appeared to have no influence on child attendance rates at school, in contrast to our objective. This finding supports the perceptions of teachers who reported no noticeable effects of the programme on attendance during the focus group session. However, the results were not substantial to determine any association between lunch provision and students' absenteeism. The reasons for these were not documented as part of the study. Therefore, no association could be established between nutrition or health and school attendance. It was proposed in earlier research that educational outcomes cannot fully be explained by

child malnutrition alone (Mcewan, 2013). Further reasons for a child's absenteeism at school can include other family responsibilities, bullying and harassment experienced resulting in an unsafe school environment and family's perception of irrelevance of education and school attendance (Balfanz and Byrnes, 2012).

In 2014, the lunch programme was only carried out from late winter and into early summer. During this period of time, it was common for the school to have more sport events or curriculum that required students to be out of class during this period of time. Consequently, it could not be concluded that the absenteeism was health-related. As the teachers did not think the lunch programme affected children's attendance, they also explained that children from these three classrooms were older, so they were aware of the support available at schools if needed, e.g. make sandwiches during lunch time. Therefore, they were still likely to attend school without lunch.

Attendance remains an important educational outcome to investigate in future research, as it has been previously suggested that there is a positive association between school absenteeism and increased BMI (Geier et al., 2007). In order to observe the long term effects of adequate nutrition in children, an extended duration of the FtN programme would be recommended. This will determine if better nutrition and diet leads to a decrease in health-related absenteeism, where reasons for children's absenteeism are documented.

5.7 Positive Behaviour for Learning (PB4L)

By assessing PB4L before and during the programme, it serves as predictors of the immediate effect of the programme. According to our findings, the association between improved nutrition and behaviours remains unclear, and also whether the findings are long-term changes. Behaviour is unlikely to be limited to intake of better nutrition, at least not within a three-month timeframe. Such relationship is often multi-factorial as many factors can have impacts on the kind of behaviours children display at schools. The different pathways that can contribute to a child's disruptive behaviours during school hours include poor parenting in their home setting, social

disengagement at schools, and affiliation with other peers which may result in criminal attitudes or behaviours (Vitaro et al., 2012).

Over the past two decades, increased prevalence of mental health disorders within this age group parallels a global decline in the quality of their diets (increased intake of foods high in fat, salt and sugar, and decreased intake of fruits and vegetables), suggesting that nutrition and diet may have considerable implications for the immediate mental health and well-being of adolescents (Kulkarni et al., 2015). Further research should ensure that PB4L data is collected appropriately for a longer duration and correlation tests could then determine if adequate nutrient intakes are associated with improvements in cognitive development and behaviours.

5.8 Perceptions towards programme

Responses from children are important in determining the success of a school lunch programme. Barriers that could limit children's participation in school lunch programmes include limited menu items, as well as their own preferences (Bhatia et al., 2011). Therefore, by identifying any potential barriers that might hinder their interest in the lunches, improvements can be made to the meals.

The children agreed that the FtN meals provided the variety and taste of foods that they enjoyed. This was evident in the comments most students had given, as most students did not usually consume hot meals during school hours. However, slightly more negative responses were observed for 'I liked eating with the rest of my class' and 'I looked forward to lunch time more on days when there was FtN'. Lunch time was the only period during the day when children were allowed outside their classrooms to socialise. Therefore, ensuring that the children were seated down to have a meal with the rest of class could be a challenge and it was expected that children did not like being confined in a room.

Despite that, most children still agreed that FtN should continue as 88% of responses were positive, consistent with the hypothesis that the programme would be well accepted by those involved. A higher satisfaction level with the lunch programme can increase children's willingness to participate in it (Lülfs-Baden and Spiller, 2009). Their

perceptions of such programme are important as parents feel the largest barrier to changing children's eating habits are the child's likes and dislikes (Barton, 2000). Although some may not have appeared to be appreciative of the benefits of such programme, the warm meals and bread rolls were well-received.

