

Fibre Intakes and the Main Food Sources of Fibre in Adolescent Males

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Abstract

Background: Based on the 2008/09 New Zealand Adult Nutrition Survey, the mean dietary fibre intake in adolescent males aged between 15 and 18 years was at 21.9 grams (g) per day, which was well below the adequate intake (AI) for their age group of 28 g/day. Given the role of dietary fibre in promoting optimal health as well as the potential of changing dietary patterns and food sources over time, an update on the dietary fibre intakes of New Zealand adolescent males is warranted.

Objective: To determine the current mean intake of dietary fibre and the main food sources of fibre in New Zealand adolescent males aged between 15 and 18 years.

Methods: The Survey of Nutrition Dietary Assessment and Lifestyle (SuNDiAL) study is an ongoing clustered, cross-sectional survey in New Zealand that began in 2019. The data presented in this thesis were collected between February and April 2020. Male participants were enrolled from 6 high schools nationwide in Otago, Wellington, Christchurch, Rotorua, Tauranga and Auckland. High schools were selected based on a student roll of at least four hundred. Socio-demographics and bowel habits were self-reported with an online questionnaire. Height and weight were measured, and a Body Mass Index z-score was generated for each participant. Dietary data were assessed via two interviewer-led 24-hour multi-pass dietary recalls on non-consecutive days. The dietary data entered into FoodWorks 9 (Xyris Software, Australia) were used to estimate mean energy and fibre intakes for each participant. These were adjusted for within-person variation using a Multiple Source Method (MSM) program to represent usual intakes. The proportion of total fibre intake provided from the 33 food groups were estimated using Stata Statistical Analysis Software 16.0 (StrataCorp, Texas).

Results: One hundred and thirty-five male participants enrolled in our study. One hundred and two of those completed one 24-hour recall and seventy-two completed a second recall. Overall, the mean fibre intake was at 24.1 g/day (95% CI: 22.2, 25.9), which was lower than the AI of 28 g/day. Bread was the single largest food source of fibre intake contributing to eighteen percent, with thirty-nine percent of the male participants consuming white bread, followed by grains and pasta, and fruits at almost twelve percent and vegetables at eleven percent. Only one hundred and twenty-nine male participants completed the bowel habits questionnaire. Fifty percent of the male participants had bowel movements of either 5, 6 or 7 times a week, with the greatest frequency at 7 times a week, and sixty-eight percent had a Type 3 stool type on the Bristol Stool Chart, indicating regular bowel habits with a normal stool consistency among the adolescent male population.

Conclusion: The mean dietary fibre intake of this convenience sample of adolescent schoolboys was lower than the recommended. Given the influence of dietary fibre on optimal health promotion and chronic disease prevention, encouraging and supporting the adolescent male population to increase fibre-dense foods and whole grains consumption in accordance with the New Zealand dietary guidelines may help in achieving their AI for dietary fibre.

Key Words: adolescent, male, boys, New Zealand, dietary, fibre, fiber, intake, food source

Preface

This thesis forms part of a Survey of Nutrition Dietary Assessment and Lifestyle (SuNDiAL) study, an ongoing clustered, cross-sectional survey in New Zealand. This study assessed the dietary habits and intakes, nutritional status, health status, motivations, attitudes, physical activity patterns and screen time habits of adolescent males. The study was conducted by the Department of Human Nutrition at the University of Otago, New Zealand and was funded by the Department of Human Nutrition at the University of Otago, and a Lottery Health Research Grant.

Dr Bernard Venn was the supervisor for this thesis writeup of the candidate. Drs Meredith Peddie and Jill Haszard were the primary study investigators who designed the study and obtained funding and ethical approval. Dr Haszard was also responsible for overseeing all data management and statistical analysis of the study. Tessa Scott liaised with schools and organised the provision of study equipment. Liz Fleming and Kirsten Webster managed the dietary data collection input and analysis.

The candidate, together with 5 other MDiet students, were responsible for the following:

- Inviting schools around the Otago region (n=3) to participate in the study by approaching the schools personally.
- Preparing presentation slides for participant recruitment, which was used in a South Otago school.
- Recruiting potential participants from the South Otago school.
- Scheduling data collection appointments and sending text reminders to participants.
- Setting and cleaning up of equipment during the in-school visit.

- Entering anthropometric, physical activity recall data into REDCap and dietary recall data into FoodWorks databases.
- Facilitating and helping the collection of blood and urine samples in the school.
- Collecting accelerometers and sleep and wear time diary from the school office.

The candidate was also responsible for the following:

- Communicating with the school to set a time and space for the in-school visit.
- Administering 24-hour recalls both face-to-face and remotely via telephone call.
- Assisting data collectors from Christchurch with dietary data entry (n=8); Auckland (n=6) and Rotorua (n=3) with data collection via telephone call, and data entry.
- Entering physical activity data (n=9) into REDCap.
- Entering dietary data (n=20) into FoodWorks.
- Creating new food recipes (n=13) based on ingredient lists of commercial products and New Zealand based recipes in FoodWorks.
- Liaising with a phlebotomist for the in-school blood and urine samples collection.
- Writing up the statistical analysis based on the compiled data for fibre with the guidance from Dr Jill Haszard, a biostatistician for the SuNDiAL study and Department of Human Nutrition.
- Preparing, writing and compiling this thesis.

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List of Abbreviations

95% CI	95 percent Confidence Interval
AACC	American Association of Cereal Chemists
AI	Adequate Intake
ANS	Adult Nutrition Survey
ANSES	Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail
AOAC	Association of Analytical Chemists
BMI	Body Mass Index
cm	Centimetres
FSANZ	Food Standards Australia and New Zealand
g	Grams
Kcal	Kilocalorie
kg	Kilogram
kJ	Kilojoule
INCA	Individual National Study of Food Consumption
IOM	Institute of Medicine
MDiet	Masters of Dietetics
MJ	Megajoule
MoH	Ministry of Health
MSM	Multiple Source Method
n	Number
NHANES	National Health and Nutrition Examination Survey
NHMRC	National Health and Medical Research Council
NSP	Non-starch Polysaccharides
REDCap	Research Electronic Data Capture
SD	Standard Deviation
SuNDiAL	Survey of Nutrition Dietary Assessment and Lifestyle
T2DM	Type 2 Diabetes Mellitus

1 Introduction

Dietary fibre has an essential role in a healthy diet. It is the edible part of a plant that is resistant to digestion and absorption in the human body (Australian New Zealand Food Standards, 2018). An adequate dietary fibre intake is associated with regular bowel movements (Dahl & Stewart, 2015; de Vries, Birkett, Hulshof, Verbeke, & Gibes, 2016) and stable body weight (Lattimer & Haub, 2010; Wanders et al., 2011). Additionally, fibres in cereal products are correlated with a reduction in blood glucose concentration (Montonen, Knekt, Järvinen, Aromaa, & Reunanen, 2003; McRae, 2018b). Moreover, supplementation with soluble fibres such as flaxseed (Mette Kristensen et al., 2012), oat bran (M. Kristensen & Bügel, 2011), pectin, guar gum and psyllium (Satija & Hu, 2012) are associated with a modulation in blood cholesterol concentration. These physiological health benefits could further reduce the risk of developing Type 2 Diabetes (McRae, 2018b), coronary heart disease (Jiang et al., 2017) and colorectal cancer (McRae, 2018a; Dekker, Tanis, Vleugels, Kasi, & Wallace, 2019; Reynolds et al., 2019).

Although dietary fibre is associated with numerous health benefits, inadequate dietary fibre intake is a dire issue in the adolescent male population. From an international perspective, dietary fibre intakes by adolescent males are still lower than recommended. In the United Kingdom, Belgium, Canada and the United States, dietary fibre intakes for this age group ranged between 12.8 grams (g) and 16.4 g, which were less than half of the adequate intake (AI) applicable to their respective countries (Dong, Chen, Gutin, & Zhu, 2019; Scientific Advisory Committee on Nutrition, 2015; Lin et al., 2011; Schenkel, Stockman, Brown, & Duncan, 2007). Similarly, from national nutrition surveys carried out in France, Denmark, Ireland, Australia, and the Netherlands, mean intakes of dietary fibre ranged between 17 g and 20 g, which were lower than the AI recommended by each of these countries (Agence nationale de sécurité sanitaire de

l'alimentation de l'environnement et du travail, 2017; Dutch Ministry of Health Welfare and Sport, 2011; Fayet-Moore, Cassettari, Tuck, McConnell, & Petocz, 2018a; Food Safety Authority of Ireland, 2011; Nordic Council of Ministers, 2012). In New Zealand, results from the previous 2008/09 Adult Nutrition Survey (ANS) reported that the mean dietary fibre intake in the adolescent male population was 21.9 g per day, which was well below their AI of 28 g per day (University of Otago and Ministry of Health, 2011). The adolescent male population is at a critical period with specific health needs as well as undergoing many psychological and social changes (Sivagurunathan, Umadevi, Rama, & Gopalakrishnan, 2015). Dietary habits established during this critical period will remain in adulthood (Mikkilä, Räsänen, Raitakari, Pietinen, & Viikari, 2004). Hence, it is noteworthy that improving dietary fibre intake during adolescence could potentially reduce the risk of developing the aforementioned chronic diseases in adulthood (Sivagurunathan et al., 2015).

Since dietary fibre intakes and AIs are country-specific, the relevance of international findings to the New Zealand context could be limited. Additionally, the most recent data on dietary fibre intake in New Zealand were obtained more than a decade ago. Considering likely changes in food patterns and food sources over time, this dietary fibre data are not current. An updated estimate of dietary fibre intake will allow for targeted nutrition interventions and initiatives to be put in place to help improve dietary fibre intakes in the adolescent male population. Therefore, in order to estimate current fibre intakes in the absence of a new national survey, a convenience sample of New Zealand adolescent boys aged between 15 and 18 years were recruited with an aim of assessing their dietary fibre intakes and the main food sources of fibre.

2 Literature Review

2.1 Methodology of Literature Review

This chapter will focus on dietary fibre intake and the main food sources of fibre in adolescent males aged between 15 and 18 years. This literature review will cover the following:

1. Overview of dietary fibre.
2. Dietary fibre and health.
3. Recommendation and dietary fibre intake in adolescent males.
4. Main sources of dietary fibre in adolescent males.

2.1.1 Search strategy

Relevant prospective, meta-analysis and cross-sectional studies in children and adolescents aged 4 to 19 years published in English between year 1953 and 2020 were included. The published studies were collected via PubMed and Scopus databases. Keywords used in both databases were 'adolescent', 'male', 'boys', 'dietary', 'fibre (fiber)', 'intakes' and 'food sources'. MeSH terms of fibre and its sub-parts were used for PubMed and were combined with the Boolean Operator of 'AND' for a narrower search. Additional literature was found using reference lists of articles.

2.2 Overview of Dietary Fibre

2.2.1 Definition

The first description of the term dietary fibre is used by Eben Hipsley in the 1950s as non-digestible components of a plant cell wall, which protects against toxemia in pregnant women (Hipsley, 1953). In the 1970s, dietary fibre was further described as constituents of plant cell

walls that cannot be hydrolysed by enzymes in the human body (Trowell, 1976). At present, there is no universally accepted definition for dietary fibre (Ha, Jarvis, & Mann, 2000), as there are two different measurement methods (Champ, Langkilde, Brouns, Kettlitz, & Collet, 2003), which will be further discussed in *Section 2.2.2*. Hence, different organisations have included different components and classification into the definition of dietary fibre, as shown in *Table 2.1*.

Table 2.1 Definitions of Dietary Fibre from Different Organisations

Organisation	Definition of Dietary Fibre
American Association of Cereal Chemists (AACC), 2001 ^a	<ul style="list-style-type: none"> • Edible component of plants or analogous carbohydrate, that is neither absorbed nor digested in the small intestine but has complete or partial colonic fermentation. • Promotes physiological health benefits: laxation, and/or blood cholesterol and/or blood glucose lowering. • Includes polysaccharides, oligosaccharides, lignin and associated plant substances.
Australian New Zealand Food Standards, 2018	<ul style="list-style-type: none"> • Similar definition to the AACC. • But excludes waxes, cutin and siberin that are based from non-digestible fatty acids and intricately bound to polysaccharides.
Institute of Medicine, 2001	<ul style="list-style-type: none"> • Classified into dietary, added and total fibre. • Dietary fibre refers to intrinsic and intact but non-digestible carbohydrates, and lignin of the plant, as well as resistant starch. • Added fibre is part of the carbohydrate that is isolated and non-digestible, which has human physiological benefits. • Total fibre is the sum of the two aforementioned fibres.
Food and Drug Administration, 2014	<ul style="list-style-type: none"> • Has a very similar definition to the total fibre in IOM. • But suggested that the non-digestible dietary fibres have three or more monomeric units and are both soluble and insoluble carbohydrates.
Food and Agriculture Organisation (FAO)/ CODEX Alimentarius, 2009 ^b	<ul style="list-style-type: none"> • Carbohydrate polymers that are not hydrolysed in the small intestine, which have more than ten monomeric units. • Belong to three categories: carbohydrate polymers, edible and synthetic carbohydrate polymers.

^aDietary Fiber Definition Committee, 2001.

^bWorld Health Organisation and Food and Agriculture Organisation of the United Nations, 2009.

Relevant for New Zealand, the Food Standards Australia New Zealand (FSANZ) Standard Code 1.2.8 defined dietary fibre as:

The fraction of the edible part of plants or their extracts, or analogous carbohydrates, that are neither absorbed nor digested in the small intestine, usually undergo partial or complete bacterial fermentation in the large intestine and promote physiological health benefits: laxation and/or reduction in blood cholesterol and/or blood glucose. The fibre components include polysaccharides, oligosaccharides (degree of polymerization >2) and lignin (Australian New Zealand Food Standards, 2018).

2.2.2 Analysis of Dietary Fibre

An enzymic-chemical method known as the Englyst method is used to specifically determine non-starch polysaccharides (NSP) (Englyst & Cummings, 1988). This method uses an enzymic treatment to separate dietary fibre from starch and sugar (McCleary, 2003). A pancreatic amylase enzyme is used to imitate the action in the human intestinal tract (Englyst & Cummings, 1988). This process produces NSP residues, which are fractionated into total, soluble and insoluble fibres (Englyst & Cummings, 1988; Champ et al., 2003).

An enzymic-gravimetric method, developed by the Association of Analytical Chemists (AOAC), is used to determine NSP, lignin and resistant starches (Institute of Medicine, 2001). The main steps for this method are the removal of starch and protein; precipitating soluble NSP components; isolating the precipitation from insoluble NSP by filtration and gravimetric quantification; correcting protein and ash in the dietary fibre residue. The final product of this method provides soluble and insoluble fractions of dietary fibre (Champ et al., 2003; McCleary, 2003).

Overall, the AOAC method produces a higher fibre content than the Englyst method (Marlett & Vollendorf, 1994; Champ et al., 2003). Currently, the AOAC method is used by regulatory boards to maintain a consistent guideline (McCleary, 2003; British Nutrition Foundation, 2018) and by New Zealand Plant and Food Research to quantify the chemical identity of dietary fibre in foods for the New Zealand Food Composition Database (University of Otago and Ministry of Health, 2011).

2.2.3 Classification of Dietary Fibre

Dietary fibre can be classified into cereal, fruit and vegetable groups (de Vries et al., 2016). These are further grouped by the ability to absorb water in the large intestine as being soluble or insoluble (Dhingra, Michael, Rajput, & Patil, 2012). The fibre in most foods comprise a mix of compounds having both solubility characteristics, which subsequently produce different physical, chemical and physiological effects (Salas-Salvadó, Bulló, Pérez-Heras, & Ros, 2006; Surampudi, Enkhmaa, Anurad, & Berglund, 2016). As an alternative, the Food and Nutrition Board of Institute of Medicine (IOM) has proposed to replace the terms soluble and insoluble fibre with viscosity and fermentability physicochemical properties (Institute of Medicine, 2001).

Viscosity refers to the internal friction of fluid in the small intestine (Dikeman & Fahey, 2006), which has the ability to thicken or form gels (Salas-Salvadó et al., 2006). Viscosity is associated with soluble fibres, such as guar gum and pectin (Dikeman & Fahey, 2006). When viscous fibre is exposed to fluid, the degree of thickening will depend on its weight, structure and volume (Wanders et al., 2011).

Fermentability is related to the function of the large intestine (Dikeman & Fahey, 2006). Fermentation is a process whereby anaerobic bacteria breaks down dietary fibre into short chain

fatty acids and other metabolites in the colon (Wanders et al., 2011; Wang et al., 2019). Among the different fibre groups, fruit fibres appear to be more fermentable than vegetable and cereal fibres (Schneeman, 1987; de Vries et al., 2016).

The classification of dietary fibre into viscosity and fermentability allows more information to be categorised based on its mode of action in the gastrointestinal tract. This will then provide an understanding on how dietary fibre has a role in contributing to the numerous health benefits.

2.3 Dietary fibre and health

Since 1976, there has been a hypothesis on the inverse relationship between dietary fibre intake and Western lifestyle related diseases (Trowell, 1976; Lattimer & Haub, 2010; Satija & Hu, 2012). Plausible mechanisms are that the viscosity and fermentability properties of fibre provide beneficial effects to bowel and weight regulation; the prevention of colorectal cancer, Type 2 Diabetes Mellitus (T2DM) and coronary heart disease (CHD) (Dikeman & Fahey, 2006).

2.3.1 Bowel Regulation

The beneficial effects of dietary fibre intake related to regularity is dose dependent (Dahl & Stewart, 2015; Reynolds et al., 2019). Hence, a higher intake of fermentable dietary fibre, especially fruit fibres (de Vries et al., 2016) has shown to promote regular bowel habits by increasing stool weight and reducing transit time (Dikeman & Fahey, 2006). Considering there is no uniform definition of normal laxation, a defecation frequency of once a day and a transit time between 2 and 3 days could be considered as normal (European Food Safety Authority, 2010).

2.3.2 Colorectal Cancer

Dietary fibre intake has been identified as being protective against the development of colorectal cancer (Dekker et al., 2019). The proposed mechanism could be due to short chain fatty acids produced by fermentable dietary fibre that can boost beneficial *bifidobacteria* growth and inhibit the growth of colonic pathogenic cells (Anderson et al., 2009; Song, Garrett, & Chan, 2015). In 2018, a World Cancer Research Fund Continuous Update Project reported that there was a 9 to seventeen percent decreased risk of colorectal cancer for every ten to ninety grams of daily cereal fibre intake (World Cancer Research Fund, 2018). Similarly, a 2019 systematic review and meta-analysis commissioned by the World Health Organisation as well as a 2018 umbrella review of meta-analysis reported that a high dietary fibre intake was associated with a sixteen percent and twelve percent reduction in colorectal cancer risk as compared to low dietary fibre intakes respectively (McRae, 2018a; Reynolds et al., 2019). However, it is noteworthy that plant foods contain other beneficial nutrients and phytochemicals (e.g. beta-carotene, Vitamin B, C, D). It is unclear whether the protective effect is solely due to dietary fibre, or the high plant-low meat and fat intake (Public Health England, 1995; L. Johnson, Mander, Jones, Emmett, & Jebb, 2008). Hence, future well designed research is required to confirm the inverse association between fibre intake and colorectal cancer risk.

2.3.3 Weight Regulation

Dietary fibre in wholegrain, bran (Lattimer & Haub, 2010; M. Kristensen & Bügel, 2011) and cereal products (Du et al., 2009) were found to regulate body weight. A plausible mechanism could be due to the viscosity of dietary fibre that increase stomach distension and reduce appetite (Wanders et al., 2011), thus decreasing energy intake and body weight (Lattimer & Haub, 2010; J. Slavin, 2013). Fibre found naturally in foods (Howarth, Saltzman, & Roberts, 2001; Du et al.,

2009; Wanders et al., 2011) and supplements with viscous or soluble fibres (Kovacs et al., 2001; Guérin-Deremaux et al., 2011; M. Kristensen & Bügel, 2011) are associated with a change in body weight. However, it should be noted that fibre-rich food is integrated within a complex diet (L. Johnson et al., 2008), which warrants more research to establish the association between the different types of dietary fibre and weight regulation.

2.3.4 Type 2 Diabetes and Coronary Heart Disease

Overweight individuals have an increased risk of T2DM and CHD (Lattimer & Haub, 2010). Viscosity of dietary fibre has been associated with a reduction in postprandial glucose (Würsch & Pi-Sunyer, 1997) and cholesterol concentrations (Mette Kristensen et al., 2012) that further reduces the risk of developing T2DM and CHD (Jiang et al., 2017). A meta-analysis exploring cholesterol-lowering effects of dietary fibre found that supplementation with flaxseed (Mette Kristensen et al., 2012), oat bran (M. Kristensen & Bügel, 2011), pectin, guar gum and psyllium (Brown, Rosner, Willett, & Sacks, 1999; Satija & Hu, 2012) are helpful in lowering the incidence of CHD. An umbrella review of meta-analysis exploring correlation with T2DM reported that only cereal fibres have a seventeen to thirty-three percent significant improvement in blood glucose concentration (Montonen et al., 2003; McRae, 2018b). Therefore, more research is required to elucidate the relationship between the effects from different fibre types and the reduction of incidence in T2DM and CHD.

Overall, findings showed that the inverse association between dietary fibre and the aforementioned health risks might not be due to the effects of dietary fibre *per se* but could be confounded by other dietary and lifestyle factors. Most studies were conducted in an adult population, thus there is a knowledge gap as to whether adequate dietary fibre intake provides similar health benefits in the adolescent male population. However, there is a convincing

evidence that the precursors of the aforementioned chronic diseases begin during childhood and adolescence (Alamian & Paradis, 2009), thus adolescent males are recommended to consume adequate dietary fibre via a mixed variety of food as a mode of preventive health care.

2.4 Recommendation and Dietary Fibre Intake

The colonisation of gut bacteria begins after birth (Kirjavainen & Gibson, 1999). Hence, dietary fibre should be introduced during infancy and consumed in an adequate amount throughout their growth to establish and maintain a healthy gut microbiota (Dreher, 2018).

Adequate dietary fibre intake is an important factor in adolescents (Kranz, Brauchla, Slavin, & Miller, 2012). This population begin to have more independence and is more decisive about their eating patterns as compared to during childhood (Reicks et al., 2015). Between the two genders, adolescent males are more active, have higher nutritional needs and energy intake than their female counterparts (Deheeger, Bellisle, & Rolland-Cachera, 2002). Since fibre-rich foods also provide other essential nutrients and food components (Lattimer & Haub, 2010), ensuring adolescent males consume adequate dietary fibre can also help with meeting other essential nutrient requirements (American Dietetic Association, 2009).

As the existing evidence is insufficient to establish a recommended dietary intake based on requirements, dietary fibre recommendations for Australia and New Zealand are displayed as adequate intake (AI), which are based on the median intakes derived from national nutrition surveys (Australian National Health and Medical Research Council and New Zealand Ministry of Health, 2005). It is noteworthy that AI represents the mean or median intake of a healthy group of people. If dietary fibre intakes in similar groups of people were found to be at or above the AI, a low prevalence of inadequate dietary fibre intake can be assumed. However, if intakes

of groups were found to be below the AI, no assumptions can be made about the prevalence of inadequacy (Murphy & Poos, 2002). Further, dietary guidelines of a country consider the dietary patterns, prevalence of common chronic diseases and deficiency disorders. Therefore, the AI values of dietary fibre are tailored to the country as they depend on the food availability and culture acceptance of the country (World Health Organisation 2003). With that, **Table 2.2** shows the recommendations of dietary fibre in adolescent males from different countries, which are presented as grams per day (g/day) or grams per energy requirement (g/MJ).

Table 2.2 Recommendations for Daily Fibre Intake in Adolescent Males

Country	Adequate Intake (AI)	Issuing Body
New Zealand and Australia	28g (15 to 18 years)	Australian National Health and Medical Research Council and New Zealand Ministry of Health, 2005
Europe	21g (15 to 17 years) 25g (18 years)	European Commission, 2020
Netherlands	36g (14 to 18 years)	Health Council of Netherlands, 2011 ^a
United Kingdom	25g (11 to 16 years) 30g (16 to 18 years)	Public Health England and Food Standards Agency, 2015 ^b
Canada	38g (14 to 18 years)	Food and Nutrition Board of Institute of Medicine (IOM), 2001 ^c
Denmark	2 to 3g/MJ (1 to 17 years) more than 3g/MJ (18 years)	Nordic Council of Ministers, 2012
United States	14g/1000kcal 30.8g (14 to 18 years)	United States Department of Health and Human Services and United States Department of Agriculture, 2015
Ireland	Age + 5g (14 to 18 years)	Food Safety Authority of Ireland, 2011
France	30g (11 to 17 years)	French Food Safety Agency, 2017 ^d
Belgium	40g (15 to 18 years)	Belgian Superior Health Council, 2011 ^e
Germany	2.4g/MJ (1 to 18 years)	German Nutrition Society, 2005 ^f

^aBrink et al., 2019. ^bScientific Advisory Committee on Nutrition, 2015. ^cTrumbo, Schlicker, Yates, & Poos, 2002. ^dAgence nationale de sécurité sanitaire de l'alimentation de l'environnement et du travail, 2017 (ANSES). ^eLin et al., 2011. ^fKersting, Alexy, & Clausen, 2005.

As shown in **Table 2.2**, the range of daily AI of dietary fibre from different countries is between 20 g and 40 g for adolescent males aged 15 to 18 years. Belgium has the highest AI at 40 g, virtually double that of Ireland at 20 g to 23 g across the 15 to 18-year age range. Nonetheless, the World Health Organisation recommends a daily dietary fibre intake of 25 g or greater (Reynolds et al., 2019), which corresponds to some of the AIs presented in **Table 2.2**.

Although dietary fibre intake is found to provide dose dependent health effects (Reynolds et al., 2019), a tolerable upper limit might be needed. With the current ubiquitous fibre supplements and added fibre products, there is a concern with extreme levels of dietary fibre consumption that could result in a change of gut microflora. This can cause a development of food intolerances (Australian National Health and Medical Research Council and New Zealand Ministry of Health, 2005) and a reduction of mineral absorption that could further result in mineral deficiencies (Turner & Lupton, 2011). However, fibre consumed via various food sources is unlikely to lead to excessive intakes and side effects (Australian National Health and Medical Research Council and New Zealand Ministry of Health, 2005). Additionally, based on the Suggested Dietary Targets (SDT) in Australia and New Zealand, an upper level at 90th centile of fibre intake consumed via various food sources was suggested to reduce the risk of developing CHD (Australian National Health and Medical Research Council and New Zealand Ministry of Health, 2005).

Given some studies included children aged below ten years, **Table 2.3** presents the existing studies in which dietary fibre intake of children and adolescents from different countries have been estimated.

Table 2.3 Estimated Intake and Sources of Dietary Fibre in Adolescent Males from Europe, United States, Canada and Australia^a

Author, Date	Country	n	Age (years)	Study Design	Fibre Measuring Methods	Estimated Intake (g/day)	Sources
Dutch Ministry of Health Welfare and Sport, 2011	Netherlands	352	14-18	Dutch National Nutrition Survey (2007-2010)	Two 24-hour dietary recall	20	Cereals and cereal products (43%), Vegetables (14%), Fruits, nuts and olives (11%), Potatoes and other tubers (10%), Cakes (5%).
Sette et al., 2011	Italy	492 ^b	4-17	National Food Consumption Survey (2005-2006)	Three day food record	18.1 (10 to 17 years)	Cereals and bakery (49%), Vegetables (21%), Fruit (14%), Potatoes (7%), legumes (6%).
Lin et al., 2015	Europe	855	12.5 to 17.5	Multi-stage random cluster sampling procedure	-Two non-consecutive computerised dietary recalls - interview - food record	20	Bread and rolls (21.6%), Potatoes and grains (18%), Snacks and desserts (17.4%), Fresh fruits (12.6%) Fresh vegetables (8.8%), Pasta (8%), Meat, poultry, fish, eggs, nuts and seeds (4.5%), Breakfast cereals (4.2%).
Lin et al., 2011	Belgium	1546	15-18	Belgian National Food Consumption Survey (2004)	Two 24-hour dietary recall	14.2	Grain products (33.2%), Potatoes (18.1%), Fruits (15.1%), Vegetables (14.4%).
Stahl, Vohmann, Richter, Heseke, & Mensink, 2009	Germany	1272 ^b	6-17	EsKiMo ^c (2003-2006)	Three day food record	27	Bread (11.9%), Vegetable/pulses (10.5%), Pasta/rice/cereals (8.9%), Fruits/nuts (8.23%), Potatoes/ potato products (5.8%).
Scientific Advisory Committee on Nutrition, 2015	United Kingdom	744	11-18	National Diet and Nutrition Survey (2009-2012)	Four day food record	12.8	For those aged 11 to 18 years: Grain products (41%), Bread (19%), Vegetables (15%), Potatoes (14%), Pasta (11%), Fruits (7%), Breakfast cereals (6%).
ANSES, 2017	France	949 ^b	11-17	INCA-3 (2014 - 2015)	2-3 non-consecutive days food record	17	Cereal products (27%), Fruits and vegetables (26%), Potatoes and potato dishes (13%), Pastries, cakes and sweet cookies (11%), Sandwiches, pizzas, pies, pastries and salted cookies (10%).

Author, Date	Country	n	Age (years)	Study Design	Fibre Measuring Methods	Estimated Intake (g/day)	Sources
Walton, McNulty, Nugent, Gibney, & Flynn, 2014	Ireland	223	13 -17	Irish Universities Nutrition Alliance National Surveys	Seven day food record	17.5	Breads (22 %), potatoes (19 %), breakfast cereals (11 %), vegetables (11 %), pasta/rice /pizza (10 %), fruits (10 %) Bread (22%), Potatoes (19%), Breakfast cereals (11%), Vegetables (11%), Pasta/rice/pizza (10%), Fruits (10%).
Pedersen et al., 2015	Denmark	251	10-17	National Survey of Dietary Habits and Physical Activity (2011-2013)	Seven day food record	20	Bread and cereal products (54%), Vegetables and fruits (18%), Potatoes (6%).
United States Food and Drug Administration, 2012	United States	672	12-19	NHANES (2009-2010)	Two 24-hour dietary recall	16.4	For those aged 2 to 18 years: Grain products (33.4%), Fruits (14.9%), Vegetables (13.7%), Bread (12.8%), Legumes (10.1%), Breakfast cereals (7.7%).
Dong et al., 2019	United States	371	14-18	Cross sectional	Seven 24-hour dietary non-consecutive recalls	13.2	
Schenkel et al., 2007	Canada	180	14-18	Cross sectional	3-day food record	13.1	Bread (14.9%), Cereals (13%), non-Citrus fruits (12.1%), Salty snacks (7.5%), Potatoes (6.8%), Pasta/ rice/ grains (6%), Legumes/nuts/seeds (5%).
Fayet-Moore et al., 2018a,b	Australia	2812 ^b	2-18	2011–2012 National Nutrition and Physical Activity Survey	One 24-hour dietary recall	18.4 (14-18 years)	Bread (11.2%), Cereal mixed dishes (11%), Ready to eat breakfast cereals (10.6%), Pome fruit (9.8%), Potatoes (4.4%), Pasta and pasta products (3.4%), Carrot and similar root vegetables (2.7%), citrus fruit (2.4%), Tropical and subtropical fruit (2.3%), Fruit and vegetable juices, and drinks (2.3%).

^a Only food sources contributing to more than two percent of dietary fibre intake were included in this table.

^b Males and females were included in the study.

^c A cross sectional representative survey: Eating study as a German Health Interview and Examination Survey for Children and Adolescents (KiGGS) Module (EsKiMo).

On average, adolescent males from different countries consume different amount of dietary fibre, as indicated in *Table 2.3*. Dietary fibre intakes among the adolescent males in France, Denmark, Ireland, Australia and the Netherlands were clearly below the AI of between 20 and 35 g (Agence nationale de sécurité sanitaire de l'alimentation de l'environnement et du travail, 2017; Dutch Ministry of Health Welfare and Sport, 2011; Fayet-Moore et al., 2018a; Food Safety Authority of Ireland, 2011; Nordic Council of Ministers, 2012). Likewise, in Belgium, as well as the United Kingdom, the United States and Canada, these adolescent males were meeting less than half of the AI for their age group (Dong et al., 2019; Lin et al., 2011; Schenkel et al., 2007; Scientific Advisory Committee on Nutrition, 2015).

In Germany, one study found that the median dietary fibre intake among adolescent males aged 12 to 17 years met the AI for their age group. This can be explained by the different food and nutrient intakes among the western and eastern Germans (Stahl et al., 2009). West Germans were found to have a higher dietary fibre intake due to a higher consumption of cereals, pasta, leafy vegetables than the East, although there was no analysis on whether high fibre options were consumed (Mensink & Beitz, 2004). Hence, the results could have skewed towards those who consumed a higher intake of dietary fibre.

In New Zealand, the 2008/09 ANS reported that the mean dietary fibre intake in males aged 15 to 18 years was 21.9 g/day, which was 6 g below the AI. It was found that the Pacific population had the highest dietary fibre intake at 22.3 g/day, followed by the New Zealand Europeans at 21.7 g/day and the lowest at 20.7 g/day among the Māori population (University of Otago and Ministry of Health, 2011).

Overall, it is clear that the dietary fibre intakes of adolescent males around the world are well below the AI, except for one study in Germany. The lowest dietary fibre intake among the

adolescent males was found to be in the United Kingdom at 12.8 g/day. Therefore, it is vital to fill in the knowledge gap by conducting more up-to-date research to determine the current intake of dietary fibre in this adolescent male population.

2.4.1 Methodology in Collecting Dietary Fibre Data

There are several methods used to collect dietary data, which include duplicate diet approach, food consumption record, 24-hour dietary recall, dietary record, dietary history and food frequency questionnaire (Shim, Oh, & Kim, 2014). The selection of method used in a study depends on time, cost, study population and number of participants (Gibson, 2005). As presented in *Table 2.3*, there are two common dietary assessment methods used in these existing studies: 24-hour dietary recalls and dietary records. However, both methods have their own strengths and limitations, as shown in *Table 2.4*.

Table 2.4 Strengths and Limitations of 24-hour Dietary Recall and Dietary Record Assessment Methods

	Dietary Assessment Methods	
	24-hour Dietary Recall	Dietary Record
Strengths	<ul style="list-style-type: none"> - Provides detailed dietary intake data - Low participant burden 	<ul style="list-style-type: none"> - Provides detailed dietary data - No interviewer is required - No recall bias
Limitations	<ul style="list-style-type: none"> - Risk of recall bias - Requires a trained interviewer - Risk of interviewer bias - Requires multiple days to assess usual intake - Possible changes to diet if measures are repeated 	<ul style="list-style-type: none"> - Large participant burden - Requires literacy and high motivation - Risk of under-reporting - Time consuming - Requires multiple days to assess usual intake - Possible changes to diet if measures are repeated

Note. Adapted from “Dietary Assessment Methods in Epidemiological Studies.”, by Shim, J.S., Oh, K., and Kim, H.C., (2014), *Epidemiology and Health*, 36, e2014009.

For obtaining quantitative recall data, 24-hour dietary recall is the most commonly used dietary assessment method (Rutishauser, 2005). This method requires only 20 to 30 minutes of the participants' time and has a lower participant burden than weighing and recording all foods and drinks consumed (R. K. Johnson, 2002). Hence, the 24-hour dietary recall method has a higher response rate and detailed dietary information can be obtained from adolescent males (Rutishauser, 2005).

2.5 Sources of dietary fibre

Fibre is only present in plant foods, major food sources being whole grain cereals, legumes, fruits and vegetables (Dhingra et al., 2012). As shown in *Table 2.3*, the main contributors to dietary fibre intake in adolescent males differ among countries.

Among the European countries, bread, cereals, fruits and vegetables including potatoes are the main contributors to dietary fibre intake (European Food Safety Authority, 2010). In the United Kingdom, grain products are the primary sources of AOAC fibre, providing thirty-eight to forty-four percent of dietary fibre intake (Scientific Advisory Committee on Nutrition, 2015). Similarly, grain-based foods (excluding desserts), cereals, fruits, vegetables and bread top the list as the main contributors to dietary fibre intakes in the French, American and Canadian adolescent males (ANSES, 2017; Phillips, Starkey, & Gray-Donald, 2004; Satija & Hu, 2012; J. L. Slavin, 2013).

In Australia, bread, breakfast cereals, cereal dishes, pome fruits and potatoes are the first five main contributors to dietary fibre intakes in the adolescent male population (Fayet-Moore, Cassettari, Tuck, McConnell, & Petocz, 2018b). Similarly, the key sources for New Zealand

adolescent males aged 15 to 18 years are bread, potatoes, kumara, taro, bread-based dishes, fruits and vegetables (University of Otago and Ministry of Health, 2011).

2.6 Conclusion

The existing studies show that adolescent males from around the world are at risk of low dietary fibre. Bread, grain products, cereals, fruits and vegetables appear to be the main contributors to dietary fibre intake in adolescent males. However, there is a shift from traditional diet towards refined grains and away from high fibre grains option, which can increase the gap for adolescent males to meet the AI for their age group. Since the health status of the adolescent male population determines the health status in their adulthood, consuming adequate dietary fibre from a mixed variety of food can help reduce the risk of developing colorectal cancer, T2DM and CHD.

In New Zealand, dietary fibre data are obtained from the 2008/09 ANS, which was conducted more than a decade ago. Considering changes in food patterns over time, it is more likely that these data are limited and outdated. Hence, this research will provide more up-to-date information about the intakes and sources of dietary fibre in the New Zealand adolescent male population aged between 15 and 18 years.

3 Objective Statement

The overall aims of the SuNDiAL project are to describe the nutritional status, dietary habits, health status, attitudes and motivations for food choice, 24-hour activity patterns and screen time habits of adolescent males aged between 15 and 18 years in New Zealand.

The aim of this thesis is to describe the fibre intakes and the main food sources of fibre in this target population. The specific objectives of this thesis in New Zealand male adolescents aged between 15 and 18 years are:

1. To determine the current mean intake of dietary fibre.
2. To assess how well the dietary fibre intakes match the New Zealand daily adequate intake of 28 g/day.
3. To evaluate the main food sources contributing to fibre intake.

4 Methods

The following describes the components of a Survey of Nutrition Dietary Assessment and Lifestyle (SuNDiAL) study methods, which are based on a previously published methods paper for SuNDiAL (Peddie et al., 2020).

4.1 Study Design

SuNDiAL is an ongoing clustered, cross-sectional survey in New Zealand. The study began in 2019 to assess the dietary habits and intakes, nutritional status, health status, motivations, attitudes, physical activity patterns and screen time habits of adolescent females. In 2020, data from adolescent males were collected in a similar manner.

The study has 6 sections: (1) an online questionnaire administered in Research Electronic Data Capture (REDCap) questionnaire (Harris et al., 2009; Harris et al., 2019); (2) an in-school visit comprising a 24-hour dietary recall; a previous day activity recall; a blood pressure measurement and anthropometry (height, weight, ulna length); (3) a telephone/video interview to administer a 24-hour dietary recall and a previous day activity recall; (4) the provision of an accelerometer; (5) the collection of a blood sample; (6) the collection of a urine sample. For each completed section, participants were reimbursed with a \$5 to a maximum of \$30 supermarket voucher (New World or Pak n Save) for their time. Prior to the study, all data collectors were trained in conducting anthropometry measurements and 24-hour dietary recalls as per Standard Operating Procedures of the study (**see Appendix A and B**).

The SuNDiAL 2020 study has been conducted in 6 high schools nationwide: Otago, Wellington, Christchurch, Rotorua, Tauranga and Auckland. Data for the study were collected between February and April 2020. For this Masters of Dietetics (MDiet) thesis, the candidate

will report on data for the questionnaires, anthropometry measurements and 24-hour dietary recalls in adolescent males.

4.2 Ethical Approval

The study was approved by the University of Otago ethics committee, with the reference number **H20/004** (see **Appendix C**) and was registered under the Australian New Zealand Clinical Trials Registry, with the reference number **ACTRN12620000185965**. The Ngāi Tahu Research Consultation Committee (the Committee) acknowledged the aims and outcomes of the SuNDiAL 2020 study (see **Appendix D**).

4.3 Eligibility Criteria

Inclusion criteria for the study were male students aged between 15 and 18 years, enrolled in one of the schools that had a total of four-hundred or more enrolled students, and were willing to complete the required online questionnaires. Exclusion criteria were students who could not speak and understand English. All potential participants gave informed online consent.

4.4 Study Procedure

4.4.1 Recruitment Process

4.4.1.1 School-based Recruitment

The selected high schools were first invited via email, and then in person by data collectors and study investigators to participate in the study. Invitations were distributed until the required number of schools were obtained. Schools that agreed to participate gave formal permission via a written consent for data collectors to visit their school. Following this, the data collectors contacted the school to set a time and date for the participant recruitment process.

4.4.1.2 Participant Recruitment

Participants were recruited via a PowerPoint presentation during the school or year group assemblies (see **Appendix D**), which described the information and tasks involved. Participants and schools were given an information sheet (see **Appendix E**) and a link to the study website (<https://www.otago.ac.nz/sundial/index.html>) for further information (see **Appendix F**).

Interested school students provided their name and contact details on the signup sheets. Alternatively, school students were able to signup via the study website.

4.5 REDCap

4.5.1 Consent and Enrolment

School students who had signed up were sent an email link to REDCap, a secure, web-based software package, to complete an online consent and enrolment. Potential participants were required to provide their name, date of birth, age, name of high school, contact details and consent to the optional parts of the study (accelerometer, blood and urine sample) (see **Appendix G**). Participants who were under 16 years of age were asked to provide an email address of a parent/guardian. Parental consents for these school students to participate in the study were required before the link to REDCap is emailed to the participant.

4.5.2 Questionnaires

The questionnaire collected information on demographic, health and dietary habits. The questionnaire took approximately 30 minutes to complete.

4.5.2.1 Demographic and Health

Data were collected for sociodemographic information and bowel habits (see **Appendix H**). Date of birth was used to calculate age of participants. Ethnicities were based on a 2006 New Zealand census question and were classified into four ethnic groups using a priority order system – Maori, Pacific, Asian, New Zealand European and others (Stats New Zealand, 2006). Socio-economic status was based on participant’s home address to determine the neighbourhood meshblocks (small areas). This was then matched to their New Zealand Deprivation score, which is based on a New Zealand Deprivation Index 2018 (NZDep2018). The NZDep2018 ranges from 1 to 10, where 1 represents the areas with the least deprived scores and 10 the areas with the most deprived scores. This is further categorised into a scale of 1 to 3 represents low deprivation; 4 to 7 as moderate deprivation and 8 to 10 as high deprivation (Atkinson J., Salmond C., & Crampton P., 2014).

Bowel Habits

Participants were asked to provide information on the frequency and stool type based on the Bristol Stool Chart provided. The chart is an ordinal scale of stool types ranging from the hardest (Type 1) to the softest (Type 7). Types 1 and 2 indicate abnormally hard stools; Type 3, 4 and 5 indicate ‘normal’ stool form; Types 6 and 7 indicate abnormally loose/liquid stools (Blake, Raker, & Whelan, 2016).

1. How many times per week do you usually have a bowel movement (poo)?

Participants had to provide a value between 1 and 70. There will be an alert for any value above this suggested range, recommending the participant to double check the value entered.

2. Please look at the picture below and select the number that corresponds to your usual and most common stool type.

Participants had to select an option based on the Bristol Stool Chart image. The available responses were: *Type 1, Type 2, Type 3, Type 4, Type 5, Type 6, Type 7.*

4.5.2.2 Dietary Habits

Questions on dietary habits related to the current thesis are discussed in the following sections.

Food Consumption

Information on the frequency of fruits, vegetables, bread, nuts, legumes and snacks were collected. For each question, participants had to select one of the responses provided: “*Never, I do not eat; less than once a week; once a week; 2-4 times a week; 5-6 times a week; once a day; 2 times a day; 3 times a day; more than 3 times a day.*” Additionally, there were responses for nuts, nut butter and legumes: “*Rarely; monthly; 2-3 times a month.*”; bread: “*White; Wholemeal (brown colour); Light grain – has some grains but soft to eat (e.g. honey grain); Heavy grain – has some grains a bit chewier (e.g. Vogels); Other (please specify).*”

Supplement Use

Participants who consumed supplements over the past twelve months had a list of options to choose from: “*Multivitamin and/or multimineral; single vitamin or mineral; sports supplement (including protein powders or shakes); others (please specify).*” For each chosen supplement, participants had to report the duration consumed and brand and/or product name. Participants had the option to upload a photo of their supplement packaging containing the brand and the list of contents onto REDCap.

4.6 Anthropometry

The study protocols for height and weight measurements were followed (see **Appendix A**), which were based on the Ministry of Health protocols (Ministry of Health, 2008). Participants were asked to empty their pockets, remove their shoes, hair ornaments or buns/braids on the top of their head and any heavy clothing (jackets, boots etc.).

Height was measured to the nearest 0.1 cm using the *Wedderburn* portable stadiometer (Wedderburn Sydney Australia, 2020); weight was measured to the nearest 0.1 kg using the *Seca Alpha 770* electronic weighting scale (Seca Hamburg Germany, 2020) on a hard and solid surface. All measurements were duplicated. A third measurement was taken if the duplicate measurements differed by more than 0.5 units. Data for height and weight were then compiled into REDCap to generate a body mass index (BMI) for each participant. BMI was calculated as weight in kilograms (kg) divided by the square of height in metres (m) (World Health Organization, 2006).

4.7 Collection of Dietary Data

Data collectors administered two 24-hour dietary recall sessions for each participant. The first dietary recall session was conducted face-to-face with students during school hours. Following the completion of the first recall, participants were asked for consent to repeat the same process with a second recall. The second recall was undertaken via a phone call or video (Zoom) the following week on a non-consecutive day. A 24-hour dietary recall multiple pass protocol was used in both recalls (Gibson & Ferguson, 2008) (see **Appendix B**). The four-stage multiple pass method is as follows:

1. Recalling foods and drinks (including water) consumed.

2. Recalling specific descriptions of foods and drinks consumed (time, cooking methods, brand names).
3. Estimating portion sizes.
4. Reviewing recall interview data.

For each interview, participants were first asked to recall and list out all foods and drinks consumed from midnight to midnight the day before. Data collectors recorded the recalled food, water and other drink items on a quick list sheet. For the second pass, data collectors went over each of the reported responses in the quick list. Participants were probed to recall the time consumed, cooking methods, type and brand of the products used where, if necessary, by referring to grocery websites from Countdown (<https://shop.countdown.co.nz/>) and New World (<https://www.newworld.co.nz/>) (see **Appendix I**). Data collectors used standardised prompts to collect detailed information for reported foods. For example, if the participant reported consuming a fruit, *'Was the fruit fresh, cooked or canned?'*. If fresh or cooked, *'Was the fruit peeled or unpeeled?'*; *'What was the colour of the fruit: red, green, yellow or orange?'*; If canned, *'Was it in syrup, juice, water or sugar?'*; *'Was the liquid drained?'*; *'How much of the amount of juice or syrup consumed: none, 1/4 of the serve or 1/2 of the serve?'* (see **Appendix J**). For the third pass, participants were asked to estimate the portion size of each food item consumed using food models (i.e. two plastic containers of dried beans, three different sizes of wooden spheres, eight similar sizes of plastic rectangular blocks); household measuring items (i.e. four different sizes of measuring cups, three different sizes of measuring spoons, a mug, a breakfast cup, a wine glass, a pudding plate, a dinner plate and a two-Cup plastic measuring jug); graduated portion-size photographs of food (see **Appendix K**). For the last step, data collectors

read the responses back to the participant to check and probe for any additional items consumed over the last 24-hours.