Culturally diversity of the meals should be considered by FtN programme in order to expand the meal options available for children, especially those who are from different cultural backgrounds and beef is not part of their diet. Vegetarian or chicken options should be recommended to ensure all students benefit from such a programme. It is also important to consider their food preferences are often affected by behaviour of peers, marketing and advertising practices (Sorhaindo and Feinstein, 2006). In order to ensure they are more receptive towards FtN meals in the future, more effort could be invested in promoting the meals in an educational setting, where learning is involved together with their peers.

Chapter Six: Conclusion

6.1 Gap in current research and aim of study

School-age children experience rapid changes in their physical, mental and social development as they grow (Ministry of Health, 2015d). Evidence from international and national studies have consistently revealed poor food choices among children during school hours (Dresler-Hawke et al., 2009, Regan et al., 2008, Belot and James, 2011, Carter and Swinburn, 2004). Key drivers for these eating patterns include over-consumption of highly palatable energy-dense and nutrient-poor foods. As a result, children are less likely to achieve their requirements of essential nutrients needed for their growth and development, as recommended by New Zealand's Ministry of Health. Sub-optimal dietary patterns among children and adolescents result in the co-existence of under- nutrition (i.e. nutrient deficiencies) and over- nutrition (i.e. overweight and obesity) within a population (Tzioumis and Adair, 2014, Piernas et al., 2015, Wong et al., 2015). Both forms of childhood malnutrition can cause undesirable short- and long- term diet-related health consequences, and also impact on children's learning and psychosocial outcomes in schools.

Schools are found to be the most appropriate setting to implement nutrition programmes for children (Utter et al., 2007, Driessen et al., 2014); especially in public schools (Damsgaard et al., 2014). Many countries around the world have adopted school lunch programmes, such as National School Lunch Programme in United States, as well as implementation of school food policies in most European countries to promote healthy eating for school-age children. In New Zealand, previous data showed high consumption of energy-dense foods of low nutritional value during school hours (Regan et al., 2008, Dresler-Hawke et al., 2009). However, there has been limited research done on benefits of a school lunch programme in this country. Therefore, the aim of this study was to evaluate the Feed the Need programme, a charitable organisation that provides warm meals for children in low-decile schools in South Auckland. Its impacts on the primary school children's nutrient intakes during school hours were investigated, and their attendance and behaviour at schools were also assessed.

6.2 Main findings of the research

The main finding of this research was the FtN programme, a winter school lunch programme, had a significant positive impact on the intakes of certain essential nutrients among primary school children.

The nutritional analysis of three FtN meals (butternut and bacon soup, hearty beef stew, and Sloppy Joes) using FoodWorks revealed that they were all low in energy and carbohydrate contents, but had significantly higher sodium level. The three meals, on average, contributed adequate levels of protein, vitamin A and iron over the week. Weighed food records were used to investigate the types of food items most consumed during school hours pre-, during and post- FtN programme timeframes, and data were entered onto FoodWorks for the nutritional analysis of the children's dietary patterns. The results showed that none of the essential nutrient intakes met the recommendations across the three timeframes, and total energy and fat intakes were not over the threshold. However, mean intakes of protein, vitamin A, vitamin D, folate, iodine and zinc were significantly higher when meals were provided. Sodium intakes were elevated throughout the three timeframes, and its high level in FtN meals was of concern as mean intakes were higher during FtN timeframe. The investigation regarding types of food items consumed revealed that a high intake of confectionery and processed foods paralleled a low intake of essential food groups during school hours, across the three timeframes.

Information for attendance and behaviour misconducts were collected from the school records, and findings showed there was no difference in both outcomes, when compared across the three timeframes. Children's and teachers' perceived views about the programme were also investigated; FtN was well-received by the majority of students, with three students not having the opportunities to consume the meals due to culturally inappropriate ingredients.

To address the issues of under- and over- nutrition in New Zealand, our findings were compared with other international and national studies. Common trends were observed for the types of food items consumed during school hours, i.e. foods of low nutritional value. Comparing school meals with packed lunches, children had greater

intakes of essential nutrients when consuming school meals (Harrison et al., 2013, Rogers et al., 2007, Evans et al., 2015). This was also evident in this study.