4.7.1 Dietary Data Analysis

All foods and drinks recorded on the 24-hour dietary recall sheet were entered into a dietary analysis software, FoodWorks 9 (Xyris Software Australia, 2017). These data were categorised into the 33 food groups, which were based on the 2008/09 New Zealand ANS (see **Appendix L**). FoodWorks uses the New Zealand Food Composition Data (FOODfiles 2016 - Version 01) (The New Zealand Institute for Plant and Food Research Limited, 2019) to estimate energy and nutrient intakes. The FOODfile dataset contains recipes created by the Department of Human Nutrition researchers at the University of Otago.

The Department of Human Nutrition staff members independently audited the FoodWorks database created by each of the data collectors, for accuracy, consistency and completeness. Extreme values or outliers for specific nutrients were identified and clarified by reviewing the original paper recording sheets. Outstanding queries were clarified with the data collectors.

4.8 Statistical Analysis

Statistical analyses for dietary fibre intakes were carried out using a Stata Statistical Analysis Software 16.0 (StataCorp Texas, 2019). For each participant, the study biostatistician used the software to calculate the proportion of total fibre intake provided from each of the 33 food groups. The repeated 24-hour dietary recall data were used to estimate mean daily fibre intakes using the Multiple Source Method (MSM) program (Harttig, Haubrock, Knüppel, Boeing, 2011).

This method determined within-person variation in fibre intakes, which was then applied to the whole dataset for the estimation of the usual dietary fibre intake for each participant.

Descriptive statistics were undertaken by the candidate. All graphs, sum of total dietary fibre from each food group, mean, Standard Deviation (SD), 95% Confidence Interval (CI) and a trendline to determine the relationship between energy and fibre intakes were generated using Microsoft Excel 2016 (Microsoft Excel 2016 for Mac Version 16.35 Microsoft Corporation, 2016).

4.8.1 Sample Size Calculation

A sample size of 100 participants would provide a precision level of plus or minus of 0.2 SD for the estimation of average nutrient intakes with a 95% precision interval. The study biostatistician calculated that 150 participants were required to allow for dropouts, incomplete data and a small design effect from school clusters. In SuNDiAL 2019, the intra-class correlation for nutrient intakes within schools in adolescent girls was small (less than 0.04). This indicates that the design effect from school clusters would likely to be less than 1.5 if at least ten boys from each school participated in the 2020 study.

5 Results

5.1 School Recruitment Process

Figure 5.1 shows the school recruitment process for the SuNDiAL 2020 study.

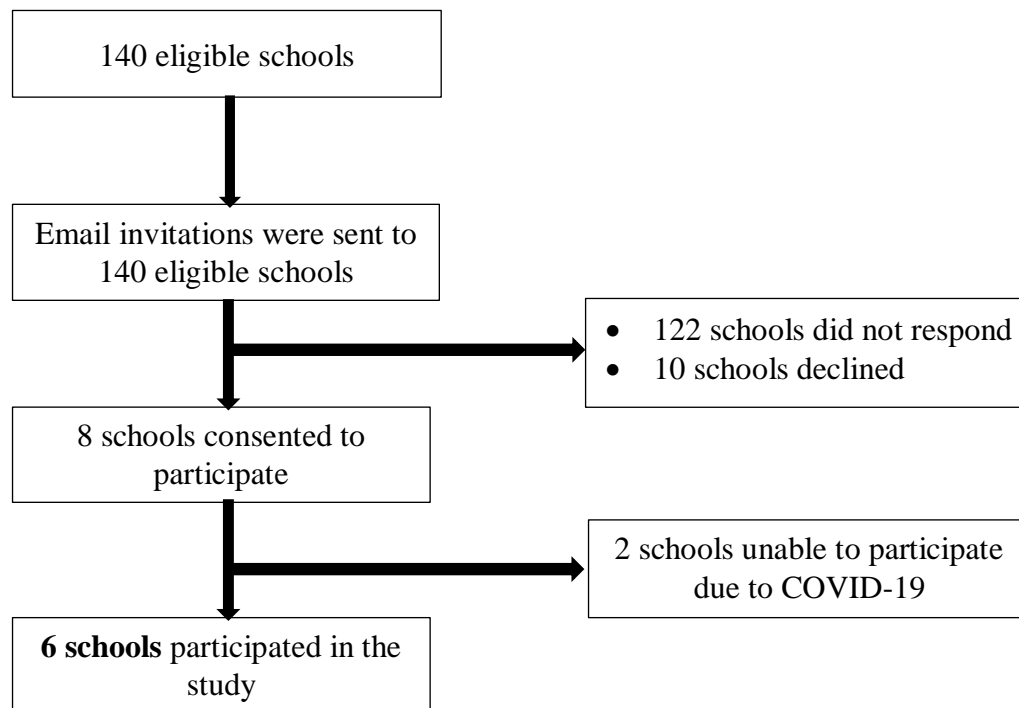
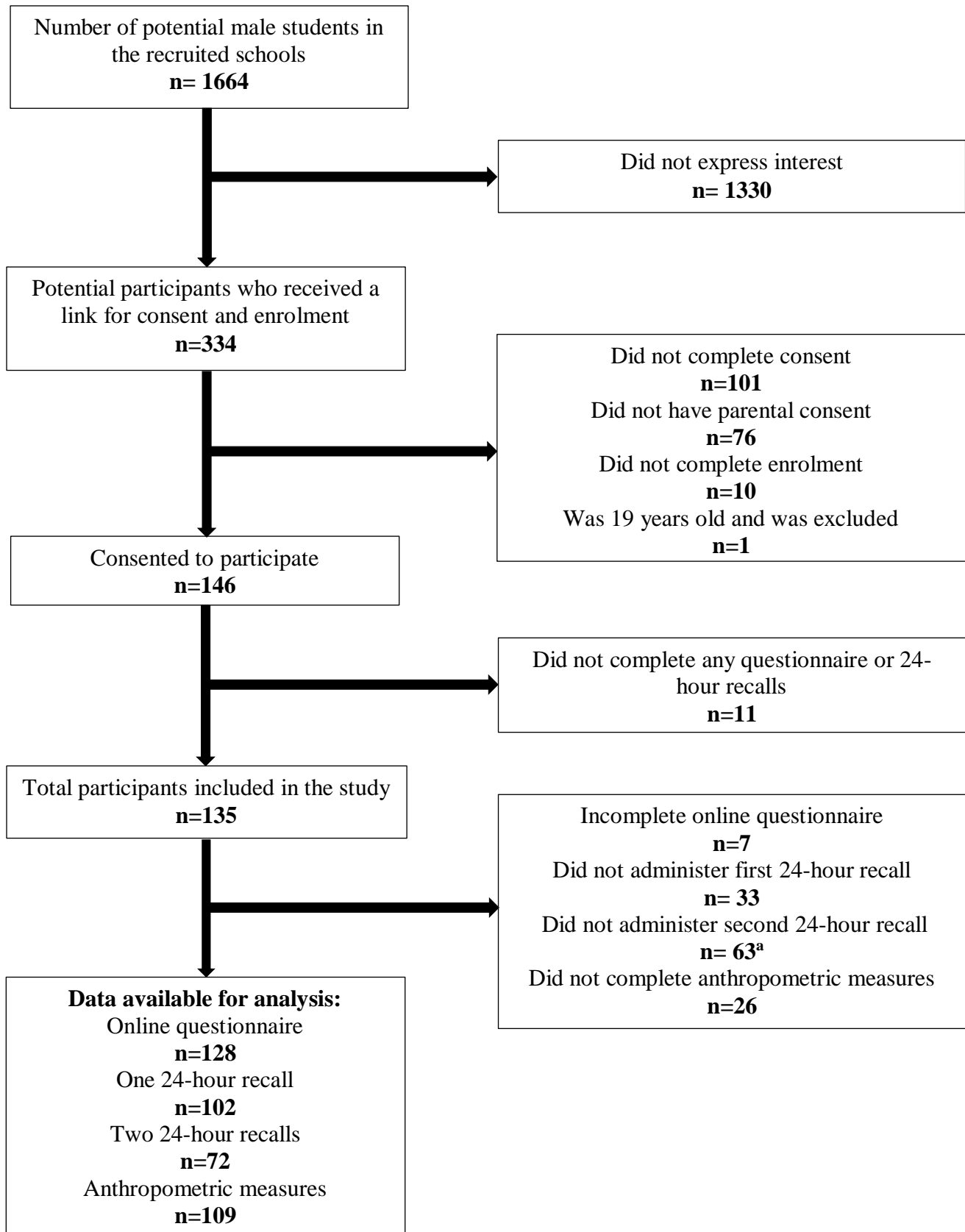


Figure 5.1 School Recruitment Process

5.2 Participant Recruitment Process

Figure 5.2 presents the male participant recruitment process for the 2020 study. Of the 6 schools included in the study, one hundred and thirty-five male participants gave consent and completed their enrolment questionnaire to participate in the study. Of the included participants, one hundred and twenty-eight completed the demographics and health section, 6 of them did not provide their ethnicity and 6 did not provide a home address for the identification of their NZDep2018. Out of the one hundred and two participants who completed a 24-hour recall, thirty participants did not complete a second 24-hour recall.



^aNumber of participants are based from the 135 participants that were included in the study.

Figure 5.2 Participant Recruitment Process

Table 2.5 displays the baseline demographic and anthropometric characteristics of the male participants. As there were no 18-year-old male participants, the number and proportion of male participants who were aged between 15 and 17 years is presented in **Table 2.5**, with a mean age of 16.6 (Standard Deviation (SD): 0.7) years. A mean BMI z-score of these participants was 0.4 (SD: 1.1) kilograms per metre squared (kg/m²).

Table 2.5 Demographic and Anthropometric Characteristics of Male Participants

Characteristics	Number of Participants (%)
Age (years)	n=135
15	20 (14.8)
16	71 (52.6)
17	44 (32.6)
Ethnicity^a	n=129
New Zealand European and Other	73 (56.6)
Māori	12 (9.3)
Pacific Islander	3 (2.3)
Asian	41 (31.8)
NZDep 2018^b	n=129
Low (1-3)	46 (35.7)
Moderate (4-7)	54 (41.9)
High (8-10)	29 (22.5)
BMI^c z-score^d	n=109
Underweight (<-2)	1 (0.9)
Healthy weight (≥-2 to ≤ +1)	73 (67.0)
Overweight (>1 to ≤ +2)	29 (26.6)
Obese (>+2)	6 (5.5)

^a The major ethnic proportions in New Zealand in 2006 are New Zealand European (67.6%), Māori (14.6%), Asian (9.2%), Pacific Islander (6.9%) (Stats New Zealand, 2006).

^b The NZDep2018 ordinal scale ranges from 1 to 10, where 1 represents the areas with the least deprived scores and 10 the areas with the most deprived scores (Atkinson J., Salmond C., & Crampton P., 2014).

^c BMI is calculated as weight in kilograms (kg) divided by the square of height in metres (m) (kg/m²).

^d The z-score is calculated as the difference between observed value and median value of the reference population divided by the standard deviation value of reference population (World Health Organization, 2020).

5.3 Fibre Intake

Table 2.6 shows the mean daily intake of fibre in adolescent males based on age, ethnicity, deprivation index and BMI z-score.

Table 2.6 Mean Daily Fibre Intake of Male Participants

Characteristics	Mean Fibre Intake (g/day)	95% CI
Age (years)	n=135	
15	22.5	[21.3, 23.7]
16	23.5	[21.9, 25.1]
17	25.7	[24.0, 27.5]
Ethnicity^a	n=129	
New Zealand European and Other	25.4	[23.7, 27.1]
Māori	21.1	[20.2, 22.0]
Pacific Islander	29.6	[26.1, 33.2]
Asian	21.8	[20.3, 23.3]
NZDep 2018^b	n=129	
Low (1-3)	23.3	[22.0, 24.6]
Moderate (4-7)	24.6	[22.7, 26.4]
High (8-10)	24.4	[22.6, 26.1]
BMI z-score	n=109	
Underweight (<-2)	25.0	[0.0, 0.0] ^c
Healthy weight (≥-2 to ≤+1)	24.1	[22.4, 25.8]
Overweight (>1 to ≤+2)	24.7	[22.8, 26.7]
Obese (>+2)	27.1	[24.3, 29.8]

Abbreviations: CI = Confidence Interval.

^{a,b} 6 participants administered at least a 24-hour dietary recall but did not provide their ethnicity and NZDep data.

^c There is only 1 participant in this BMI z-score category and the sample size for this category is considered too small to calculate a confidence interval.

A distribution of fibre intake in male participants is shown in **Figure 5.3**. The mean fibre intake of this population was 24.1 g/day (95% Confidence Interval (CI): 22.2, 25.9); median fibre intake was 23.4 g/day (25th percentile: 17.1, 75th percentile: 29.7). The fibre intake in the adolescent male population is reasonably normally distributed, although there were 3 participants who had an atypical high fibre intake of more than 50 g/day. Additionally, based on the diet habits questionnaire, no fibre supplement use was reported by the male participants.

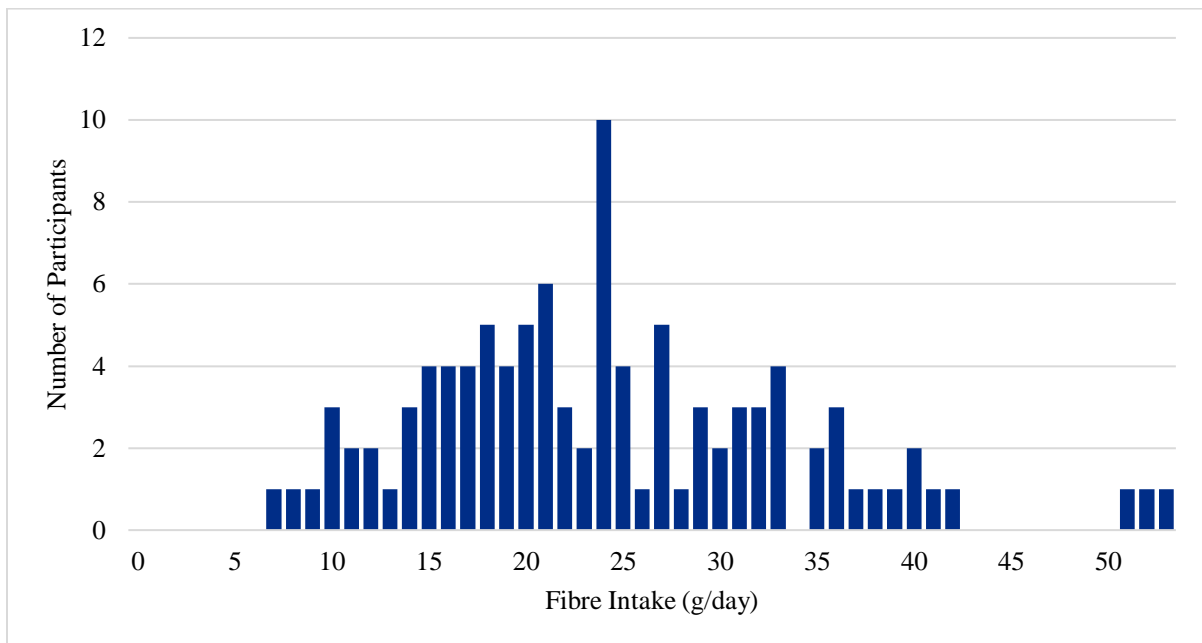


Figure 5.3 Distribution of Fibre Intake in Adolescent Males.

A scatter chart to determine the correlation between energy and fibre intakes is presented in **Figure 5.4**. The mean energy intake was 10077 kJ/day (95% CI: 9452.8, 10700.6); median energy intake was 9349.6 kJ/day (25th percentile: 8403.7, 75th percentile: 11810.4). One outlier from **Figure 5.4** was excluded as there was 1 participant who had an implausible high energy intake at 29467 kJ/day.

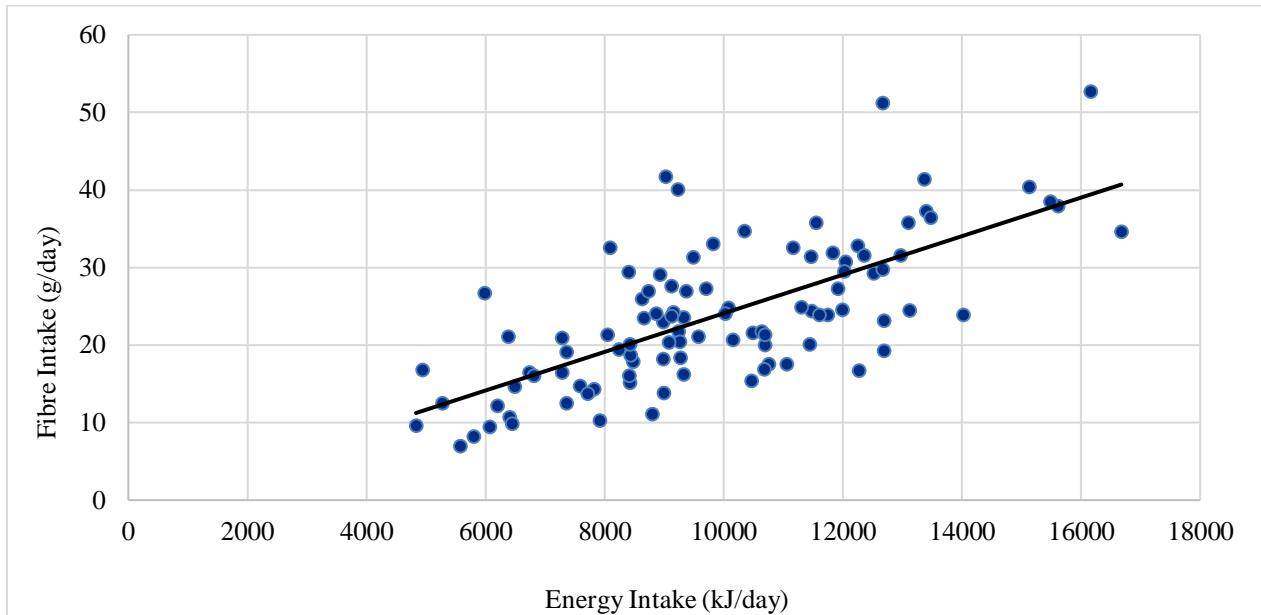
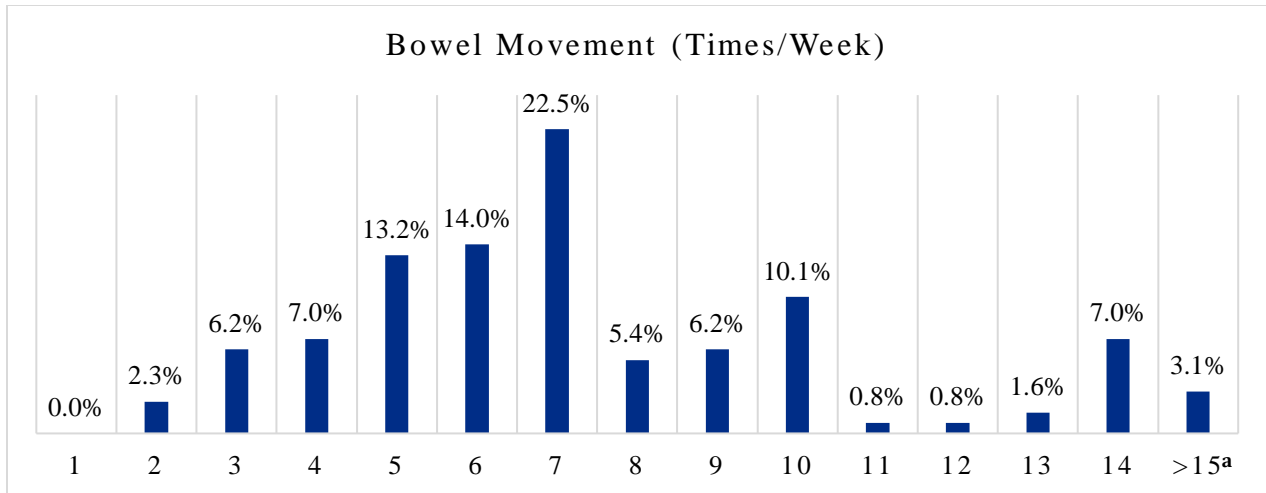


Figure 5.4 Relationship between Energy and Fibre Intake in Adolescent Males.

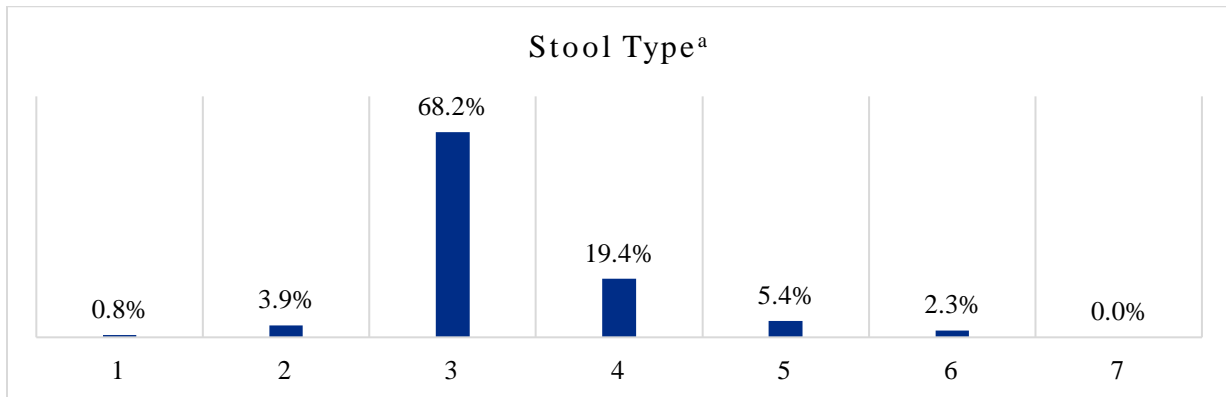
5.4 Bowel Habits

The frequency and consistency of bowel movement in adolescent males are displayed in *Figure 5.5* and *5.6*. Most of the adolescent males had a bowel movement of between 5 and 7 times a week, with the greatest frequency at 7 times a week. Of the analysed data from one hundred and twenty-nine male participants, more than half of the participants had a Type 3 stool consistency on the Bristol Stool Chart.



^a 3 participants had bowel movements of fifteen times a week and 1 participant had twenty-one bowel movements a week.

Figure 5.5 Frequency of Bowel Movement of Adolescent Males.

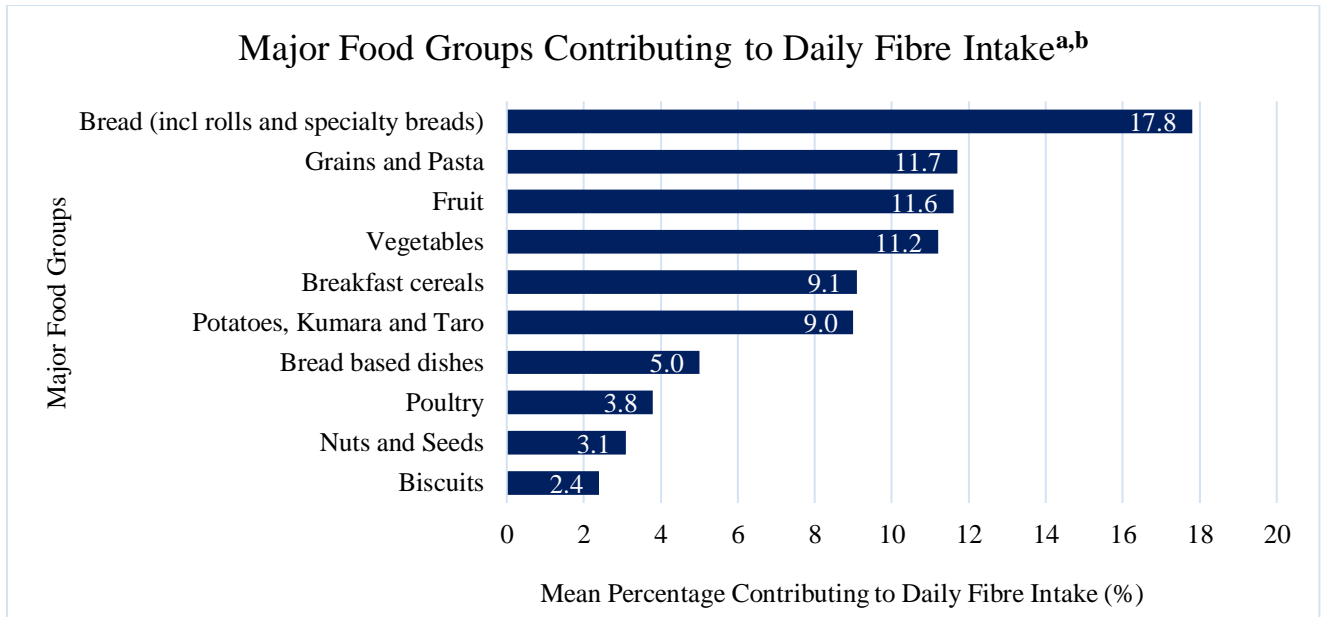


Note: ^a Based on the Bristol Stool Chart. The chart is an ordinal scale of stool types ranging from the hardest (Type 1) to the softest (Type 7). Types 1 and 2 indicate abnormally hard stools; Type 3, 4 and 5 indicate 'normal' stool form; Types 6 and 7 indicate abnormally loose/liquid stools (Blake, Raker, & Whelan, 2016).

Figure 5.6 Stool Type of Adolescent Males.

5.5 Food Sources Contributing to Fibre Intake

Figure 5.7 shows the main food sources that were contributing to the daily fibre intake in the adolescent male population. Of the 33 ANS main food groups, only ten food groups contributed to more than 2 % of daily fibre intake in adolescent males.

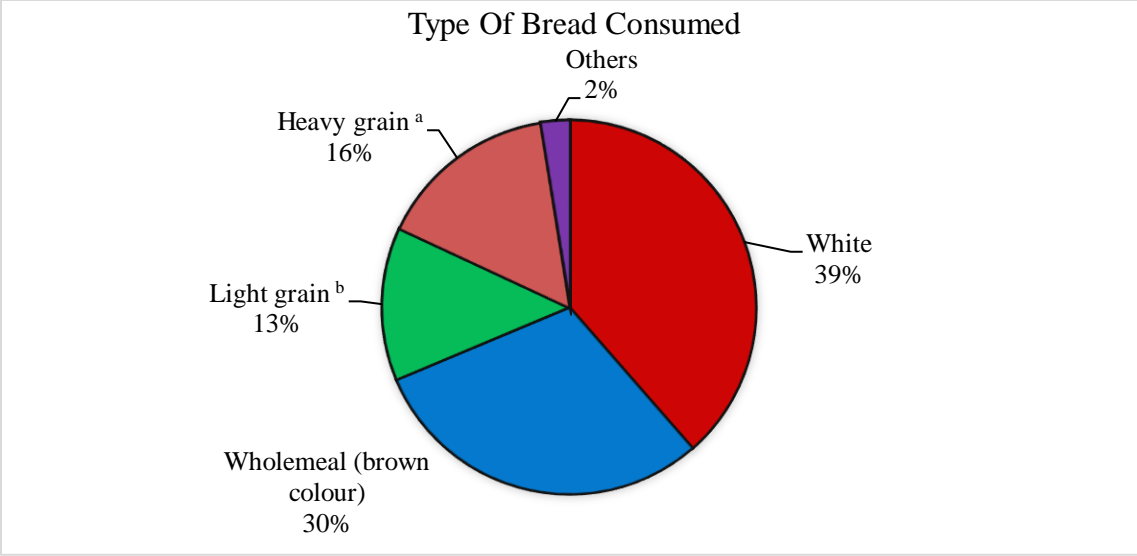


Note: ^a Food groups contributing more than 1% (in descending order): Pies and pastries, Snack foods, Cakes and muffins, Savoury sauces and condiments, Sausages and processed meats, Non-alcoholic beverages, Snacks sweet, Soups and stocks, Beef and veal.

^b Food groups contributing less than 1%: Puddings/desserts, Milk, Dairy products, Cheese, Butter and margarine, Fats and oils, Eggs and egg dishes, Lamb/Mutton, Pork, Other meat, Fish/Seafood, Sugar/sweets, Alcoholic beverages, Supplements providing energy.

Figure 5.7 Major Food Groups Contributing to Daily Fibre Intake.

A pie chart of the different types of bread consumed by the adolescent males is shown in *Figure 5.8*. From the dietary habits questionnaire, 2 participants reported to consume other types of bread: rye and a type of white bread with added oats (brand: Oatlicious).



^a Heavy grain bread option has some grains and a has a chewier texture. An example of a heavy grain bread is Vogels.

^b Light grain bread option has some grains but has a softer texture. An example of a light grain bread is Honey Grain.

Figure 5.8 Type of Bread Consumed by Adolescent Males.

6 Discussion

To our knowledge, the two-year SuNDiAL study is the first New Zealand study in which the intakes and sources of fibre in an adolescent population have been estimated. This study found that the mean dietary fibre intake in adolescent males was at 24.1 g/day (95% CI: 22.2, 25.9), which was lower than the AI for their age group of 28 g/day. Nonetheless, these male participants tend to have regular bowel habits with normal stool consistencies. The top 5 food sources contributing to fibre intake were bread; grains and pasta; fruits; vegetables; breakfast cereals.

The current finding of a relatively low intake of dietary fibre by New Zealand adolescent males is consistent with other existing international literature. In the United Kingdom, the United States, Belgium and Canada, dietary fibre intakes in adolescent males ranged from 12.8 g to 16.4 g, which were less than half of the AI applicable to their respective countries (Dong et al., 2019; Lin et al., 2011; Schenkel et al., 2007; Scientific Advisory Committee on Nutrition, 2015). Further, previous national nutrition surveys carried out in France, Denmark, Ireland, Australia, Netherlands as well as New Zealand revealed that the mean dietary fibre intakes of adolescent males ranged from 17 g to 22 g, which were lower than the AI recommended by each of these countries (ANSES, 2017; Dutch Ministry of Health Welfare and Sport, 2011; Fayet-Moore et al., 2018a; Food Safety Authority of Ireland, 2011; Nordic Council of Ministers, 2012; University of Otago and Ministry of Health, 2011). Since the AI is based on mean population intakes rather than requirement, no estimation can be made of the probability of dietary fibre inadequacy in this New Zealand adolescent male population (Murphy & Poos, 2002).

High fibre foods tend to be low energy dense (L. Johnson et al., 2008). However, there was a positive association between energy and fibre intakes in our participants. This relationship

is attributed to high energy consumers ingesting large amounts of food in total, including high fibre foods. In contrast, when similar quantities of food are eaten, a high fibre diet generally results in a lower energy intake (Burton-Freeman, 2000), presumably due to the physicochemical properties of fibre that are likely to contribute to satiety and the resulting low energy intake (Wanders et al., 2011). For instance, viscous fibres are associated with soluble fibres, such as guar gum and pectin (Dikeman & Fahey, 2006) that have the ability to thicken or form gels (Salas-Salvadó et al., 2006). Hence, they may increase stomach distension and delay gastric emptying, which may induce satiety and a subsequent lower energy intake as compared to low fibre-high energy dense foods (Wanders et al., 2011).

Additionally, lower energy intakes contributed from high fibre foods may result in a lower BMI. This can be reflected in studies with participants consuming fibre-rich foods (Howarth et al., 2001; Du et al., 2009; Wanders et al., 2011) as well as those supplemented with viscous or soluble fibres (Kovacs et al., 2001; Guérin-Deremaux et al., 2011; M. Kristensen & Bügel, 2011). However, it should be noted that fibre-rich food is integrated within a complex diet containing other essential nutrients that can contribute to satiety and weight regulation (L. Johnson et al., 2008). Further, adolescent males have an active lifestyle, which could affect their energy balance (Deheeger, Bellisle, & Rolland-Cachera, 2002). These factors could explain the greater percentage of adolescent males who were in a healthy weight range (67 %) as compared to those having obesity (5.5 %). Hence, the relationship between energy intakes and body weight could be due to a number of food and healthier lifestyle related factors.

Further, overweight and obesity are associated with an increased risk of T2DM and CHD (Lattimer & Haub, 2010). There is evidence that the precursors of the aforementioned chronic diseases begin during childhood and adolescence (Alamian & Paradis, 2009), which will track

into adulthood (Sivagurunathan et al., 2015). Since existing literature showed that there is a noticeable transition from a less energy dense to more energy dense foods as children age (Walton et al., 2014), this emphasises the need for adolescent males to consume adequate fibre-rich foods that are low energy dense for optimal health promotion and chronic disease prevention.

Dietary fibre has been identified to promote bowel regularity (Dikeman & Fahey, 2006). Although our adolescent males did not meet their AI for dietary fibre, majority of them had regular bowel motions with a stool consistency of Type 3 on the Bristol Stool Chart. About fifty percent of the adolescent males revealed that they had bowel movements of either 5, 6 or 7 times a week, with the greatest frequency at 7 times a week. Hence, on average, the adolescent males in our study had one bowel movement each day. Furthermore, ninety-three percent of our male participants reported to have a Type 3, 4 or 5 stool consistency, indicating that they have a normal stool form (Blake et al., 2016). The conflicting results of not meeting the AI of dietary fibre and normal bowel movements could be due to the high consumption of low fibre density foods, which generally do not increase fibre intake levels effectively (Kranz et al., 2012). This warrants for encouraging the intakes of dietary fibre with high fibre density to help increase stool weight and reduce transit time (Dikeman & Fahey, 2006), ensuring regular bowel motions (Kranz et al., 2012; Dahl & Stewart, 2015; Reynolds et al., 2019) in all adolescent males.

Moreover, adequate dietary fibre may associate with a lower colorectal cancer risk (World Cancer Research Fund, 2018). In New Zealand, colorectal cancer has been rated as the second highest cause of cancer deaths (World Cancer Research Fund, 2018). A proportion of dietary fibre intrinsic to fruits and vegetables undergoes fermentation whereby the fibres are broken down into short chain fatty acids and other metabolites in the colon (Wanders et al., 2011; Wang et al., 2019). These by-products have the ability to inhibit pathogenic colonic cell

growth (Anderson et al., 2009; Song et al., 2015), which may reduce colorectal cancer risk. However, it is noteworthy that fibre-rich foods also contain other health promoting nutrients (e.g. antioxidant vitamins, phenolic compounds, flavonoids), thus the influence of dietary fibre *per se* on the beneficial health effects remains unresolved. This warrants for future well-designed research to determine the association between dietary fibre intake and its subsequent health effects in the adolescent male population. Nonetheless, adolescent males are still encouraged to meet the AI for their age group for the potential health protective effects of dietary fibre.

Bread was the single largest food group contributor to daily fibre intake in our adolescent male population. This finding is consistent with the national nutrition surveys carried out in Europe, Denmark, Germany, Ireland, Canada and Australia (Lin et al., 2015; Pedersen et al., 2015; Schenkel et al., 2007; Stahl et al., 2009; Walton et al., 2014; Fayet-Moore et al., 2018b). However, our study did not analyse the differences between refined and whole grains in the bread food group. It should be noted that white breads that are made from refined grains provide a low amount of fibre, unless they have been fortified with fibre, as they have had most or all bran and germ that are high in fibre, removed (Ministry of Health, 2012). Considering the New Zealand Food Composition Data do not distinguish the difference between fortified and non-fortified white bread (The New Zealand Institute for Plant and Food Research Limited, 2019), therefore, if a large proportion of our male participants consumed white bread that had been fortified with fibre, the contribution of fibre-fortified white bread to fibre intakes, indeed, overall fibre intake would have been underestimated. Nonetheless, our study found that almost forty percent of adolescent males consumed white bread. This pattern is consistent with other literature, where fifty percent of the Polish adolescent males consumed white bread daily compared to wholegrain bread at 9 percent (Krusinska, Wuenstel, Kowalkowska, Wadolowska, & Slowinska,

2017). Hence, encouraging the substitution of refined breads with fibre-dense wholegrain bread options may be useful to help this male population to meet the AI for their age group.

Considering the mean dietary fibre intake in the adolescent male population was lower than the AI, there is a concern whether they could achieve the AI in their adulthood. Although fibre supplements are widely sold, adequate fibre intake consumed from food sources rather than supplements is recommended (Ministry of Health, 2012). Consuming fibre-rich foods allow adolescent males to meet other nutrient requirements that can provide a range of other health-promoting substances (American Dietetic Association, 2009) while reducing the risk of adverse effect due to interaction with other nutrients that is associated with supplementation (Lichtenstein & Russell, 2005). Furthermore, fibre supplements may promote poor food choices in this population due to a false sense of security about fibre adequacy (Smith, Wilson, & Parnell, 2005). This recommendation is consistent with our findings where no fibre supplement use was reported. Only a minimal amount of fibre such as kelp (6mg) and glycerol (no amount stated) were used as a bulking agent in some multivitamins consumed by some of our male participants. Hence, our study highlights the importance of encouraging adolescent males to consume fibre-rich food sources in accordance with the New Zealand dietary guidelines to achieve the AI for their age group and further during adulthood.

This study was not without limitations. As the SuNDiAL 2020 study was conducted only in certain parts of New Zealand (Otago, Wellington, Christchurch, Tauranga, Rotorua and Auckland), sampling of our study might not be representative to the whole New Zealand. Hence, our male participants could differ from the general population of adolescent males in regard to ethnicity and NZDep. Additionally, majority of our male participants were found to be New Zealand European (57%) and Asian (32%). Based on the 2006 New Zealand census, the Maori

population accounted for the second main ethnic proportion after New Zealand Europeans (Stats New Zealand, 2006). Hence, Maori male participants were underrepresented in the total sample. Due to the cross-sectional design of the study, cause and effect conclusions were precluded.

It should be noted that part of our study was conducted during the pandemic situation of Covid-19, when adolescent males nationwide were under lockdown. Hence, anthropometry measurements, blood and urine sample provision were suspended halfway through the study, with both first and second 24-hour recalls administered remotely via phone call or Zoom. Another limitation to this study was that dietary data might not reflect the usual intake of adolescent males during this lockdown period. Although some of our male participants were still having their online learning, it is noteworthy that they were homebound all day. Hence, it is more likely that they have been eating differently as compared to when they were in school.

Furthermore, poor response rates from schools and participants were limitations that need to be considered in this study. Of the one hundred and forty eligible schools, only 6 were able to participate in our study. Likewise, only one hundred and thirty-five participants out of three hundred and thirty-four male students participated in this study. Considering the Covid-19 situation, data collection process was completed abruptly in only 3 months rather than the proposed 6 months. A longer study period would have allowed more response from schools, which would increase our study sample size for more representative and precise mean dietary fibre intakes in this New Zealand adolescent male population.

A considerable strength of this study was the multi-centric study setting that included adolescent males from different parts of New Zealand. This allowed the inclusion of male participants from areas with different deprivation index in our study as compared to a study exclusively to an area. Further, dietary fibre data was obtained from repeated diet recalls, which

has a lower participant burden as compared to other methods (R. K. Johnson, 2002). Additionally, during the lockdown period, most foods consumed by adolescent males were at home. This allowed them to easily consult the person who prepares food at home and provide accurate descriptions of the food and drinks consumed. Furthermore, since the multi-pass method was used during the two 24-hour dietary recalls, detailed dietary intake data was obtained (Rutishauser, 2005), which provided a higher accuracy for day-to-day variations in dietary fibre intake by our male participants.

Moving forward, a regular and comprehensive monitoring of dietary fibre intakes in adolescent males through nutrition surveys is of utmost importance. A national set of data allows more detailed tracking and thorough understanding on the association between dietary fibre and its subsequent health outcomes in this male population. This enables more effective nutrition interventions and initiatives to be put in place to help increase dietary fibre intakes in adolescent males. This would give guidance to this male population as to the ways to meet the AI for their age group and during adulthood. Hence, there is a need for further research that is more sample representative with respect to fibre intakes in New Zealand adolescent males.

6.1 Conclusion

Overall, this study explored the dietary fibre intake and its main food sources in adolescent males. Our study found that this population did not meet the AI for their age group. The main food sources contributing to more than ten percent of fibre intake were bread, grains and pasta, fruits and vegetables. Despite the low dietary fibre intake, adolescent males were found to have regular bowel motions and normal stool forms. Given the health protective effects of dietary fibre, this study warrants the need to encourage and support adolescent males to consume more fibre-dense foods and whole grains in accordance with the New Zealand Dietary Guidelines.

7 Application of Research to Dietetic Practice

Adequate dietary fibre intake is associated with bowel and body weight regulation, and certain fibre types may reduce the risk in developing CHD, colorectal cancer and T2DM (Li & Komarek, 2017). Our study found that adolescent males are not meeting the AI. Although no estimation could be made of the probability of dietary fibre inadequacy in adolescent males, dietetic practice involvement is still warranted (Pérez-Rodrigo & Aranceta, 2003) to increase dietary fibre intakes to reduce the risk of developing CHD (Australian National Health and Medical Research Council and New Zealand Ministry of Health, 2005).

Since most meals consumed by adolescent males are either at home or at school (Welker, Lott, & Story, 2016), nutrition education should extend to teachers and parents. They play a key role in setting norms of consuming fibre-rich sources of wholegrains, fruits and vegetables within the school and family, and act as role models for adolescent males (Pérez-Rodrigo & Aranceta, 2003; Hills, Byrne, Lindstrom, & Hill, 2013). With that, incorporating these fibre-rich foods into the diet of adolescent males will be more empowering and less challenging than asking this population to modify their diet on their own (Shepherd et al., 2005).

Considering small modifications to the diet are achievable (Hills et al., 2013), dietitians can educate adolescent males, teachers and parents in reading nutrition labels to swap and look out for affordable high fibre options. Since bread is mostly consumed by adolescent males, looking out for “wholegrain”, “multigrain”, “whole-meal”, “wheat-meal” or white bread with added fibre options in front-of-pack or ingredient lists are recommended to increase the consumption of dietary fibre. In addition, swapping plain discretionary foods that are low in dietary fibre to whole/wheat-meal biscuits or sweet biscuits with dried fruit can help boost dietary fibre intake (Queensland Government, 2013). However, caution should be exercised with

discretionary products that claim to be high in fibre on the packaging, which often can be confusing as discretionary foods may be high in sugar and fat (B. J. Johnson, Bell, Zarnowiecki, Rangan, & Golley, 2017). Excess intake of discretionary products can displace more healthful high-fibre-low energy dense options (Fayet-Moore et al., 2018b), which can increase the risk of obesity in adolescent males (B. J. Johnson et al., 2017). Hence, substituting low fibre foods with fibre-dense whole grain options are useful to help increase dietary fibre intake and reduce the risk of developing the aforementioned chronic diseases in this male population.

Additionally, dietitians need to encourage adolescent males to act in accordance with the New Zealand dietary guidelines by increasing their high-fibre wholegrain, fruit and vegetable intakes (Ministry of Health, 2012). This can further reduce the intake of processed, high fat and sugar products. Moreover, dietitians should ascertain whether adolescent males are using fibre supplements. There may be particular reasons for supplement use, if not, dietitians should encourage this population to increase their fibre intake from food rather than supplements as a means to assist overall nutrient adequacy for optimal general health and wellbeing.

Overall, adolescence is a critical period for establishing healthy eating habits, which will track into adulthood (Sivagurunathan et al., 2015). Considering many adolescent boys were consuming high amount of refined low-fibre options, this research experience was an eye-opener and had taught me to value the importance of building rapport and open-ended questions to ensure accurate and detailed dietary data were provided. Additionally, I was grateful to have the experience of speaking to adolescent boys of different ethnicities and cultures. It had facilitated my realisation on the importance of adopting an open-minded approach by considering the budget, practicality and cultural needs for each client. This advocates for the consideration of the determinants of health and health equity – a core principle of effective health promotion.

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9 Appendix

Appendix A: Anthropometry Measurement Protocol

Appendix B: 24-hour Dietary Recall Protocol

Appendix C: Ethical Approval

Appendix D: Participant Recruitment Presentation Slides

Appendix E: Study Information Sheet

Appendix F: Screenshots of Study Website

Appendix G: Consent and Enrolment Questionnaire

Appendix H: Relevant Questionnaires

Appendix I: Screenshots of Grocery Websites Used

Appendix J: Show Cards for 24-hour Dietary Recall

Appendix K: Graduated Food Portion-size Photographs

Appendix L: 2008/09 New Zealand ANS Food Groups

9.1 Appendix A: Anthropometry Measurement Protocol

SuNDIAL Project 2020

Study protocol

Version 1 December 2019

Anthropometric Measurements

To complete anthropometric measurements you will need:

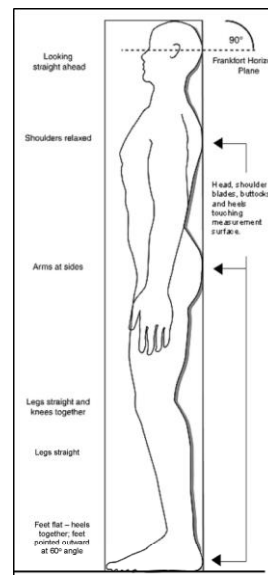
- This protocol
- A stadiometer that has been assembled correctly, and positioned appropriately against a straight wall
- A set of body weight scales
- A steel anthropometric measuring tape
- The blood pressure and anthropometry recording sheet

Make sure you have taken the ID number from the name & ID spreadsheet and written it correctly on the blood pressure and anthropometry recording sheet.

Gain verbal consent from the participant for each measurement and explain fully what you will do to obtain them, specifically asking them if it is ok to touch the top of their head with the stadiometer when doing the height measurement. Before beginning, gain consent from the participant to use non-permanent pen for marking anatomical land marks.

HEIGHT

1. Ask the participant to remove their shoes, as well as any hair ornaments or buns/braids on the top of the head.
2. If the participant is taller than the investigator, use a step tool to take the measurements. Errors can be minimised by the investigator being parallel to the participant and the headpiece.
3. Tell the participant to stand with their heels together and toes apart pointing outward at approximately a 60-degree angle.



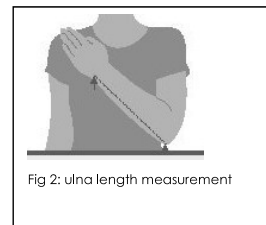
4. Make sure the back of the head, shoulder blades, buttocks, and heels of the participant are touching the backboard/stadiometer.
5. Make sure the participant's head is aligned in the Frankfort horizontal plane, where a horizontal line connects from the ear canal to the lower border of the orbit of the eye.
6. Lower the headpiece to rest firmly on the top of the participant's head and ask the participant to stand as tall as possible and take a deep breath.
7. Record the result to the nearest 0.1 cm in the HEIGHT 1 box on the recording sheet without informing the participants.

WEIGHT

1. Ask the participant to remove any heavy clothing (such as jackets, heavy tops, boots etc). As the participant would have just had their height measurement done, they should not be wearing shoes.
2. Turn on the scales, ensure they are switched on to metric (kg).
3. Ask the participant to step on to the scales so that they are facing away from the display (to prevent seeing the weight) cautioning them that they need to step up onto the scales.
4. Wait for the scales to read or come to a stable number.
5. Record the participant's weight to the nearest 0.1 kg in the WEIGHT 1 box on the recording sheet without informing the participant.

ULNA LENGTH:

Ulna length is measured between the point of the elbow and the midpoint of the prominent bone of the wrist using an anthropometric steel tape. This value is then compared with a standardized height conversion chart. Participants should be dressed in light clothing with no wrist watch or other jewellery on the arm that is to be measured.



1. Measure between the point of the elbow and the midpoint of the prominent bone of the wrist (non-dominant side).
2. Read and accurately record the measurement to the nearest 0.1 cm in the UNLA LENGTH 1 box on the recording sheet without informing the participants.

NB: anthropometry tapes have a blank lead before measurement markings start - consider this when reading a measurement.