The results of the study show that FtN school lunch programme, upon modifications and improvement of the recipes, can be a useful instrument for the long term prevention for nutrient inadequacies, and diet-related complications.

6.3 Strengths of the study

This research was a cross-sectional study capturing a snapshot of the primary school children's usual dietary patterns during school hours. The study design allowed the researcher to examine the types of foods children were consuming the most, without any dietary manipulations that changed their eating habits. In addition, the study design also enabled multiple outcomes to be studied at a given point in time (i.e. nutrient intakes, attendance/behaviours, perception and views of programme). Data were also collected pre, during and post- the programme, where similarities in pre- and post- FtN timeframes would provide substantial insight into what school children are usually consuming.

Furthermore, the Daily Food Record method used, which involved children completing a food record during each meal time, was deemed the 'gold standard' in assessing dietary intake (Biro et al., 2002). The compliance was ensured by teachers instructing and assisting the children in the classes during the completion of food records. The availability of weighing scale and portion size guide also ensured the accuracy of data collected. While entering data, the nutritional database FoodWorks was used for the analysis of the FtN meals and the food items consumed by children. The database contained nutritional information which was specific to NZ food items. Therefore, the data collected and the results of analysis had high reliability.

This research is a pioneer for school lunch programmes research in New Zealand, evaluating the impacts of such programme. Study findings also contributed to the existing data regarding children's nutrition during school hours in lower socioeconomic areas, and most of our findings were consistent with the existing literature, both nationally and internationally. A previous study, which trialled school breakfast

programme in New Zealand, did not find substantial benefits for the children involved (Ni Mhurchu et al., 2012). However, it is worth noting that many children's daily energy and nutrient intakes derive mainly from lunch meals. Lunches provide sufficient energy when children's energy levels may be diminishing around mid-day in schools (Ministry of Health, 2015d). Children may possibly eat very little or avoid breakfasts in the mornings; therefore acceptance of a lunch programme could be higher.

Another strength of our study was that it was focussed on primary school children from a low-decile school. Although we were not able to predict the long term effects of FtN programme, well-planned nutrition support programmes with the potential to reach children from various socio-economic backgrounds will be the most feasible approach for many countries (Darnton-Hill et al., 2004). If these observations of improved nutrient intakes can be sustained in these young school-age children, prevalence of nutrient inadequacy could be lowered in the long run.

6.4 Limitations of study

Although the participation rate to our study was relatively high, there are several limitations that are worth noting. As this was a cross sectional study, we did not have a "control school" to compare the effects with, to determine whether the study findings were a result of participation in the lunch programme. The association that was detected in the study may or may not be repeated in similar studies. Another limitation to this study was some children did not complete food records for all the days during data collection. However, missing data were likely to only affect the strength, but not the direction, of our findings. Moreover, due to the inconsistencies in students completing the food records, the mean nutrient intakes could not be a true reflection of FtN meals consumption, especially during the FtN timeframe. This was further compromised by children who had consumed the meals but did not complete their food records, which would have negatively skewed the results. Another constraint relating to data collection was that because it was a cross sectional study, results may differ, if another week was chosen to be "during FtN" timeframe, as different recipes would have been chosen for analysis. When using daily food records to collect dietary data on children and adolescents, reporting errors are likely

(Livingstone et al., 2004). In this particular study, under-reporting could be a limitation and was a contributing factor to the low energy and nutrient intakes during the FtN programme. Therefore, when using one third of nutritional requirements as a comparison, the outcomes should also be interpreted carefully. Not meeting one third of requirements does not necessarily warrant inadequacy or malnutrition in these children.

Although the research has reached some of its objectives, food records collection presents numerous difficulties. Upon completion of the food records by the children, it was apparent that there were some missing food records, missing information, as well as illegibility of certain food items. Although teachers and children were approached for clarification whenever possible, the process was occasionally compromised by teachers' busy schedules and children's unavailability in classes. Assumptions would then have to be made, regarding the weight or amount consumed, which was defaulted to weight of a normal serving size. Another possible limitation was that students who were more likely to have poorer eating habits might have lower compliance in completion of their food records. This could have resulted in a biased observation.