REPEAT ALL MEAUREMENTS

Repeat all three measurements again, in the same order, entering the measurements in the HEIGHT 2, WEIGHT 2 and ULNA LENGTH 2 box as appropriate (do not tell participant measurements).

CHECK: are any of the 1st and 2nd measurements are more than 0.5 units apart? If so take a third measurement where required.

Anthropometric measurements will need to be entered into REDCap (see REDCap data entry protocol)

Participant ID: _____ Interviewer: _____

Date: _____ Day of the Week: _____

HEIGHT 1 (to nearest 0.1 cm)		HEIGHT 2 (to nearest 0.1 cm)	
WEIGHT 1 (to nearest 0.1 kg)		WEIGHT 2 (to nearest 0.1 kg)	
ULNA LENGTH 1 (to nearest 0.1 cm)		ULNA LENGTH 2 (to nearest 0.1 cm)	

↓

Do the height, weight and ulna measurements
fall within 0.5 of each other?
(Subtract to find out e.g. HEIGHT 1 – HEIGHT 2)

↙ ↘

YES (0.5 or lower):
Don't take a third
measurement

NO (greater than 0.5)
Take a third
measurement

↓

HEIGHT 3 (to nearest 0.1 cm)	
WEIGHT 3 (to nearest 0.1 kg)	
ULNA LENGTH 3 (to nearest 0.1 cm)	

9.2 Appendix B: 24-hour Dietary Recall Protocol

SuNDiAL Project 2020

Study protocol

Version 1 December 2019

24 Hour Dietary Recall

To complete the 24 h dietary recall you will need:

- This protocol, including the tips sheet and useful prompts.
- The 24 h dietary recall recording sheet.
- Portion size box, including measurement aids and food photographs.

Make sure you have taken the ID number from the name & ID spreadsheet and written it on every page of the 24 h diet recall recording sheet.

Explain the 24 h recall to the participant

“I am going to ask you about everything that you ate and drank yesterday. Please try to recall, and tell me about everything that you had to eat at drink, whether it be at home, or away from home, including snacks, drinks and water. We are not here to decide if what your eating is healthy or not – we just want to understand what boys around New Zealand are eating, so we would like you to be really honest with us”

Stage One – Quicklist

“First, we will make a quick list of all the things you ate and drank, and then we will go back over this list and I will ask you more details about the specific foods and drinks, and the amounts.”

“It might help you remember what you ate by thinking about where you were, who you were with, or what you were doing yesterday; like going to school, eating out, or watching TV. Feel free to keep these activities in mind and say them aloud if that helps.”

“So starting from midnight the day before yesterday, what was the first thing you remember eating?”

Start recording quick list – keep prompting until finished

“That’s great. Sometimes people forget to tell us about drinks, particularly water when we do this list.”

“How much water do you remember drinking yesterday?” *(record)*

“Did you have any other drinks you might have forgotten about?” *(record)*

Stage two – Collect more information

“I am now going to ask you some more specific questions about each food. We also need to work out how much of each food that you ate or drank”

“Let’s start at the beginning – the first thing you remember eating was xxxx” *(record)*

What time did you eat/drink that? *(record)*

Go on to collect specific information that is relevant to each food based on the tips provided on the tip sheet. Record as much specific information as you can. Record each food item in a different row.

Use the photos and measurement aids to help the participant estimate the portion size. Remember that brand and package size will always give you the most accurate information.

Before you go onto the next food on the quick list be sure to ask if they added anything to the food they have just described.

Stage 3 – check for any further additions

“Ok, thanks for working with me to provide all of that detail. We are now going to do one more check to make sure there isn’t anything else that should be on this list. I am going to read this list back to you. If you remember anything else that you ate while I am reading it back to you please interrupt me and we will record it”

Read through with the participant all the food and drink they have listed

“Is there anything you can think of that we need to add in?” (record as necessary)

“Last Question: Do you know if the salt you use at home contains iodine?” (tick appropriate box)

“Great thank you again. If it is ok with you one day in the next week I would like to ring you and go through this process again on a different day, so that we can get an idea of how the foods you eat change from day to day. What time of the day (outside of school time) would suit you for me to ring you?”

Record preferred times - remember, ideally this second 24 h recall will occur on a randomly selected day, but that might not always be possible (at the very least it should be a different day of the week than today)

The 24 h diet recalls will need to be entered into FoodWorks following the FoodWorks Protocol.

Tips Sheet

Remember that the more information you can obtain about each food the more accurate the data is going to be. Please keep in mind that some of your fellow MDiet students are writing their thesis on nutrients (like Folate) that will vary from brand to brand depending on fortification so please be as careful and accurate as possible.

You need to gather more information about each food identified on the Quicklist. Below are some prompts that might help you do this.

Where possible for packaged foods collect the brand name.

Potential questions to consider asking (depending on the food reported):

- What is the brand name?
- Was it fresh, canned, frozen or rehydrated?
- Was it home made? Do they know the recipe? If they do record on the recipe sheet) – this is more important for savory foods than baking (as the basic composition of a biscuit or a cake varies much less than the composition of, for example, a stir fry)
- How was it cooked? Was it baked, fried, or boiled?
- Was the item coated before cooking, if so what it with flour, batter, eggs, or breadcrumbs etc?
- Was it standard, low fat, low sugar caffeine free?

Do not

- x Collect information about herbs and spices that are used in very small quantities
- x Ask leading questions
- x Ask for recipes for traditional home baking, but do note if it is gluten free.

- x Make assumptions
- x Respond in a judgmental way (positive or negative) to the foods or drinks consumed

Do

- ✓ Keep your prompts neutral
- ✓ Ask about cooking method and the type of fat used in cooking e.g. if they say baked, ask what with?
- ✓ Collect brand names for margarine, butter, juices/fruit drinks, breakfast cereals, energy drinks, breads, dairy alternatives (e.g. almond milk) as the micronutrient content of these products can vary considerably from brand to brand
- ✓ Ask for the recipe for less traditional home baking (e.g. brownies made with black beans, raw caramel slice etc)

Useful Probes for Specific Food Groups

FRUIT

- Peeled or unpeeled
- Colour? – e.g. red/green apple
- Tinned? – if so was it tinned in syrup or juice, how much of the syrup/juice did they have
- Use photos of tinned peaches, wooden balls, cups or beans to help estimate portion sizes

VEGETABLES

- Fresh, frozen or tinned (if tinned were they tinned with flavoured sauce/syrup/juice)
- Cooking method – boiled, baked (with fat/oil – what type and how much?), microwaved, steamed etc
- Colour – e.g. red/green capsicums
- Potatoes – with or without skin, if mashed what was added and how much?
- Quantities could be recorded in cups (sliced/whole/mashed/diced) or how much of a whole vegetable (e.g. ½ a medium capsicum)
- Use photos to help estimate portion size for similar vegetables not shown in pictures (e.g. broccoli can be used to estimate cauliflower, peas can be used for corn or bean etc). Use thickness guides and rulers to help estimate sliced vegetables (e.g. cucumber)

DAIRY

- Milk – brand name and fat content (show picture of bottle tops)
- Yoghurt – brand and with fruit or plain/natural or vanilla, reduced fat, low fat
- Ice cream – brand, any additions? If in a bowl use pictures to help estimate amounts

- Cheese - type (e.g. Edam, Colby, Feta), brand, grated (in cups or use pictures) or sliced (thickness guides)

NUTS

- Roasted, raw, salted, other favouring, blanched
- Whole, chopped, slivered
- Mixed – with or without peanuts
- How many cups or how many whole nuts? or can use beans to estimate handful size

BREAD

- White, wholemeal, wholegrain, light or dark rye (use photos to help with identification)
- Brand name (important for fortification)
- Toast or sandwich slice (thick or thin)
- For buns – any toppings (don't worry about small amounts of seeds, but do record cheese, bacon etc)

MARGARINE/BUTTER/TABLE SPREAD

- People often use the term butter and margarine interchangeably so collect the brand name (do not comment on the fact they might not have used the correct description)
- Low fat or standard
- Phytosterols (cholesterol reducing)
- Use pictures to help indication of thickness of spread

DRINKS

- Juices/Fruit Drinks
 - Terms used interchangeably so always collect brand information if possible

- 100% juice or fruit drink
- No sugar added or sweetened?
- Added vitamins
- Commercial or freshly squeezed
- Did they dilute with water, is so how much?
- Use cups or pictures of cans and bottles to help estimate portion size

- Fizzy drinks
 - Brand
 - Flavour
 - Diet, standard, zero sugar, type of sweetener
 - Caffeinated
 - Use cups or pictures of cans and bottles to help estimate portion size

- Made from liquid (cordial) or powdered concentrate (Raro)
 - Brand and flavour details of concentrate
 - Standard or low energy/ low sugar version
 - How much concentrate?
 - Did they make it with water or something else?
 - How much water or other substance was added?

PACKAGED FOODS

- Brand and package size most important
- Did they consume everything in the packet?

MIXED DISHES

- Try and record recipe if possible
- If recipe unavailable try and get as much detail as possible
- Check any protein ingredients, starchy ingredients, vegetables, sauces

- Use photos, cups, plates and bowls to estimate portion size

9.3 Appendix C: Ethical Approval



H20/004

Academic Services
Manager, Academic Committees, Mr Gary Witte

10 February 2020

Dr M Peddie
Department of Human Nutrition
Division of Sciences

Dear Dr Peddie,

I am again writing to you concerning your proposal entitled "**SuNDiAL Project: Survey of Nutrition Dietary Assessment and Lifestyle 2020: Adolescent males.**", Ethics Committee reference number **H20/004**.

Thank you for your email of 5th February 2020 with response attached addressing the issues raised by the Committee.

On the basis of this response, I am pleased to confirm that the proposal now has full ethical approval to proceed.

The standard conditions of approval for all human research projects reviewed and approved by the Committee are the following:

Conduct the research project strictly in accordance with the research proposal submitted and granted ethics approval, including any amendments required to be made to the proposal by the Human Research Ethics Committee.

Final report: A Final Report is required by the Committee upon completion of the study. The Final Report template can be found on the Human Ethics Web Page

<https://www.otago.ac.nz/council/committees/committees/HumanEthicsCommittees.html>

Adverse or unforeseen events: Inform the Human Research Ethics Committee immediately of anything which may warrant review of ethics approval of the research project, including: serious or unexpected adverse effects on participants; unforeseen events that might affect continued ethical acceptability of the project; and a written report about these matters must be submitted to the Academic Committees Office by no later than the next working day after recognition of an adverse occurrence/event. Please note that in cases of adverse events an incident report should also be made to the Health and Safety Office:

<http://www.otago.ac.nz/healthandsafety/index.html>

Discontinuation: Advise the Committee in writing as soon as practicable if the research project is discontinued.

Amendments: Make no change to the project as approved in its entirety by the Committee, including any wording in any document approved as part of the project, without prior written approval of the Committee for any change. If you are applying for an amendment to your approved research, please email your request to the Academic Committees Office:

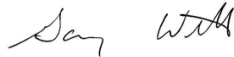
gary.witte@otago.ac.nz

jo.farronediaz@otago.ac.nz

Locality authorisation: Studies requiring locality authorisation, i.e. permission from the organisations at which the study is taking place or from which participants are being accessed, must be confirmed before the study commences.

Approval period: Approval is for up to three years from the date of this letter. If this project has not been completed within three years from the date of this letter, re-approval or an extension of approval must be requested. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing.

Yours sincerely,



Mr Gary Witte
Manager, Academic Committees
Tel: 479 8256
Email: gary.witte@otago.ac.nz

c.c. Assoc. Prof. L Houghton Department of Human Nutrition

NGĀI TAHU RESEARCH CONSULTATION COMMITTEE
TE KOMITI RAKAHAU KI KĀI TAHU

Wednesday, 12 February 2020

Dr Meredith Peddie
Department of Human Nutrition

Tēnā Koe Dr Meredith Peddie,

**SuNDIAL Project: Survey of Nutrition Dietary Assessment and Lifestyle 2020:
Adolescent males**

The Ngāi Tahu Research Consultation Committee (the Committee) met on Tuesday, 11 February 2020 to discuss your research proposition.

By way of introduction, this response from the Committee is provided as part of the Memorandum of Understanding between Te Rūnanga o Ngāi Tahu and the University. In the statement of principles of the memorandum it states "Ngāi Tahu acknowledges that the consultation process outline in this policy provides no power of veto by Ngāi Tahu to research undertaken at the University of Otago". As such, this response is not "approval" or "mandate" for the research, rather it is a mandated response from a Ngāi Tahu appointed committee. This process is part of a number of requirements for researchers to undertake and does not cover other issues relating to ethics, including methodology they are separate requirements with other committees, for example the Human Ethics Committee, etc.

Within the context of the Policy for Research Consultation with Māori, the Committee base consultation on that defined by Justice McGechan:

"Consultation does not mean negotiation or agreement. It means: setting out a proposal not fully decided upon; adequately informing a party about relevant information upon which the proposal is based; listening to what the others have to say with an open mind (in that there is room to be persuaded against the proposal); undertaking that task in a genuine and not cosmetic manner. Reaching a decision that may or may not alter the original proposal."

The Committee is aware of the researcher's experience in similar studies that have been referred to this Committee. As in the past, the Committee encourages the collection of ethnicity data as part of the research project as a right of participants to express self-identity. The Committee also supports the analysis of cultural perspectives on diet, nutrition and social activities such as screen time which may have an impact on the research findings.

The Committee acknowledges the aims and outcomes of this research project, and wishes to advise that further consultation is not required.

This letter of suggestion, recommendation and advice is current for an 18-month period from Tuesday, 11 February 2020 to 11 August 2021. The Committee would

The Ngāi Tahu Research Consultation Committee has membership from:

*Te Rūnanga o Ōtākou Incorporated
Kāti Huirapa Rūnaka ki Puketeraki
Te Rūnanga o Moeraki*



NGĀI TAHU RESEARCH CONSULTATION COMMITTEE
TE KOMITI RAKAHAU KI KĀI TAHU

appreciate receiving a copy of the research findings.

The recommendations and suggestions above are provided on your proposal submitted through the consultation website process. These recommendations and suggestions do not necessarily relate to ethical issues with the research, including methodology. Other committees may also provide feedback in these areas.

Nāhaku noa, nā





Claire Porima
Manager, Māori Research Consultation; Senior Project Manager
Office of Māori Development
Te Whare Wānanga o Otākou
Ph: +64 3 4798081
Email: claire.porima@otago.ac.nz
Web: www.otago.ac.nz

The Ngāi Tahu Research Consultation Committee has membership from:

*Te Rūnanga o Ōtākou Incorporated
Kāti Huirapa Rūnaka ki Puketeraki
Te Rūnanga o Moeraki*

9.4 Appendix D: Participant Recruitment Presentation Slides

<h3>Who are we looking for??</h3> <ul style="list-style-type: none"> • Male • 15-18 years of age • Enrolled in one of the recruited high schools • Speak and understand English • Able to complete the required online questionnaires 	<div style="background-color: #333; color: white; padding: 10px;"> <h3>What is involved?</h3> </div> <ul style="list-style-type: none"> • Consent form and Questionnaire • Two 24-hour diet recall • Two previous day activity recall • Physical Measurement (height, weight, ulna length) • Blood Pressure measurement • Wear an accelerometer (7 days) (Optional) • Urine and Blood samples (Optional)
<div style="text-align: center;">  <h3>Consent form</h3> </div> <ul style="list-style-type: none"> • Online • 15 years old: require parent's consent 	<div style="text-align: center;"> <h3>Online questionnaire</h3> </div> <ul style="list-style-type: none"> • Dietary habits • Reasons on why you choose a certain food • Complete at own time. 

 <div style="background-color: white; border-radius: 50%; width: 150px; height: 150px; display: flex; align-items: center; justify-content: center; margin: 20px auto;"> <p style="text-align: center;">SuNDiAL project 2020</p> </div>	<p style="text-align: center;">Survey of Nutrition, Dietary Assessment and Lifestyle X South Otago High School</p> 	<div style="text-align: center;">  <h3>Who are we??</h3> <p>University of Otago, Masters of Dietetics Students Department of Human Nutrition</p> </div>
<h3>The SuNDiAL project</h3> <ul style="list-style-type: none"> • Survey of Nutrition, Dietary Assessment, and Lifestyles • Nationwide survey : Auckland, Tauranga, Hawke's Bay, Wellington, Christchurch, Dunedin 		<div style="text-align: center;">  <h3>Aim of SuNDiAL</h3> <ul style="list-style-type: none"> • To describe the nutritional status, dietary habits, health status, motivations, attitudes for food choice, 24-hour activity patterns and screen time of adolescent boys (15 – 18 y) in New Zealand. </div>

Urine and blood samples

- **Optional**
- Blood samples : trained phlebotomist/ research nurse
- Urine samples : You



What do you get out of this??

- For every section completed : **\$5** supermarket voucher!!
- **TOTAL : \$30 !!**






How to join?

- Fill out the **signup sheets**
- Link provided to complete the sign up, consent and questionnaires online
- Visit the **study website** (Sundial @ Otago)
<https://www.otago.ac.nz/sundial/index.html>



we need you, you & you





24-hour Dietary Recall

- What did you eat in the last 24 hours?
- **Twice**
- > In-person (in school)
- > Zoom (video call) or phone call

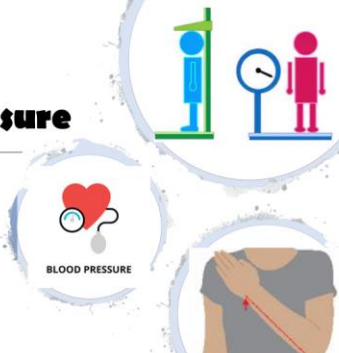
Activity recall

- What main activities did you do outside of school time in the last 24 hours?
- **Twice**
- > In-person (in school)
- > Zoom (video call) or phone call



Physical Measurements and Blood Pressure

- In school
- **Private and confidential**
- Weight and height
- Length of your lower arm
- Blood pressure




Accelerometer

- **Optional**
- Worn **24 hours** a day
- **7 days**
- Sleep and wear time diary

Questions?



9.5 Appendix E: Study Information Sheet



Participant Information Sheet

Study title:	The SuNDiAL Project 2020: A survey of nutrition, dietary assessment and lifestyle	
Principal investigators:	Names Dr Jill Haszard & Dr Meredith Peddie Department: Human Nutrition Position: Research Fellows	Contact phone number: 03 479 5683 03 479 8157

Introduction

Thank you for showing an interest in this project. Please read this information sheet carefully. Take time to think about it and talk with family or friends before you decide whether to take part or not.

If you decide to take part we thank you. If you decide not to take part that won't disadvantage you and we thank you for considering our request.

What is the aim of this research project?

The food and activity patterns of teenage boys probably influence their health and wellbeing. However, we don't know much about teenage boys' food intakes and physical activity patterns in New Zealand. Teenagers often make their own decisions about what foods to eat, but *why* they choose the foods they do is not well known. Last year we conducted a similar study in teenage girls. To get a more complete picture of what the teenagers of New Zealand eat and how they spend their time the SuNDiAL project is now going to investigate the food intakes and physical activity of adolescent males (aged 15-18 years), and why they choose to eat the way they do.

Who is funding this project?

This project is funded by the Department of Human Nutrition, University of Otago

Who are we seeking to participate in the project?

We are looking for at least 150 male high school students who are between 15 and 18 years old. To be eligible to take part, your high school must have agreed to take part in the study, you must speak and understand English, and be able to complete the questionnaires.

If you participate, what will you be asked to do?

If you agree to take part in this study you will be asked to do three things:

1) Complete an online questionnaire

After you have completed the consent process you will be asked to complete an online questionnaire that asks questions about your health and some general questions such as what ethnicity you identify with. This online questionnaire also asks you about your overall eating habits, and why you choose to eat the foods that you do. It should take about 30 minutes to complete all the online questionnaires.

2) Attend a session at your school with our research team

This visit will take about 60 minutes during the school day and you will be asked to:

- Complete a face to face interview with one of our research team where you will be asked to recall everything you ate and drank the day before. They will also ask you to recall how you spent your time during that day.
- At this session one of our research team will also measure your blood pressure, height, weight, and the length of your lower arm. Blood pressure will be measured three times, and the other measurements will be taken twice to make sure they are as accurate as possible. This will be done in a private space and you won't be told these measurements unless you ask for them.

3) Complete a second interview about the food you have eaten and your physical activity on another day

Sometime in the 2 weeks after you have finished the session at school you will be contacted by the research team and asked to complete a second interview where you will be asked to recall everything you ate and drank and how you spent your time on a different day of the week than the first interview. This is important because sometimes you can eat quite differently or do different activities from one day to the next. **This interview will be performed over Facetime or Zoom, at a time that is convenient for you.**

There are three other parts to the SuNDiAL project that are entirely optional.

Please read the following information carefully before you decide whether to take part in these optional bits of the study. If you agree to do these, but change your mind later, that's OK - there is no disadvantage to you if you decide not to do these. You will be asked again on the day if you still want to do them.

1) Provide a blood sample

We would like you to provide a blood sample (which would be collected by someone with extensive training in how to take a blood sample), but we understand that not everyone feels comfortable about this so it is entirely up to you if you do this. However, if you do provide a blood sample, we can tell you the cholesterol and HBA1c concentrations in your blood.

Cholesterol is a type of fat, and HbA1c is a measure of how much sugar you have had in your blood over the last few weeks. You can still take part in the rest of the study even if you don't do this bit. If you do agree to give a blood sample, an appointment will be made to get this done at school, and collection of the sample should only take about 10 minutes.

2) Provide a urine sample

We would like you to give a urine ("pee") sample (which is easy for you collect yourself in the bathroom with the equipment we give you). You can still take part in the rest of the study even if you don't do this bit. If you do agree to give a urine sample, we will tell you a day that you can drop in and do this at school.

3) Wear an accelerometer for a week

We would like you to wear a small red box called an accelerometer on an elastic belt 24 hours a day for the seven days following the session at your school. This will tell us how much time you spend sitting down, moving around, and sleeping. If you choose to wear the accelerometer you will be asked to complete a little diary about the times you took the device off, and what time you went to bed each night on the days that you wear it. One of our research team will return to your school the week after this visit to collect the accelerometer. You can still take part in the rest of the study even if you don't do this bit.

After the completion of the study you will receive a \$5 supermarket voucher for each component of the study that you complete. That is \$5 for completing the online questionnaire, \$5 for completing the face to face interview about what you ate in the last 24 hours and what activity you did, \$5 for completing the second interview about what you ate and what activity you did; \$5 for providing a blood sample; \$5 for providing a urine sample or \$5 for wearing the accelerometer for a week. Adding to a possible total of \$30 in supermarket vouchers.

Is there any risk of discomfort or harm from participation?

If you choose to provide a blood sample, you should know that there is a risk of a little pain or discomfort, and possibly a small bruise from the blood test. Any bruising should only last a few days and an experienced nurse or phlebotomist (someone with training to take blood samples) will collect the blood to minimise any discomfort to you.

What specimens, data or information will be collected, and how will they be used?

The answers you provide to the questionnaires and the food and activity questionnaire will be entered into a database with every other participants' answers. All your answers will be kept confidential and stored using an ID number, not your name. This information will provide valuable and unique information about the food intakes and activity levels of male high school students in New Zealand. Information about why people eat the way they do will also be very helpful as some eating patterns provide health benefits. Ultimately, the results of this study will support the development of up-to-date government and health agency guidelines for young men in New Zealand.

If you provide a blood sample it will be taken to a local laboratory where it will be analysed for cholesterol and HbA1c concentrations.

If you provide a urine sample it will be transported to the Department of Human Nutrition at the University of Otago where it will be stored in a freezer until it is analysed for iodine concentrations.

Once all of the analysis on your blood and urine samples has been completed they will be disposed of using standard biohazard protocols. **We will only test your samples for the things listed here, and won't test them for anything else.**

What about anonymity and confidentiality?

Once your information has been collected and entered into our database your information will be identified with an ID number only. This database will be stored on the researchers' computers which are password protected. A backup copy may also be stored on the University's shared server space, but only Jill Haszard and Meredith Peddie will have the password so no one else can access the information .