The mean nutrient intakes observed in this study were overall means of the sample of participants. It is unclear to what extent these means reflected individual's nutrient intakes, as means were affected by values in both extremes (i.e. outliers). For example, on observations and food records, some children consumed a piece of fruit for lunch; whereas others consumed six pieces of sandwich with Nutella spread and fruit rolls.

Furthermore, limited data were available for attendance and PB4L during the study period to draw any conclusion regarding the association between adequate nutrition and outcomes in school. Reasons for absenteeism were unknown, and further documentations are needed to identify the causes. Although there was no impact found in the short duration of the FtN programme, the question of whether children's absenteeism and their behavioural disturbances can be associated with diet and nutrition were worth exploring and remain an issue for further research.

Lastly, this study provided an overview of the impacts of the FtN programme. However, due to the numerous aspects being investigated, it was difficult to discuss all significant findings in great depth. Limited time prior to the start of data collection was also a limiting factor as there was no substantial prior knowledge on the most appropriate method to examine the impacts of school lunch programme in the literature. More investigation should have been carried out to identify specific nutrients that would have been more beneficial to examine in the study, rather than all 17 nutrients.

6.5 Use of the research findings

Based on the findings of this study, New Zealand policy makers and Government must determine the allocation of scarce resources to address childhood malnutrition and identify nutritional deficiencies, as well as the future onset of co-morbidities as a result of diet inadequacy. From nutrition and public health perspectives, our research findings support the necessity for children to have increased exposure to adequate nutrition during school hours. School lunch meals can be a useful tool in educating school-age children about reducing the consumption of poor energy-dense food choices with little nutritional value.

These results also indicate that existing initiatives which do not place emphasis on the provision of health and nutrition knowledge and skills might not be able to sustain any nutrition related behavioural changes. Current programmes such as Fruit in School and Milk at School are providing children with essential nutrients; however without the education component, efforts to increase children's level of nutrition knowledge and practice may not be attainable.

Results from this research can also be used as a guide to develop a nutritionally balanced lunch meal for children. As the FtN programme had just commenced, further modifications could be done to create lunch meals that meet the nutritional requirements, based on the recipe analysis from this study and the project by Massey University's Dietetics students. The nutritional analysis also implied that school meals should be of high-quality in order to offer a positive nutritional experience for children (Bartrina and Pérez-Rodrigo, 2006).

Our findings are useful when determining children's perceptions of school lunches. It is indicative that more emphasis or effort in social eating occasions are needed to promote the social meaning and importance of eating, and to enable social learning of food preferences (Westenhoefer, 2002).

6.6 Recommendations and directions for future studies

The findings of this study support the need for further high quality evidence on school meal programmes in New Zealand. More well-designed studies, such as longitudinal cohort studies or multiple cross sectional, should be conducted to investigate the validity of the findings of this study. From a nutrition and public health perspective, it is important to ensure that children are able to report their dietary intakes accurately, and further assistance in data collection would be beneficial. With more accuracy and consistency in the data collected, further investigations could be carried out to examine specific nutrients, such as percentage of energy that derive from empty calories, protein, and fat.

Future studies should address the rising malnutrition rates among school-age children from all socioeconomic classes, regardless of status. Although there is sufficient evidence supporting that those in lower socioeconomic areas have poorer food choices, dietary intakes of children from higher socioeconomic background should also be examined. These findings can be strengthened by having follow up observations to assess the long term effects of school lunch programmes on children's dietary intakes as well as educational outcomes. This would determine whether school lunch programme participants resume their usual dietary intakes once the program completes.

A similar study currently carried out by first year Massey Dietetics students involve the investigation of sources of food items (e.g. Fruit in School, Milk at School, school canteen). This would further strengthen the theory of school-based nutrition initiatives. These initiatives and policies should also be appropriate to a child's age and his or her stage of cognitive development, in order to increase their effectiveness.

Parental engagement and involvement in nutrition initiatives are advocated to be important for school-based initiatives. There is a necessity for more research and studies to compare school-based nutrition initiatives with and without a parental component. Such a recommendation can determine if initiatives within the school setting are sufficient to create and sustain changes, or are needed to be expanded further. Nutrition education should also be considered in future initiatives – the FtN programme could collaborate with nutrition and dietetic students to provide simple nutrition education to primary school children, paralleling the meal provision over winter months.

Lastly, as most New Zealand literature has originated from findings of the 2002 National Children's Nutrition Survey, a new national survey for school-age children will be of benefit in order to explore the current dietary intakes to increase the validity of our findings.

6.7 Conclusion

The Feed the Need programme contributed to a higher intake of essential nutrients when compared to children's usual dietary patterns during school hours. Children also reported lower consumption of high energy-dense foods during the week FtN provided lunch meals. Their attendance and behaviour conducts remained unaffected by this short term winter school lunch programme. Overall, it was well-received by this particular sample of children and teachers involved. However, in order to promote healthy eating habits in the long run, additional aspects, such as nutrition education and school food policies, will need to be introduced in conjunction with meal provision to increase effectiveness.

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Appendix A: Recipes of the FtN meals

Butternut and bacon (680 portions)	**Amount**
Cooking oil	2 L
Diced bacon	6 kg
Finely diced onions	16.5 kg
Diced potatoes	22 kg
Diced carrots	11 kg
Diced butternut	44 kg
Cream	4 L
Salt	To taste
Pepper	To taste
Vegetable stock powder	11 cups

Hearty beef stew (680 portions)	**Amount**
Cooking oil	2 L
Diced beef	39 kg
Finely diced onions	13 kg
Diced carrots	39 kg
Diced potatoes	39 kg
Water	12 L
Beef stock	11 cups
Fresh sage	350 g
Crushed garlic	500 g
Cornflour	To thicken
Salt	To taste
Pepper	To taste

Sloppy Joes (685 portions)	**Amount**
Beef mince	52 kg
Finely diced onions	26 kg
Tomato sauce	10 L
Baked beans	19 x 3 kg
Worcestershire sauce	2 L
Salt	To taste
Pepper	To taste

Appendix B: Food record for pre- and post- FtN timeframes

Daily Food Record

First name & Room number: _____

Day/date: _____

You will be given this piece of paper at each meal to record what food you eat at school today. Describe your food the best you can! ☺

Meals	Food items	Brand	Flavour	Amount (quantity or weight)
Morning tea				
Lunch				
Afternoon tea/fruit				

Appendix C: Food record for during FtN timeframe

Daily Food Record

First name & Room number: _____

Day/date: _____

You will be given this piece of paper at each meal to record what food you eat at school today. Describe your food the best you can! ☺

Meals	Food items	Brand	Flavour	Amount (quantity or weight)
Morning tea				
Lunch	Feed the Need lunch Weight (before): Weight (after):			
Afternoon tea/fruit				

Appendix D: Positive Behaviour for Learning (PB4L) form

Behaviour Data Collection Form

R - Respect E - Excellence A - Attitude L - Life Long Learners

Name: _____ Room: _____ Year: _____

Referring Staff: _____ Time: _____

Location	Others Involved	Possible Motivations
☑ Play area	☑ Peers	☐ Attention Peers
☐ Toilet area	☐ Teachers	☐ Attention staff
☐ Classroom Hall	☐ Other staff member	☐ Avoid peers
☐ Library	☐ Other	☐ Avoid tasks
☐ Swimming Pool	☐ **Names:**	☐ Obtain items
☐ Office	_____	☐ Don't know
☐ Other	_____	☐ Other