The information linking you to your ID number will be stored in a separate password protected file that only Jill Haszard and Meredith Peddie will have access to. The only reason they would access this information once you have completed the study would be if you requested your individual results. This file will be destroyed once all participants have been given the opportunity to request individual information. The de-identified information collected as part of this research will be kept in secure storage for at least 10 years.

If you agree to participate, can you withdraw later?

You may pull out of the project before the study has been completed (anticipated to be October 2020) without any disadvantage to yourself of any kind. Once data collection is completed and your information is integrated into the study it will no longer be possible to withdraw your information from the study.

Any questions?

If you have any questions now or in the future, please feel free to contact either:

Name: Dr Jill Haszard Position: Senior Research Fellow Department of Human Nutrition	Contact phone number: 03 479 5683
Name: Dr Meredith Peddie Position: Research Fellow Department of Human Nutrition	Contact phone number: 03 479 8157

This study has been approved by the University of Otago Human Ethics Committee (Health). If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (phone +64 3 479 8256 or email

9.6 Appendix F: Screenshots of Study Website

The screenshot shows the home page of the SuNDiAL website. The browser address bar displays "otago.ac.nz/sundial/index.html". The page features a blue header with the University of Otago logo and "Coronavirus COVID-19 information". A yellow search bar is located in the top right. A blue sidebar on the left contains the SuNDiAL logo and navigation links: "About the survey", "For schools", "For participants", and "Contact us". The main content area has a dark blue background with a globe image and the text: "The SuNDiAL Project is a survey about the foods New Zealanders, particularly teenagers, are eating". Below this, there is a paragraph explaining the survey's purpose and a section titled "What is the survey about?" which describes the nationwide survey conducted by researchers from the Department of Human Nutrition at the University of Otago. Further down, there is a section titled "What does the survey involve?" which details the requirements for high school students, including completing questionnaires and providing biological samples. At the bottom of the page, there are four yellow buttons: "More about the survey", "Information for schools", "Information for female participants", and "Information for male participants".

The screenshot shows the enrolment page of the SuNDiAL website. The browser address bar displays "otago.ac.nz/sundial/enrol.html". The page features a blue header with the University of Otago logo and "Coronavirus COVID-19 information". A yellow search bar is located in the top right. A blue sidebar on the left contains the SuNDiAL logo and navigation links: "About the survey", "For schools", "For participants", and "Contact us". The main content area has a dark blue background with a globe image and the text: "Enrol in the SuNDiAL study". Below this, there is a section titled "SunDial participant request" which contains a form with the following fields: "Your full name" (must complete), "Your school" (must complete), "Your email address" (must complete), "Your age" (must complete), and "If you are under 15, please provide a parent or caregiver's email who is able to give consent". At the bottom of the form, there is a checkbox for "I'm not a robot" and a reCAPTCHA logo. A green "Submit request" button is located at the bottom of the page.

9.7 Appendix G: Consent and Enrolment Questionnaire

Confidential

Page 1

Study Consent & Eligibility

Thank you for showing an interest in this project. Please read the information about the SuNDiAL project carefully. This can be found on our website www.otago.ac.nz/sundial. Take time to think about it and talk with family or friends before you decide whether to take part or not. If you decide to take part we thank you. If you decide not to take part that won't disadvantage you and we thank you for considering our request.

What is the aim of this research project?

The food and activity patterns of teenage boys probably influence their health and wellbeing. However, we don't know much about teenage boys' food intakes and physical activity patterns in New Zealand. Teenagers often make their own decisions about what foods to eat, but why they choose the foods they do is not well known. Last year we conducted a similar study in teenage girls. To get a more complete picture of what the teenagers of New Zealand eat and how they spend their time the SuNDiAL project is now going to investigate the food intakes and physical activity of adolescent males (aged 15-18 years), and why they choose to eat the way they do.

Who is funding this project?

This project is funded by the Department of Human Nutrition, University of Otago.

Who are we seeking to take part in the project?

We are looking for at least 150 male high school students who are between 15 to 18 years old. To be eligible to take part, your high school must have agreed to take part in the study, you must speak and understand English, and be able to complete the questionnaires.

If you take part, what will you be asked to do?

If you agree to take part in this study you will be asked to do three things:

1) Complete an online questionnaire

After you have completed the consent process you will be asked to complete an online questionnaire that asks questions about your health and some general questions such as what ethnicity you identify with. This online questionnaire also asks you about your overall eating habits, and why you choose to eat the foods that you do. It should take about 30 minutes to complete.

2) Attend a session at your school with our research team

This visit will take about 60 minutes during the school day and you will be asked to:

Complete a face to face interview with one of our research team where you will be asked to recall everything you ate and drank the day before. They will also ask you to recall how you spent your time during that day.

At this session one of our research team will also measure your blood pressure, height, weight and the length of your lower arm. Blood pressure will be measured three times, and the other measurements will be taken twice to make sure they are as accurate as possible. This will be done in a private space and you won't be told these measurements unless you ask for them.

20-04-2020 11:04am

projectredcap.org



3) Complete a second interview about the food you have eaten and your physical activity on another day

Sometime in the 2 weeks after you have finished the session at school you will be contacted by the research team and asked to complete a second interview where you will be asked to recall everything you ate and drank and how you spent your time on a different day of the week than the first interview. This is important because sometimes you can eat quite differently or do different activities from one day to the next. This interview will be performed over Facetime or Zoom, at a time that is convenient for you.

Any questions?

Contact Meredith or Tessa (ph 03 479 8157) or Jill (ph 03 479 5683) or email us on: sundial@otago.ac.nz

This study has been approved by the University of Otago Human Ethics Committee (Health) reference number H20/004. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (phone +64 3 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Electronic consent
Click on the "agree" button below if:

You have read the information about the study and understand the aims of the study

You have had all your questions answered about the study and understand that you can ask for more information at any stage

You are a young male who is 15 to 18 years old

You have chosen to take part, but you know you can pull out of the study anytime before it finishes in October 2020

You know that as a participant you will be asked to complete questionnaires about why you choose to eat the foods that you do, and have your blood pressure, height, weight and the length of your forearm measured, and complete interviews about the food that you eat and how you spend your time over two different 24 h periods

You know that the responses you provide to the questionnaires in this study will be recorded against an ID number, not your name. The information linking you to this ID number will be destroyed once all the data has been collected and you have been given the opportunity to request your individual information. The remaining data, which will not be able to be linked back to you in anyway, will be placed in secure storage and kept for at least ten years

You understand the results of the project may be published and be available from the University of Otago

You know that no commercial use will be made of this data

You know that for each component of the study you complete you will receive a \$5 voucher (up to a possible total of \$30)

Agreeing to this part of the study does not mean that you have agreed to give a blood sample, a urine sample or to wear an accelerometer (you will be asked about those bits separately)

If you don't want to take part in the SuNDiAL project, please click on the "DISAGREE" button.

- AGREE
- DISAGREE

Confidential

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Thank you for agreeing to taking part in the SuNDiAL project! If you are male and aged 15-18 years of age, please answer the following questions:

What age are you as of today?

- 15
- 16
- 17
- 18
- None of the above

What high school do you attend?

- Macleans College
- John Paul College
- Papamoa College
- Catholic Cathedral College
- South Otago High School
- St Patrick's College Silverstream
- Wesley College

Thank you! You are eligible to take part in the SuNDiAL project!

There are three other parts to the SuNDiAL project that are optional. Please read the following information carefully before you decide whether to take part in these optional bits of the study. For each one of these that you do, you will receive a \$5 gift voucher from New World or PaknSave.

If you agree to do these, but change your mind later, that's OK - there is no disadvantage to you if you decide not to do these.

Once all of the analysis has been completed the samples will be disposed of using standard biohazard protocols.

Electronic consent

Click on the "AGREE" button below if:

- You have read the information on the website
- You want to take part in these parts of the study

If you don't want to take part in these parts of the study, please click on the "DISAGREE" buttons.

BLOOD SAMPLE:

We would like you to provide a blood sample (which would be collected by someone with extensive training in how to take a blood sample), but we understand that not everyone feels comfortable about this so it is entirely up to you if you do this. You can still take part in the rest of the study even if you don't do this bit.

Click on the 'AGREE' button below if:

You agree to have a blood sample collected by a phlebotomist (someone with special training in how to take a blood sample) You understand the possible risk and discomfort involved in providing a blood sample You understand that your blood sample will be analysed locally for concentrations of cholesterol and HbA1c You know that the concentrations of things measured in your blood will be recorded against an ID number. The information linking you to this ID number will be destroyed once all the data has been collected and you have been given the opportunity to request your individual information. The remaining data, which will not be able to be linked back to you in any way, will be placed in secure storage and kept for at least ten years You will receive an additional \$5 voucher if you provide a blood sample. If you do not wish to provide a blood sample, please click the 'DISAGREE' button

- AGREE
 DISAGREE

URINE SAMPLE:

We would also like you to give a urine sample ("pee or wee") - which is easy for you collect yourself with the equipment we give you. You can still take part in the rest of the study even if you don't do this bit.

Click on the 'AGREE' button below if you are ok with providing a urine sample:

You agree to provide a urine sample You understand that your urine sample will be frozen and transported to the University of Otago where it will be stored until it is analysed for iodine concentrations You understand that your urine sample will only be analysed for iodine concentrations You know that the concentrations of iodine measured in your urine will be recorded against an ID number. The information linking you to this ID number will be destroyed once all the data has been collected and you have been given the opportunity to request your individual information. The remaining data, which will not be able to be linked back to you in any way, will be placed in secure storage and kept for at least ten years You will receive an additional \$5 voucher if you provide a urine sample. If you do not wish to provide a urine sample, please click the 'DISAGREE' button

- AGREE
 DISAGREE

ACCELEROMETER:

We would also like you to wear a small red box called an accelerometer on an elastic belt 24 hours a day for seven days. This will tell us how much time you spend sitting down, moving around, and sleeping. If you choose to wear the accelerometer you will be asked to complete a little diary about the times your took the device off, and what time you went to bed each night on the days that you wear it.

One of our research team will return to your school the week after this visit to collect the accelerometer. You can still take part in the rest of the study even if you don't do this bit.

Please click the 'AGREE' button below if:

You agree to wear an accelerometer for 24 hours a day for seven days You understand the during this time you will asked to record in a diary provided to you when you take the accelerometer on and off, and when you go to bed each night You know that amount of time you spend sleeping and moving will be recorded against an ID number. The information linking you to this ID number will be destroyed once all the data has been collected and you have been given the opportunity to request your individual information. The remaining data, which will not be able to be linked back to you in anyway, will be placed in secure storage and kept for at least ten years You will receive an additional \$5 voucher if you wear the accelerometer for seven days and return it to the research team when they visit your school If you do not wish to wear an accelerometer, please click the 'DISAGREE' button

- AGREE
- DISAGREE

Please let us know which type of gift card you would prefer:

- New World
- PaknSave

Please answer the following questions:

What is your first name?

What is your last name?

What is your date of birth?

Today's date for age calculation

Age

What is your phone number (mobile would be best - so we can text you reminders)?

What is your email address?

Thank you for enrolling in the SuNDiAL project!

What happens next?

We are now going to ask you to complete a health and demographic questionnaire. If you want to complete it at a later time, please click the "Save and Return" button at the bottom of this page (if you click this button you will be given a code which you will need to write down and which you will need to use to return to and continue this survey). Or, click the "Submit" button to continue.

You will also get an email and/or text to tell you when you can visit the SuNDiAL clinic at your school to complete the other measurements, a food recall and an activity recall.

9.8 Appendix H: Relevant Questionnaires

Confidential Page 1

Health & Demographics

Please answer the following questions:

We need a bit more information about you.

Please provide an address where we can send your voucher:

Street address: _____

Suburb: _____

City: _____

Post code: _____

Is this your home address? Yes
 No


If no, please put your home address: _____

Do you live at this address during school term? Yes
 No

Do you live in a boarding house during school term?
(Don't include private boarding) Yes
 No

Please put the name and/or address of the boarding house
_____ (number & street, suburb, city, postcode)

What is the address that you live at during school term?
_____ (number & street, suburb, city, postcode)

20-04-2020 11:05am projectredcap.org 

Please tell us about your ethnicity:

Which ethnic group do you belong to? (Mark those that apply)

- New Zealand European
- Māori
- Samoan
- Cook Island Maori
- Tongan
- Niuean
- Chinese
- Indian
- Other such as Dutch, Japanese, Tokelauan, please state..

Other: please state

Bowel Habits Questionnaire

Confidential








Page 4

How many times per week do you usually have a bowel movement (poo)? _____

Please look at the picture below and select the number that corresponds to your usual and most common bowel movement (poo) type:

- Type 1
- Type 2
- Type 3
- Type 4
- Type 5
- Type 6
- Type 7

Bristol Stool Chart

Type 1		Separate hard lumps, like nuts (hard to pass)
Type 2		Sausage-shaped but lumpy
Type 3		Like a sausage but with cracks on its surface
Type 4		Like a sausage or snake, smooth and soft
Type 5		Soft blobs with clear-cut edges (passed easily)
Type 6		Fluffy pieces with ragged edges, a mushy stool
Type 7		Watery, no solid pieces. Entirely Liquid

Dietary Habits Questionnaire

Fruit

On average how many servings of fruit - fresh, frozen, canned or stewed - do you eat per day or per week?
Do not include fruit juice or dried fruit.

A serving is the same as a medium piece of fruit like an apple or two small pieces of fruit like two apricots, or half a cup of stewed or canned fruit.

- Never I don't eat fruit
- Less than 1 serving a week
- 1 serving a week
- 2-4 servings a week
- 5-6 servings a week
- 1 serving a day
- 2 servings a day
- 3 servings a day
- More than 3 servings a day

Vegetables

On average how many servings of vegetables - fresh, frozen or canned - do you eat per day or per week?
Do not include vegetable juices.

A serving is the same as one potato, half a cup of peas or a cup of salad.

- Never I don't eat vegetables
- Less than 1 serving a week
- 1 serving a week
- 2-4 servings a week
- 5-6 servings a week
- 1 serving a day
- 2 servings a day
- 3 servings a day
- More than 3 servings a day

Bread

On average how often do you eat bread?

Include slices of bread, rolls, bagels, wraps, and gluten-free bread.

- Never I don't eat bread
- Less than once a week
- Once a week
- 2-4 times a week
- 5-6 times a week
- Once a day
- Twice a day
- 3 times a day
- More than 3 times a day

What type of bread, rolls or toast do you eat most of the time?

- White
- Wholemeal (brown colour)
- Light grain - has some grains but soft to eat (eg honey grain)
- Heavy grain - has some grains and a bit chewier (eg Vogels)
- Other (please specify)

If Other, please specify:

Nuts

How often do you eat the following types of nuts? (Include nuts in cooked foods, bars, cereals etc but don't include peanut butter or other nut butters)

	More than 3 times a day	2-3 times a day	Once a day	5-6 times a week	2-4 times a week	Once a week	2-3 times a month	Monthly	Rarely	I do not eat these
Almonds	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Brazil	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cashew	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hazelnut	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Macadamia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Peanut	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pecan	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pine nut	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pistachio	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Walnut	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How often do you eat nut butters?

	More than 3 times a day	2-3 times a day	Once a day	5-6 times a week	2-4 times a week	Once a week	2-3 times a month	Monthly	Rarely	I do not eat these
Almond butter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cashew butter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hazelnut butter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Peanut butter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Walnut butter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Legumes

How often do you eat lentils, chickpeas, kidney beans or baked beans? (Don't include peas or peanuts)

- I do not eat legumes
- Rarely
- Monthly
- 2-3 times a month
- Once a week
- 2-4 times a week
- 5-6 times a week
- Once a day
- 2-3 times a day
- More than 3 times a day

Snacks

How often do you eat lollies, sweets, chocolate or confectionary?

- I do not eat these
- Rarely
- Monthly
- 2-3 times a month
- Once a week
- 2-4 times a week
- 5-6 times a week
- Once a day
- 2-3 times a day
- More than 3 times a day

How often do you eat biscuits, cakes, slices, muffins, sweet pastries or muesli bars?

Include nut and other sweet snack bars.

- I do not eat these
- Rarely
- Monthly
- 2-3 times a month
- Once a week
- 2-4 times a week
- 5-6 times a week
- Once a day
- 2-3 times a day
- More than 3 times a day

How often do you eat savoury snacks such as chips (crisps not hot chips) and crackers?

- I do not eat these
- Rarely
- Monthly
- 2-3 times a month
- Once a week
- 2-4 times a week
- 5-6 times a week
- Once a day
- 2-3 times a day
- More than 3 times a day

Supplement Use

Did you take any supplements during the last year? Yes
 No

What type of supplement was it? (Select as many as apply)

- Multivitamin and/or multimineral
- Single vitamin or mineral
- Sports supplement (including protein powders or shakes)
- Other (please specify)

Multivitamin and/or multimineral:
How often did you take the supplement in the last 12 months? Daily
 More than once a week
 Once per week
 Monthly
 Regularly but for a limited time
 Not very often

Multivitamin and/or multimineral:

If you know the brand name and/or the product name please write them here. Please provide as much information about the product as possible. _____

Multivitamin and/or multimineral:

If you are able to take a photo of your supplement packaging, please do so and upload here (you can complete the questionnaire and come back to upload a photo at a later time).

When taking a photo (or two), please make visible the brand and the list of contents.

Single vitamin or mineral: Please tell us what vitamin or mineral it was: _____

Single vitamin or mineral:
How often did you take the supplement in the last 12 months? Daily
 More than once a week
 Once per week
 Monthly
 Regularly but for a limited time
 Not very often

Single vitamin or mineral:

If you know the brand name and/or the product name please write them here. Please provide as much information about the product as possible. _____

Single vitamin or mineral:

If you are able to take a photo of your supplement packaging, please do so and upload here (you can complete the questionnaire and come back to upload a photo at a later time).

When taking a photo (or two), please make visible the brand and the list of contents.

Sports supplement (including protein powders or shakes):
How often did you take the supplement in the last 12 months?

- Daily
- More than once a week
- Once per week
- Monthly
- Regularly but for a limited time
- Not very often

Sports supplement:

If you know the brand name and/or the product name please write them here. Please provide as much information about the product as possible.

Sports supplement:

If you are able to take a photo of your supplement packaging, please do so and upload here (you can complete the questionnaire and come back to upload a photo at a later time).

When taking a photo (or two), please make visible the brand and the list of contents.

If Other, please specify:

Other:
How often did you take the supplement in the last 12 months?

- Daily
- More than once a week
- Once per week
- Monthly
- Regularly but for a limited time
- Not very often

Other:

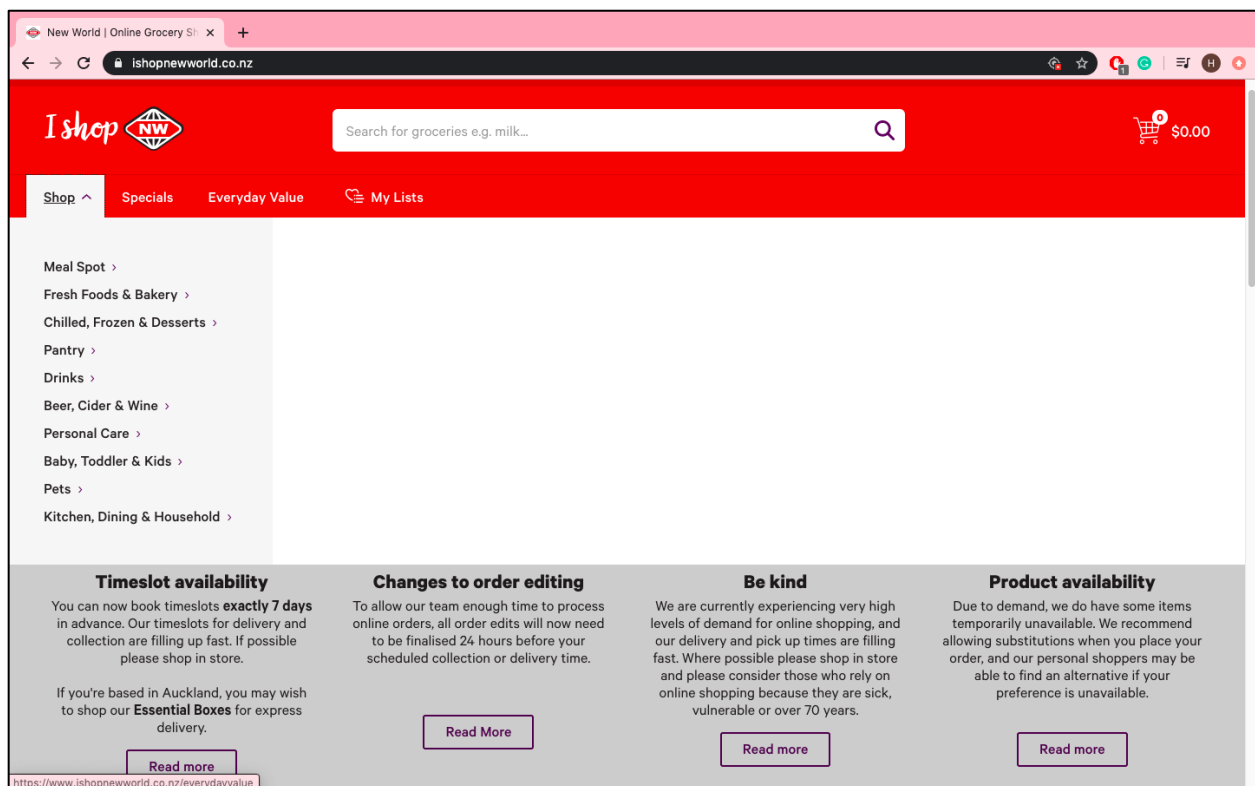
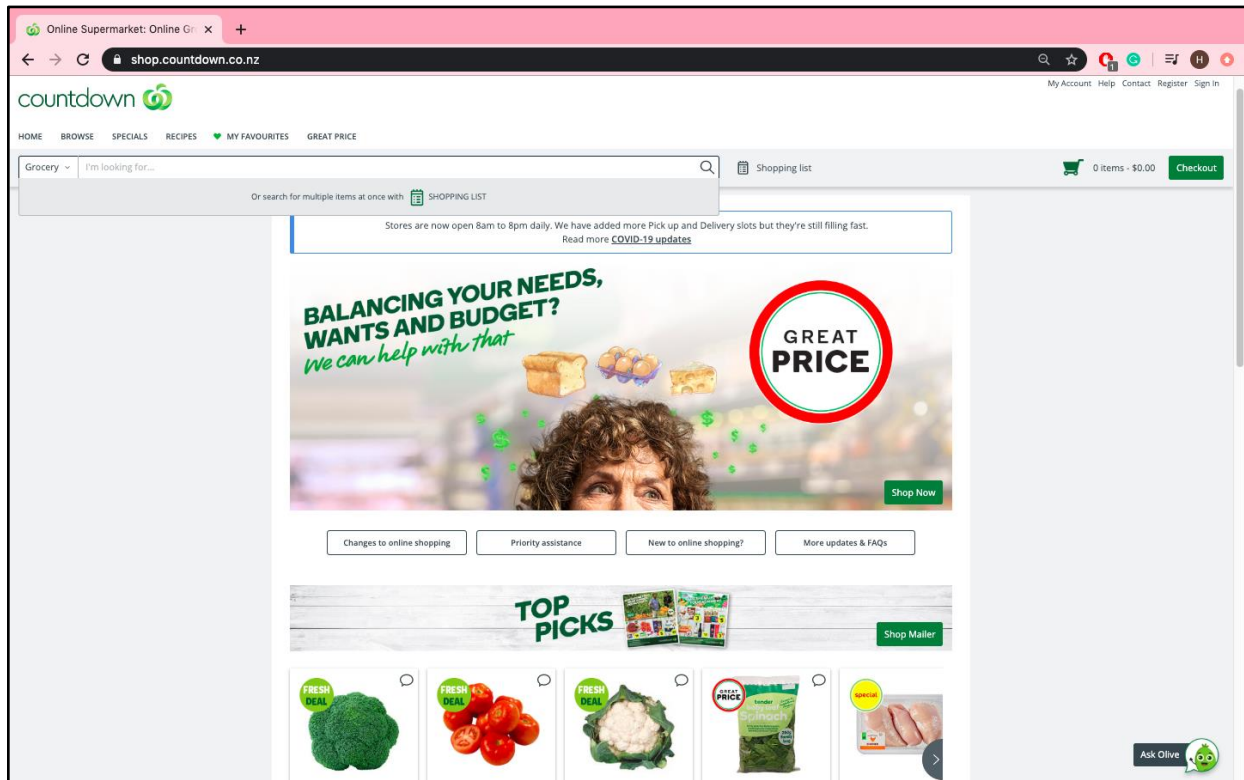
If you know the brand name and/or the product name please write them here. Please provide as much information about the product as possible.