Issue of Concern

Minor	Major
☐ Defiance/Disrespect/Non Comp	☐ Defiance/Disrespect/Non Comp
☐ Disruption	☐ Dishonesty
☐ Property Misuse	☐ Physical Aggression
☐ Inappropriate Language	☐ Property Misuse
☐ Inappropriate Physical Contact	☐ Harassment/Bullying
☐ Late to class	☐ Verbal Assaults

Teacher Consequences

☐ Proximal Control	☐ Provide choice	☐ Reteach
☐ Non-verbal Cues	☐ Rethink & Reflect	☐ Student Conference
☐ Ignore, Attend, Praise	☐ Refer to Team Leader	
☐ Error Correction	☐ Contact Home	**Sign:** _____
☐ Redirect		

Senior Management Consequences

☐ Loss of Privilege	☐ Conference with Student
	☐ Behaviour Modification Form
☐ Individual instruction	☐ Stand Down _____ Days
☐ Parent Contact	☐ Exclusion

Appendix E: Assumptions and decisions for data entry

Food groups	Assumptions and decisions made
Fruit • Banana • Apple • Orange • Kiwifruit • Mandarin • Grapes *Default was used most of the time instead of whatever was written on the records as children were probably unaware of the real weight and made up numbers*	Default weight if not written: 120g 120g 130g 81g 72g 46g = 0.5 cup = 1 serving size
Dairy foods • Yoghurt (150g) • Calciyum (150g)	 "yoghurt, assorted fruits and flavours, sweetened" if unspecified "Dessert,dairy food,assorted flavours"
Cereal/muesli bar • Muesli bar • Mother Earth fruit sticks (19g), Pingo (17g) • Tasti Muffin bar • Nutrigrain bar (24g) • Milo bar (27g) • Nice and natural bar (32g) • Flemings muesli bar (30g)	 "Muesli bar" if unspecified "Cereal soft bar,Mother Earth,whmeal,frt" "Cereal soft bar, wholemeal, frt, assorted"+ 0.38g salt, table (?fat) "Muesli bar,Magic Muesli,asst flavours" + Salt,table 0.15g "Muesli bar, chocolate chip"
Potato/vege, crisps/chips • Potato chips • Shapes • Vege chips/cassava chips • Munchos ETA (14g) • Grainwaves, Bluebird (18g)	 "Potato crisps, Natural, Eta" "Crackers, assorted flavours" "snacks, sweet potato chips" 12g + 0.35g of salt,table "Corn chips, cheese flavour" + 0.35g of salt,table
Corn snacks • Twisties (18g) • Cheezels (18g) • Rashuns (18g) • Burger Rings (18g) • Oriental Super Rings (14g) • Corntoz (15g)	 "Corn snacks,cheese flavour"

Baked goods • Biscuits/cookies • Oreos (31g), Wheelies • Lemon biscuits • Fun Sticks (18g) • Creamed donut • Chocolate donut • Tiger sticks (18g – assumed same as Fun Sticks) • Subway chocolate chip/M&M cookies • A slice of cake	"Biscuit, basic, NZ recipe" if unspecified "Biscuits, chocolate cream" for all flavours (vanilla, chocolate, strawberry, orange, banana) "Biscuit, short-sweet" "Chocolate, fancy&filled" + 0.1g salt, table "Doughnut, ring" with "cream, standard 25g "Doughnut, ring" with 2 tb chocolate sauce "Chocolate, fancy&filled" 45g per serve if unspecified 120g per serve if unspecified
Confectionery • Fruit vines (20g) • Fruit O's (20g) • Fruit strings (17g) • Fruit skulls (17g) • Fruit zombies (17g)	"Fruit bar/roll, apricot" (other than protein, per serve 1.4g, only 0.1g on Foodworks)
Confectionery • Fruit nuggets (17g) • Fruit hoops (20g) • Fruit sticks (17g) • Natural Goodness – gummy candy • Angry birds chocolate • Apollo layer cake (18g)	"Fruit bar/roll, apricot" "Fruit bar/roll, apricot" "Fruit bar/roll, apricot" + 0.02g salt,table "Chocolate bar,milk" "Cake,sponge,jam filled"
Drinks • Snack pack flavoured drinks (180ml Winnie's) (300ml Bonko) • Twist blackcurrant juice • Twist orange and mango • Twist apple • Twist pineapple	"Drink flavour,<flavour>,diluted" – strawberry, pineapple, mango *Navel orange flavour if unspecified* "Juice, apple&blackcurrant, Fresh up" "Fruit drink concentrate,orange&mango" "Juice concentrate,apple,unsw,Fresh Up" "Juice,pineapple" Apple juice – Juice,tropical with apple base Winnies (180ml) – all 'drink flavour, etc..' – strawberry (raspberry)
Processed foods • Luncheon/ham • Salami • Bacon • Beef,corned,silverside,lean • Pie	2 slices per sandwich if unspecified 190g