Other:

If you are able to take a photo of your supplement packaging, please do so and upload here (you can complete the questionnaire and come back to upload a photo at a later time).

When taking a photo (or two), please make visible the brand and the list of contents.

9.9 Appendix I: Screenshots of Grocery Websites Used



9.10 Appendix J: Show Cards for 24-hour Dietary Recall

Sundial project

Show Cards for 24-hour recall

FRUIT

Fresh/ cooked	Preparatio n	Colour	In juice/syrup	Amount of juice/syrup
Fresh	Peeled	Red	Juice	None
Canned	unpeeled	Green	Syrup	¼ of the serve
Cooked		Yellow	Water	½ of the serve
		Orange	Sugar	

Salt

Default amount

Pinch =

VEGETABLES

Fresh/ cooked	Colour	Cooking method	Preparatio n	In sauce/ syrup/juic e	Amount of sauce juice/ syrup
Fresh	Red	Boiled	Peeled	Sauce	None
Canne d	Green	Baked	Unpeeled	Juice	¼ of the serve
Cooked	Yellow	Stir fried		Syrup	½ of the serve
Frozen	Orang e	Roasted		Brine	
Dried		Deep fried		water	
		Microwave d			
		Steamed			

Was this food cooked in fat or oil **Yes** **No**

Type of fat/oil	Margarine	Fat	Oil	Other oil
Butter	Olive oil	Beef fat	Canola	Sesame
Butter semi- soft	Canola oil	Lard	Olive	Grape seed
Light dairy Spread	Sunflower	Chefade	Rice bran	Nut oil, e.g. walnut
	Vegetable oil	Kremelta	Sunflower	
	Reduced fat or light	Cooking margarine	Peanut	
	Catering		Coconut	

POTATOES

Fresh/ cooked	Cooking method	Preparation	Additions
Cooked	Boiled	Peeled	Milk
Canne d	Baked	Unpeeled	Butter
Frozen	Stir fried	Mashed	Margarine
	Deep fried	Wedges	Cream
	Roasted	Shoe string fries	Salt
	Microwaved	Thick fries	Tomato sauce
	Steamed	Hash browns	Aioli

Was this food cooked in fat or oil **Yes** **No**

Type of fat/oil	Margarine	Fat	Oil	Other oil
Butter	Olive oil	Beef fat	Canola	Sesame
Butter semi- soft	Canola oil	Lard	Olive	Grape seed
Light dairy Spread	Sunflower	Chefade	Rice bran	Nut oil, e.g. walnut
	Vegetable oil	Kremelta	Sunflower	
	Reduced fat or light	Cooking margarine	Peanut	
	Catering		Coconut	

Meat, Poultry

Type of meat	Cut of meat	Cooking method	Fat on meat	Crumbed
Beef	Steak	Stewed	Not removed	No crumbs
Lamb	Chop	Casseroled	Removed before cooking	Crumbs added
Pork	Schnitzel	Baked	Removed after cooking	
Venison	Breast	Roasted		
Chicken		Deep fried		
Turkey	Thigh	Stir fried		
	Wing	Barbecued		
	Mince	Steamed		
	Stir-fry	Microwaved		
		Boiled		

Was this food cooked in fat or oil **Yes** **No**

Type of fat/oil	Margarine	Fat	Oil	Other oil
Butter	Olive oil	Beef fat	Canola	Sesame
Butter semi-soft	Canola oil	Lard	Olive	Grape seed
Light dairy Spread	Sunflower	Chefate	Rice bran	Nut oil, e.g. walnut
	Vegetable oil	Kremelta	Sunflower	
	Reduced fat or light	Cooking margarine	Peanut	
	Catering		Coconut	

Processed meat

Product	Type of meat	Cooking method	Fat on meat	Crumbed
Sausage	Beef	Stewed	Not removed	No crumbs
Bacon	Lamb	Casseroled	Removed before cooking	Crumbs added
Ham	Pork	Baked	Removed after cooking	
Patty/burger	Venison	Roasted	Sausage pricked before cooking	
Salami	Chicken	Deep fried		
Bier stick	Turkey	Stir fried		
Nugget	Fish	Barbecued		
Chorizo		Steamed		
Crab stick (surimi)		Microwaved		
		Boiled		

Was this food cooked in fat or oil **Yes** **No**

Type of fat/oil	Margarine	Fat	Oil	Other oil
Butter	Olive oil	Beef fat	Canola	Sesame
Butter semi-soft	Canola oil	Lard	Olive	Grape seed
Light dairy Spread	Sunflower	Chefade	Rice bran	Nut oil, e.g. walnut
	Vegetable oil	Kremelta	Sunflower	
	Reduced fat or light	Cooking margarine	Peanut	
	Catering		Coconut	

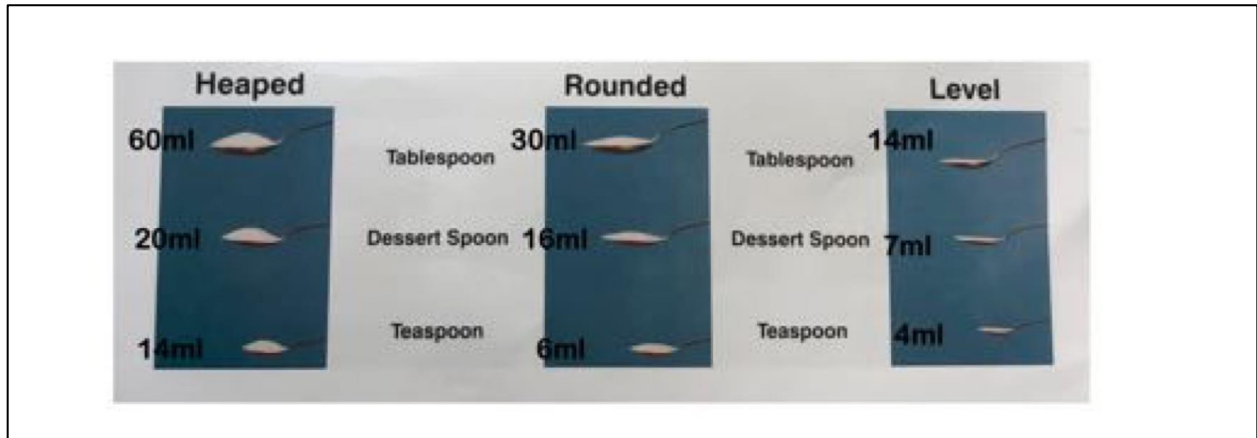
Fish

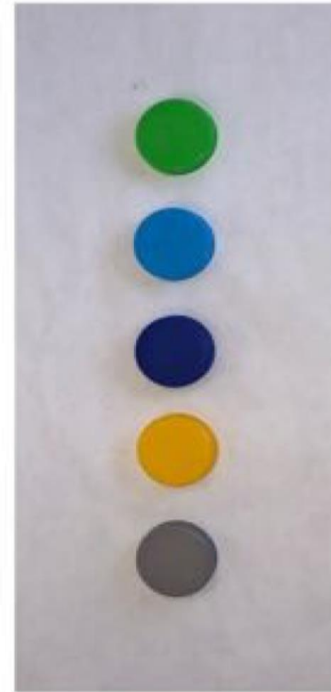
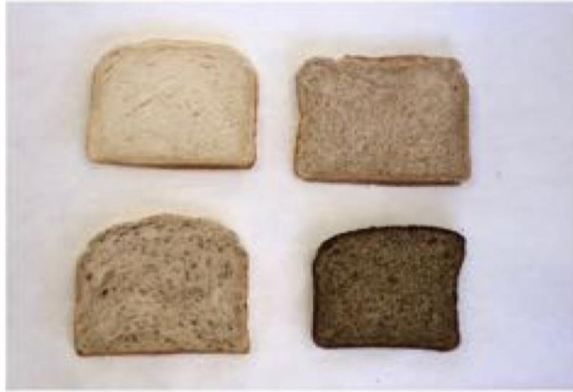
Type of fish		Cooking method	Crumbed
White Fish	Sole	Stewed	No crumbs
	Blue Cod	Casseroled	Crumbs added
	Red Cod	Baked	Battered
	Gurnard	Roasted	
	Hoki	Deep fried	
	Monkfish	Stir fried	
	Tarakihi	Barbecued	
	Snapper	Steamed	
Fatty fish	Salmon	Microwaved	
	Tuna	Boiled	
Shellfish	Mussel	Canned	
	Oyster		
	Paua		
	Scallop		
	Pipi		
	Cockles		
	Squid		

Was this food cooked in fat or oil **Yes** **No**

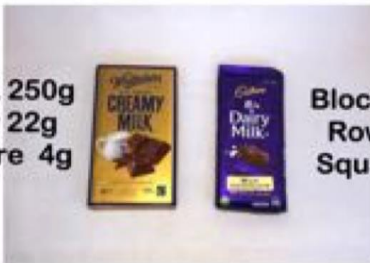
Type of fat/oil	Margarine	Fat	Oil	Other oil
Butter	Olive oil	Beef fat	Canola	Sesame
Butter semi-soft	Canola oil	Lard	Olive	Grape seed
Light dairy Spread	Sunflower	Chefade	Rice bran	Nut oil, e.g. walnut
	Vegetable oil	Kremelta	Sunflower	
	Reduced fat or light	Cooking margarine	Peanut	
	Catering		Coconut	

9.11 Appendix K: Graduated Food Portion-size Photographs





Block 250g
Row 22g
Square 4g



Block 200g
Row 25g
Square 5g



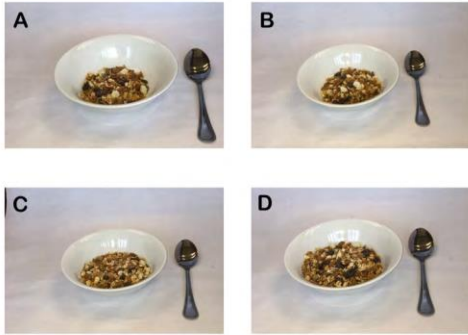
Block 100g
Row 20g
Square 10g



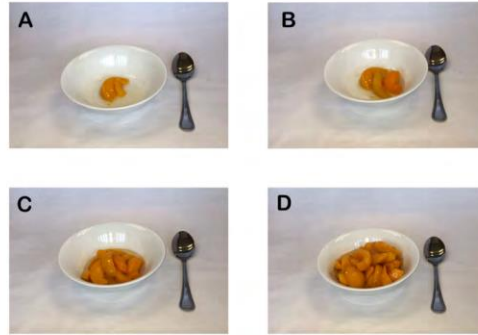
Block 200g
Row 25g
Square 5g



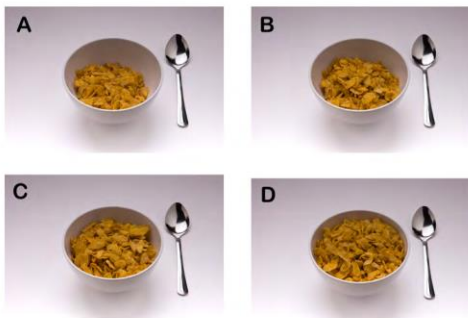
Muesli



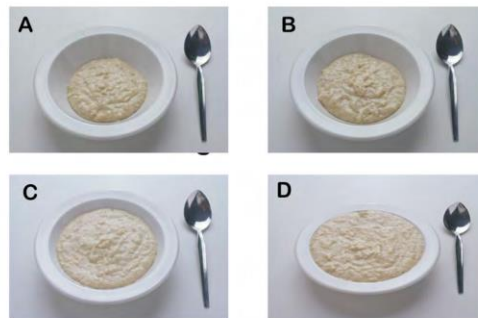
Peaches



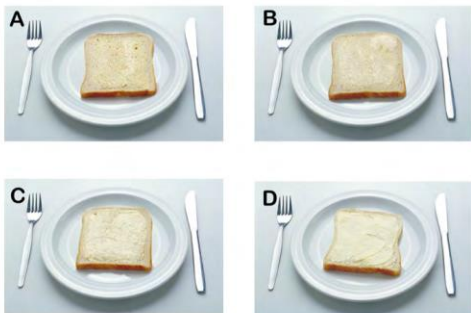
Cornflakes



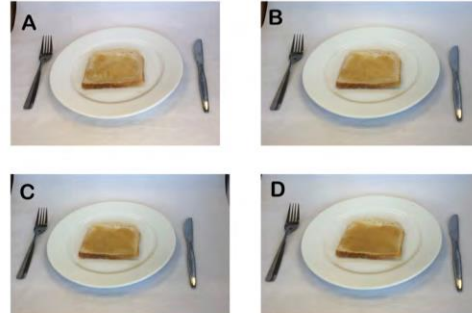
Porridge



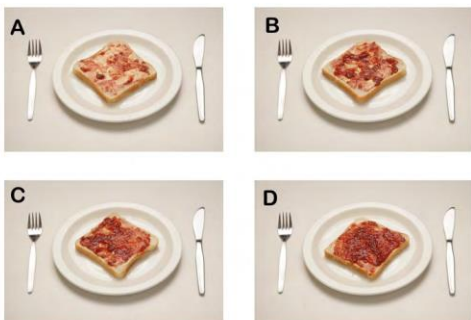
Margarine/butter



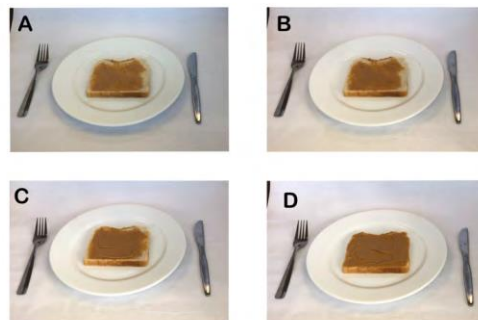
Honey



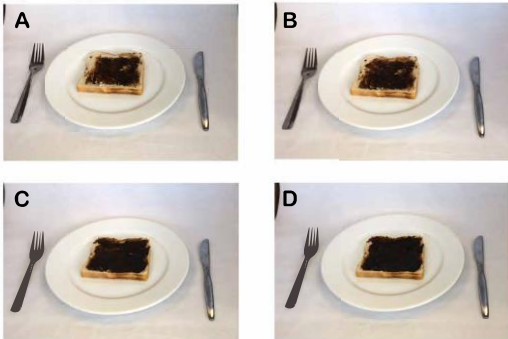
Jam



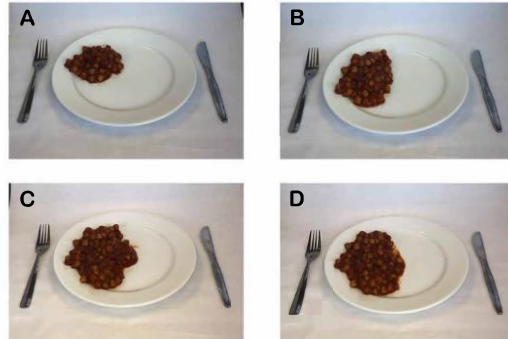
Peanut butter



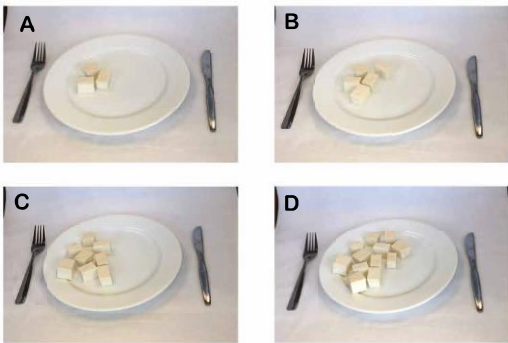
Marmite



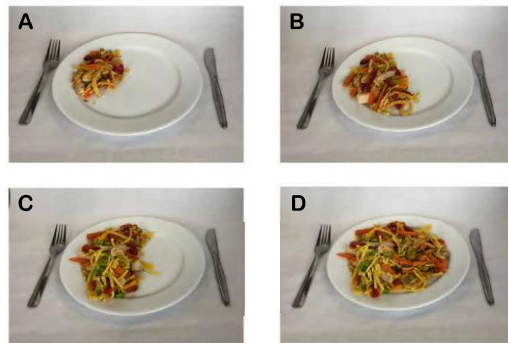
Chickpea stew



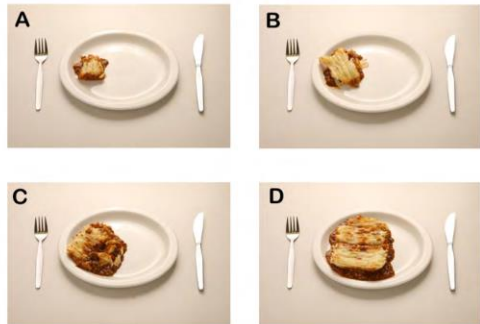
Tofu



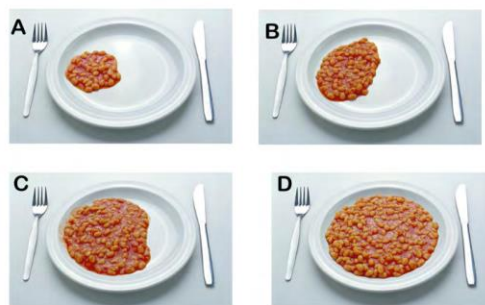
Stir Fry



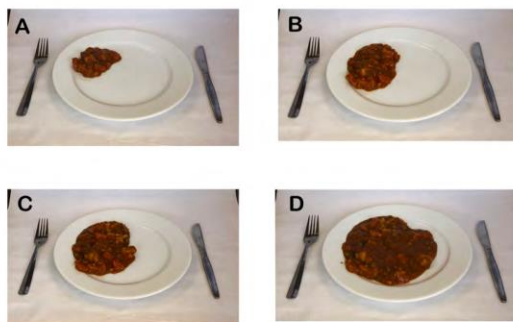
Shepards Pie



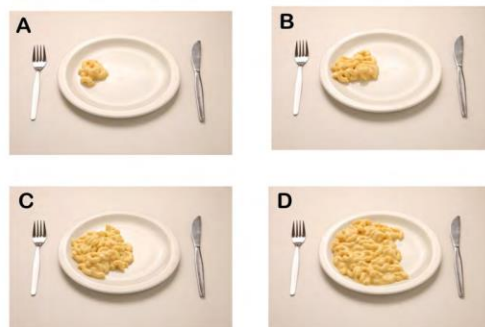
Baked Beans



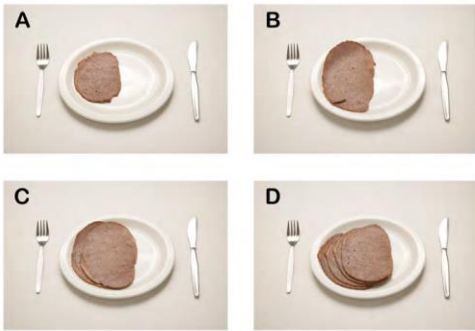
Stew



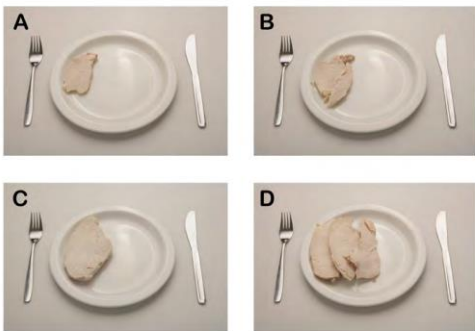
Mac & cheese



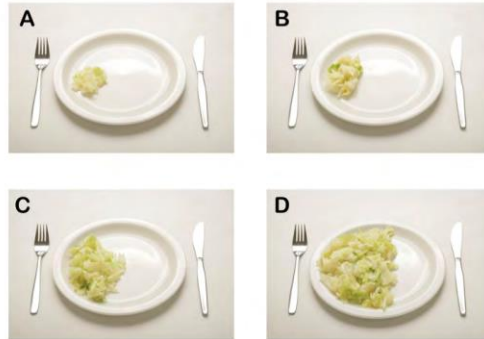
Sliced meat



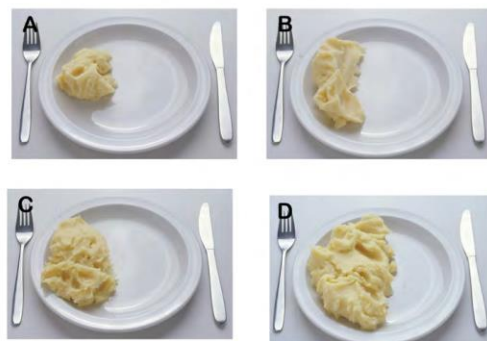
Sliced chicken



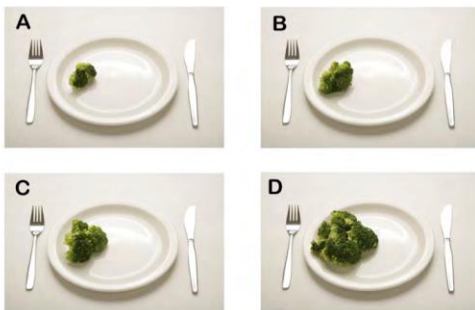
Cabbage



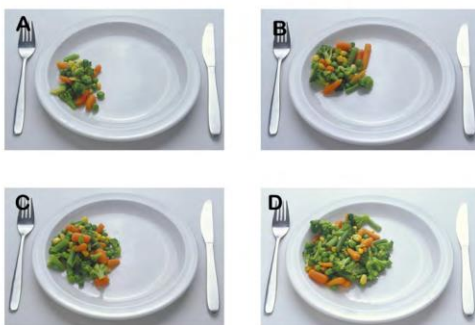
Mashed Potato



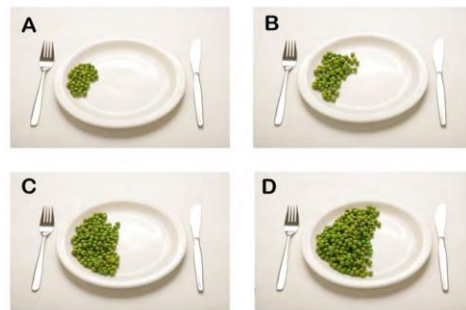
Broccoli



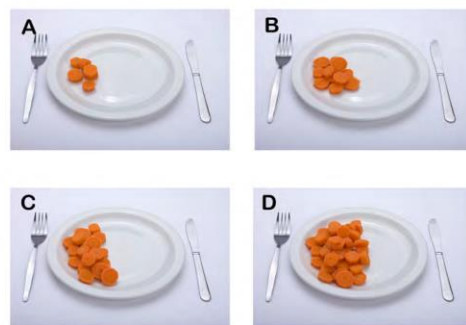
Mixed Vegetables



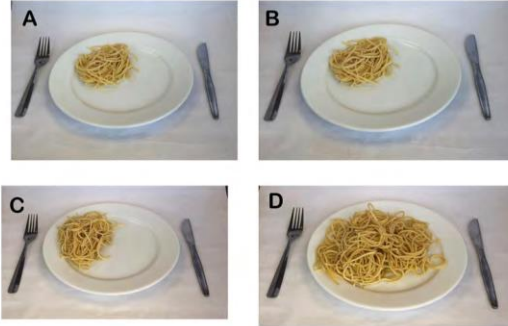
Peas



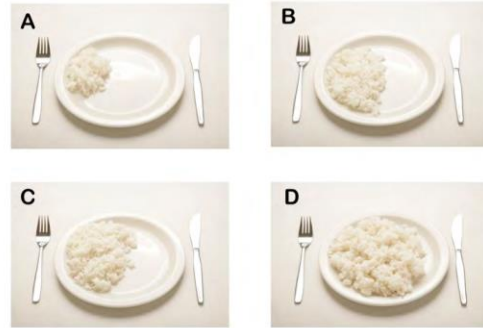
Carrots



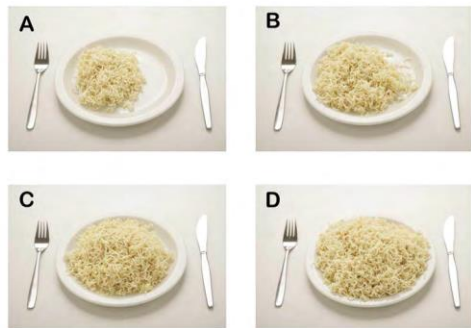
Spaghetti



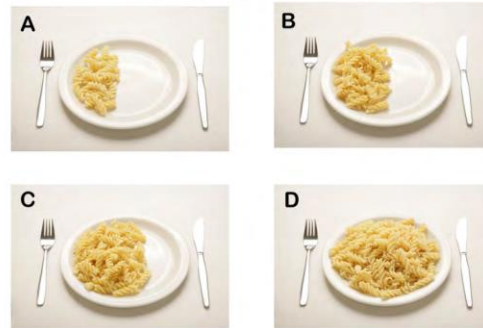
Rice



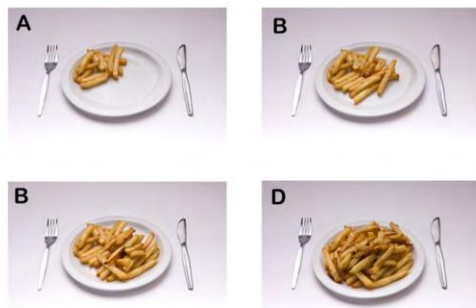
Noodles



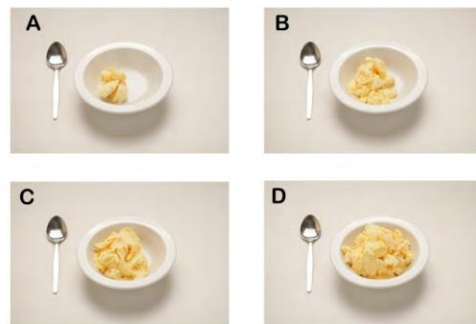
Spiral Pasta



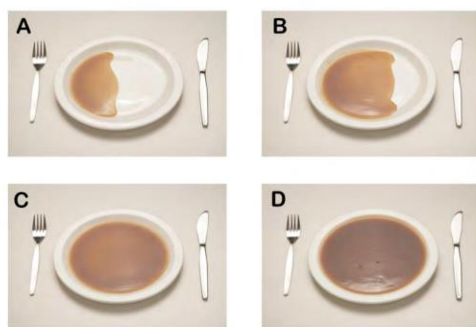
Chips



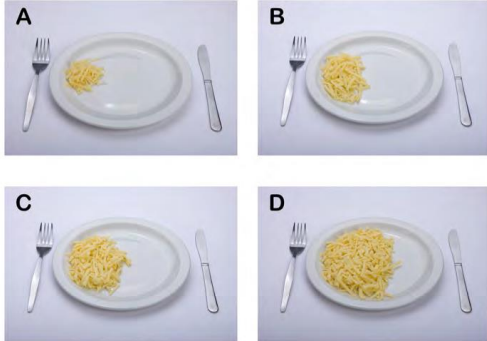
Ice cream



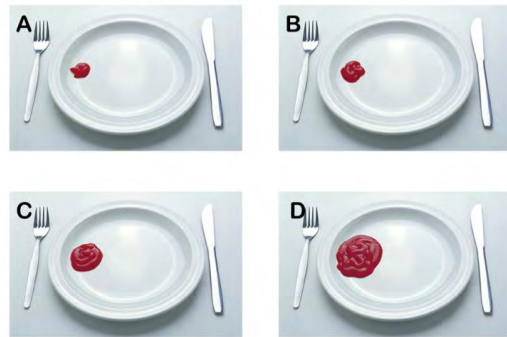
Gravy



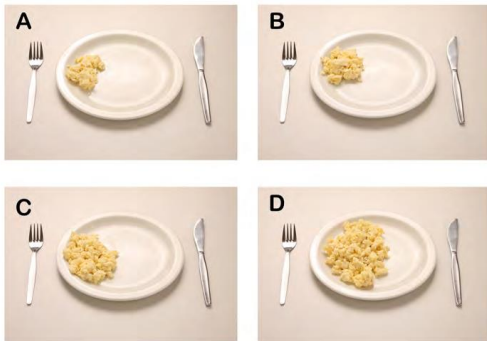
Grated cheese



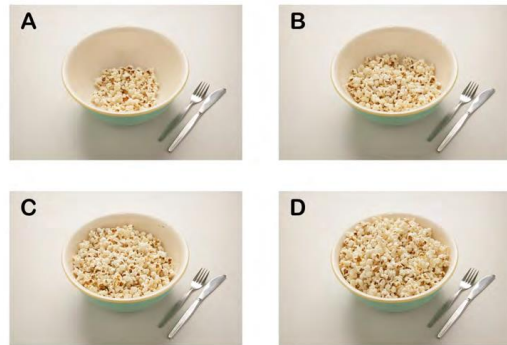
Tomato sauce



Scrambled egg



Popcorn



Breakfast bowls

Muesli

A: 25g
B: 50g
C: 75g
D: 100g

Peaches

A: 23g
B: 56g
C: 138g
D: 340g

Cornflakes

A: 32g
B: 41g
C: 55g
D: 72g

Porridge

A: 111g
B: 50g
C: 278g
D: 418g

Spreads

Margarine/butter

A: 4g
B: 5g
C: 9g
D: 12g

Honey

A: 10g
B: 18g
C: 25g
D: 35g

Jam

A: 10g
B: 18g
C: 25g
D: 35g

Peanut butter

A: 9g
B: 12g
C: 16g
D: 20g

Marmite

A: 4g
B: 5g
C: 9g
D: 12g

Mains

Chickpea stew

A: 130g
B: 200g
C: 250g
D: 300g

Tofu

A: 41g
B: 69g
C: 109g
D: 168g

Stir Fry

A: 100g
B: 182g
C: 320g
D: 480g

Shepard's Pie

A: 43g
B: 85g
C: 168g
D: 332g

Baked Beans

A: 40g
B: 81g
C: 166g
D: 337g

Stew

A: 100g
B: 170
C: 260g
D: 360g

Mac & cheese

A: 24g
B: 52g
C: 113g
D: 243g

Sliced meat

A: 30g
B: 51g
C: 87g
D: 150g

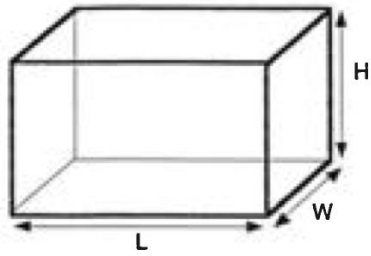
<i>Sliced chicken</i> A: 25g B: 50g C: 101g D: 204g	<i>Carrots</i> A: 20g B: 37g C: 67g D: 122g	<i>Rice</i> A: 54g B: 101g C: 191g D: 359g	<i>Icecream</i> A: 30g B: 54g C: 99g D: 180g
Vegetables	<i>Cabbage</i> A: 14g B: 30g C: 67g D: 150g	<i>Noodles</i> A: 92g B: 148g C: 246g D: 387g	<i>Grated cheese</i> A: 10g B: 21g C: 44g D: 91g
<i>Broccoli</i> A: 17g B: 33g C: 66g D: 137g	<i>Mashed Potato</i> A: 102g B: 151g C: 223g D: 330g	<i>Spiral Pasta</i> A: 55g B: 101g C: 188g D: 350g	<i>Tomato sauce</i> A: 4g B: 9g C: 20g D: 46g
<i>Peas</i> A: 16g B: 31g C: 59g D: 112g	Carbohydrates	<i>Chips:</i> A: 70g B: 118g C: 198g D: 334g	<i>Scrambled egg</i> A: 30g B: 51g C: 87g D: 148g
<i>Mixed Vegetables</i> A: 28g B: 44g C: 69g D: 109g	<i>Spaghetti</i> A: 60g B: 100g C: 145g D: 224g	Misc	<i>Popcorn</i> A: 14g B: 43g C: 94g D: 146g
		<i>Gravy</i> A: 20g B: 41g C: 85g D: 175g	

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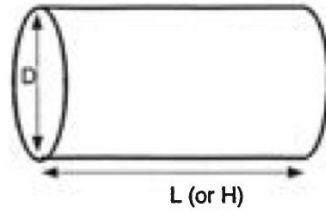
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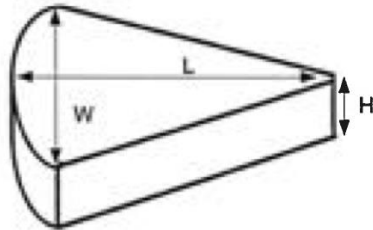
Baked beans	Grated cheese	Noodles	Shepard's pie
Broccoli	Gravy	Peas	Sliced chicken
Cabbage	Ice cream	Popcorn	Sliced meat
Carrots	Mac and cheese	Porridge	Spiral pasta
Chips	Mashed potato	Rice	Tomato sauce
Cornflakes	Mixed vegetables	Scrambled egg	



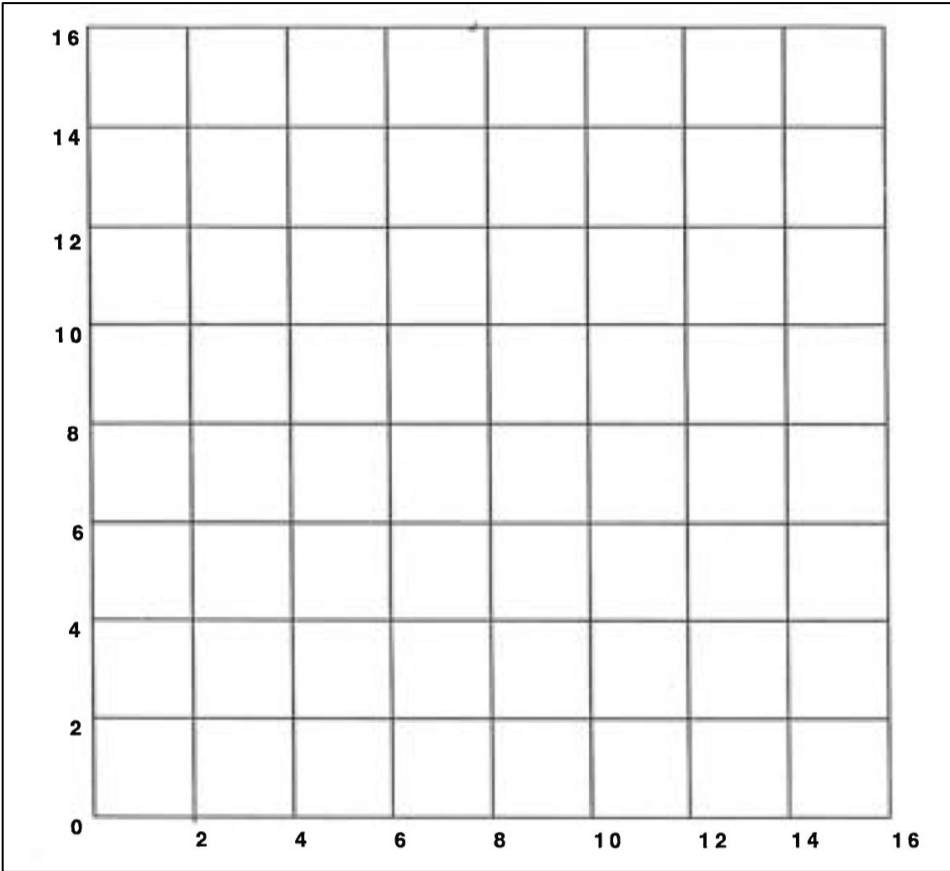
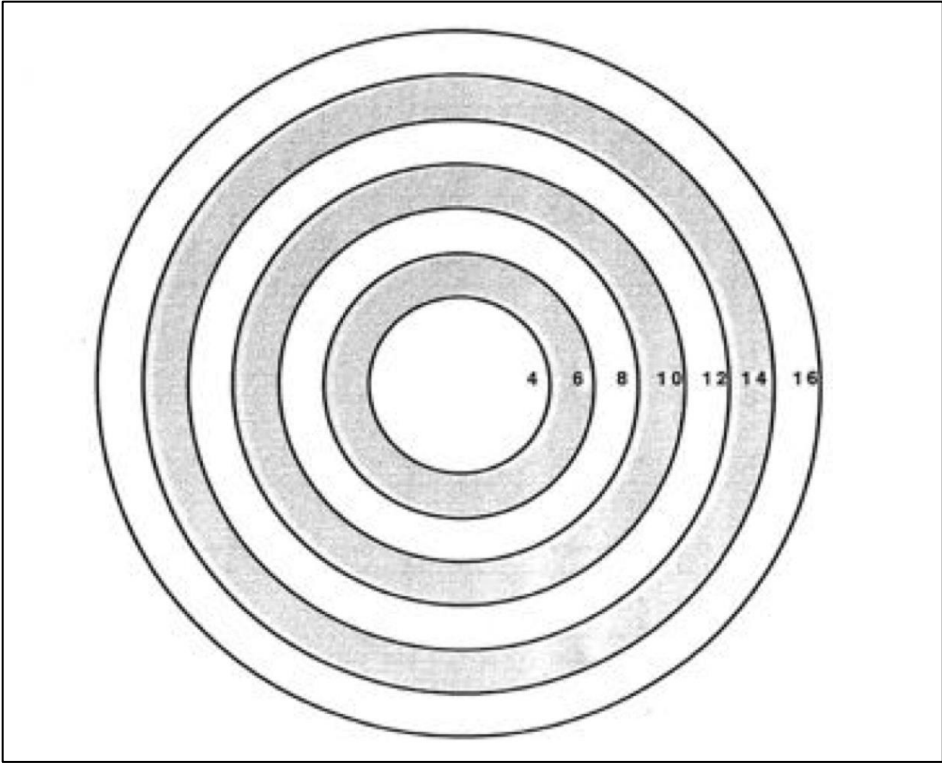
SQUARE OR RECTANGLE
(3 Dimensions required)
L=length
W=width
H=height



CYLINDER
(2 Dimensions required)
D=diameter
L=length



WEDGE
(3 Dimensions required)
L=length
W=width
H=height / thickness



9.12 Appendix L: 2008/09 New Zealand ANS Food Groups

Major food group number	Major food group description	Sub food group description
1	Grains and pasta	Rice; Flour; Pasta; Bran and Germs; Cereal based products & cereal based dishes: Pasta and sauce, and other cereal based dishes eg. Lasagne; Other grains and cereals.
2	Bread (incl rolls and specialty breads)	Regular bread and rolls: white, fibre white, wholemeal, mixed grain, rye and heavy types, corn bread, fruit bread, wheatmeal; Flat bread, Pita bread, tortillas (plain), pizza bases; Speciality breads (Bread (inc rolls & speciality breads): Garlic breads, Cheese/tomato/pizza topped breads, Flavoured breads; Bagels, English muffins and crumpets; Sweet yeast buns includes iced buns and buns with sweet fillings; cream, custard, jam etc (Bread (inc rolls & speciality breads)).
3	Breakfast cereals	Other breads; Wheat based biscuits and shredded wheat; Puffed or flaked cereal; Extruded cereals: Single and multigrain extruded cereals – sweetened and unsweetened; Porridge and cooked cereals; Bran based cereals: Single and multigrain bran based cereals with fruit/nuts; Toasted muesli; Untoasted muesli.
4	Biscuits	Sweet: Plain, Chocolate coated or chocolate chip, fruit filled, cream filled or with icing/dipping sauce, biscuits with fruit and/or nuts; Savoury: single or multi grain base - low fat (<=5% fat), single or multi grain base - medium and high fat (>5% fat).
5	Cakes and muffins	Plain: includes fruit (includes fruit cakes and sultana cakes) & plain cakes (eg Chocolate, banana), Sponge includes plain sponges and sponges with fillings; Slices; Cake type desserts/gateaux includes fancy rich cakes and gateaux; Sweet muffins; Savoury muffins; Low fat and bran muffins, scones, pancakes, pikelets, waffles; Doughnuts/dumplings: Doughnuts includes plain doughnut and doughnuts with cream and/or jam; Pastry: includes croissant, danish and other sweet pastries, plain pastries (eg Puff, choux, shortcrust) and chocolate eclairs; Cake bars.
6	Bread based dishes	Sandwiches, filled rolls, filled pita breads and croissants; Burgers and hot dogs; Pizza; Tortilla, tacos, doner kebabs, buritos, nachos; Dim sums, spring rolls, wontons, bread based batters; Stuffings (bread based); Other products: pancakes.
7	Puddings/desserts	Milk puddings: includes rice pudding, instant puddings, custards and trifle; Cheesecakes; Fruit crumbles; Mousse; Sponge (steamed); Sweet pies eg. fruit or custard pies; Pavlova & meringues.

8	Milk	Cows milk: whole fluid, homogenised fluid (blue), semi trim (light blue), trim (green), calcium enriched fluid; Goats milks; Milks for reconstitution: Evaporated/ Condensed undiluted, Milk powder- low fat or regular; Milkshakes; Flavoured milks; Soy milk; Other milk: rice milk, whey drink, whey protein concentrate, cows milk fluid made from whey powder.
9	Dairy products	Cream; Sour cream; Ice cream; Yoghurt; Fromage frais; Dairy based dips.
10	Cheese	High fat cheese (>30g fat/100g) blue cheeses, cheddar, cream cheese, colby, gouda, parmesan; Medium fat cheese (20-30g fat/100g) edam, processed cheese, cheese spread, camembert; Low fat cheese (<20g fat/100g) includes cottage cheese, quark, ricotta, mozzarella, feta.
11	Butter and Margarine	Butter/margarine blends; Polyunsaturated margarine (approximately 70%)- includes flavoured margarine; Monounsaturated margarine; Reduced fat spreads.
12	Fats and oils	High SAFA/MUFA: includes beef dripping, lard, chefade, palm oil, suet; Coconut oil (high SAFA); High MUFA/PUFA includes sesame oil, corn oil; High MUFA includes canola shortening, canola oil, peanut oil, olive oil; High PUFA includes sunflower oil, soybean oil, safflower oil, oil blends and other oils.
13	Eggs and egg dishes	Eggs; Egg dishes: Scrambled eggs and omelettes with cheese and other additions, Self-crusting quiches, Eggs with additions (scrambled eggs and omelettes with fat/milk), Egg stir-fries and egg foo yung.
14	Beef and veal	Muscle meat: includes steak, roast, schnitzel, corned beef, mince & other muscle meats; Casseroles/stews: with gravy sauce/tomato based sauce/cream based sauce and vegetables/ cereals/ pasta; Stir-fries: Stir-fries with beef, sauce & vegetables and rice/noodles
15	Lamb/Mutton	Muscle meats; Casseroles/ stews: with gravy sauce/tomato based sauce and vegetables/ cereals/ pasta; Stir-fries: with meat, sauce and rice/noodles;
16	Pork	Bacon, Ham, Pork muscle meat, Casseroles/stews with gravy sauce/ tomato based sauce and vegetables/ cereals/pasta; Stir-fries: with meat, sauce, vegetables and rice/noodles;
17	Poultry	Chicken muscle meat; Chicken processed meats; Casseroles/Stews: with gravy sauce/ tomato based sauce/ cream based sauce and vegetables/ cereals/ pasta; Stir-fries: with meat, sauce & vegetables and rice/noodles; Duck; Turkey; Other poultry.
18	Other meat	Venison; Rabbit/Hare; Offal meats; Goat; Ostrich; Kangaroo/crocodile.
19	Sausages and processed meats	Sausages; Luncheon; Frankfurters; Saveloys/Cheerios; Salamis; Meat-loaf; Meat patties.

20	Pies and pasties	Beef pies/ Chicken pies: includes pies with pastry, potato topped pies; Pasties; Savouries; Sausage rolls; Bacon and egg pie; Quiche; Other pies: includes seafood pies, mutton pies, vegetarian pies.
21	Fish/Seafood	Fried fish in batter; Canned fish; Fin fish; Shell fish and non-fin fish; Fish/seafood pie; Fish/seafood casserole stirfries and fritters; Fish/seafood products incl's fish fingers, fish cakes, fish paste and roe.
22	Vegetables	Leafy greens includes lettuce, spinach, silver beet, bok choy etc; Beans/ peas/ corn; Tomatoes and tomato products; Orange vegetables; Cauliflower/ Broccoli/Brussel sprout/ cabbage/turnip & other brassicas; Onion/garlic/leeks; Other vegetables includes parsnip, marrow/courgettes and eggplant etc; Vegetable mixes: Carrots/ peas/ beans/corn mixes, Stir fry mixes, Legumes, pulses and products: includes meat substitutes and dishes; Stuffed vegetables and vegetable dishes; Salad recipes (includes green salads, coleslaw, vegetable salads etc.).
23	Potatoes, kumara and taro	Potatoes: includes boiled and baked potatoes, Potato chips/wedges/croquette/hash browns, Potato crisps – regular/ reduced fat, Mashed potatoes with cheese added, Scalloped potatoes, Stuffed potatoes and other potato dishes, Potatoes with additions (eg. mashed with fat/milk added); Kumara; Taro.
24	Snack foods	Corn snacks including corn chips; Popcorn; Extruded snacks and other crisps (not potato or corn); Other including mixes; Other crisps eg. grain or kumara crisps.
25	Fruit	Pome fruit: Apple, Pear, Quince; Berry Fruit; Stone fruit; Citrus; Tropical fruits; Other fruits; Dried fruit: Dried vine fruit, Other dried fruit and mixes, Fruit leather/roll ups; Mixed fruits/fruit salad.
26	Nuts and Seeds	Nuts: Peanuts, Coconut, other nuts; Nut products: nut butters, coconut products including coconut cream, nut based dips; Seeds; Seed products: Tahini.
27	Sugar/sweets	Sugar; Syrup; Lollies; Chocolate and chocolate based confectionery; Sugar based toppings, sauces and icings; Ice blocks including milk or juice base; Jam/ marmalade/honey; Other eg jelly; Artificial sweeteners.
28	Soups and stocks	Soup (includes dry, condensed and homemade); Stocks.
29	Savoury sauces and condiments	Gravies and Savoury sauces (dry mixes and commercial sauces); Condiments, salt and other flavourings; Other additional sauces inc steak sauce, fruit (eg plum/apricot/apple), mustard and mustard sauces, hollandaise and bernaise sauces, soy/ worcestershire/oyster/chilli; Tomato sauce (Savoury sauces and condiments); Roux sauces includes white sauces, cheese sauces; Salad dressings; Pickles and chutneys; Yeast and vegetable extracts.

30	Non-alcoholic beverages	Tea; Coffee; Hot drinks includes Milo, hot chocolate, cocoa and cereal beverages etc; Fruit Juices includes apple, orange, grapefruit, grape etc; Vegetable juices; Cordials and fruit drinks; Soft drinks; Water; Sports drinks; Energy drinks; Powdered drinks.
31	Alcoholic beverages	Beer; Wine; Spirits; Liqueurs and cocktails.
32	Supplements providing energy	Meal replacements bars and drinks; Protein supplements; Carbohydrate supplement includes electrolyte replacement drinks; Fat supplement.
33	Snacks sweet	Fruit break/wholemeal fruit bars (fruit wrapped in cereal based casing); Muesli bars (rolled oat base); Soft and hard mixed grain bars (mixed cereal base); Puffed cereal bars (based on rice or corn); Other breakfast cereal based bars; Nuts and/or seed bars.