Spreads • Nutella, peanut butter, jam	2 tsp per sandwich if unspecified Use weight if number is indicated e.g. 303, 264 etc.
Chicken sandwich or roll	2 bread slices/1 bread roll 0.5 cup chicken, flesh, cooked 2 tsp dressing, mayonnaise, commercial 2 tsp margarine 0.25 avocado *or* 1 lettuce leaf and 15g tomato
Bacon and egg sandwich	2 bread slices 50g of pork,bacon,rashers,lean&fat,grilled 1 Egg,chicken,boiled
Tuna sandwich	2 bread slices 2 tsp of tuna, in spring water, canned, drained 2 tsp of Dressing,Mayonnaise,commercial
Pizza Stick	"Pizza,BBQchic,large,bkd,comm,thick crust" 1 slice = 1 stick
Toasted sandwich (from school)	2 Bread,white,sliced,prepacked 2 80g Spaghetti,in tomato sauce,canned 20g Cheese,Cheddar,Mild,Valumetric
Subway (6 inch sub) • Ham • Roast beef	1 Bread roll,white,supermarket fresh 2 slices of Ham,sliced,sandwich or Beef,bolar roast,lean,roasted 1 lettuce leaf 15g tomato 15g cucumber 1 slice of Cheese,processed

Appendix F: Main findings from FtN project

● = Provides 50-99% of the RMI X = Does not meet the RMI √ = Meets or exceeds the RMI (≥ 100%)

Nutrient	Soups								Beef & Lamb						Sausages			
	Butternut & Bacon Soup with wholemeal roll & butter		Pumpkin Soup with wholemeal roll & butter		Italian Beef Soup with wholemeal roll & butter		Sloppy Joe's with wholemeal roll & butter		Hearty Beef Stew		Warming Beef Goulash		Winter Lamb Stew		Winter Sausage Casserole		Cowboy Casserole	
	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G	B	G
Energy (kJ)	●	●	X	●	●	●	X	X	X	X	X	X	X	X	X	X	X	●
Dietary fibre (g) 9-13 yr	√	√	●	●	√	√	●	●	X	X	X	X	●	●	X	X	●	●
Fat (g)	●	●	X	●	●	●	X	X	X	X	X	X	X	X	X	X	X	X
- Saturated (g)	√	X	√	X	√	X	√	√	√	√	√	√	√	√	√	√	√	√
Carbohydrates (g)	●	●	X	●	●	●	X	X	X	X	X	X	X	X	X	X	X	X
- Sugars (g)	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Protein (g)	√	√	●	●	√	√	√	√	√	√	√	√	√	√	●	●	●	√
Iron (mg)	√		●		√		√		●		√		●		●		√	
Calcium (mg)	X		X		X		X		X		X		X		X		X	
Iodine (ug)	√		X		X		●		X		X		X		X		X	
Sodium (mg)	X		X		X		X		√		√		√		X		X	
Folate (ug)	●		X		●		●		X		X		X		X		●	
Vitamin A (RE)	√		√		√		√		√		√		√		√		X	
Vitamin B12 (ug)	●		X		●		√		●		√		√		●		X	
Selenium (ug)	●		X		●		●		X		●		X		X		X	
Vitamin C (mg)	√		√		√		●		√		√		√		√		√	