Dietary intakes and food sources of dietary fat among vegetarian and non-vegetarian female adolescents in New Zealand.

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Abstract

Background: Adolescents are often exploring how they want to identify within society and this may be represented in the decisions they make surrounding food choices. One pattern of eating called vegetarianism appears to be increasing in popularity, often influenced by environmental concerns, animal welfare, or religious practices. The lower intake of saturated fatty acids [SAFA], and higher intake of unsaturated fatty acids [FA] that typically accompany the avoidance of meat, contribute to the cardioprotective FA profile found among vegetarians that follow traditional vegetarian diets. However, in an environment where processed foods are more readily available, it is not known whether ‘new age’ vegetarians are adopting vegetarian diets of the same nutrient profile. Female adolescents adhering to a vegetarian diet are an important, yet under-studied and vulnerable subset of the New Zealand population. It is therefore important to examine whether the food sources and dietary fat intakes among this group are healthful.

Objective: To describe and compare the dietary intakes and food sources of total fat, SAFA, cis-monounsaturated fatty acids [MUFA] and cis-polyunsaturated fatty acid [PUFA] among vegetarian and non-vegetarian female adolescents in New Zealand.

Design: This was a multi-centred, nationwide, cross-sectional survey called the Survey of Nutrition, Dietary Assessment and Lifestyles [SuNDiAL]. Two-hundred and eighty-two female adolescents aged 15 to 18 years old, who attended secondary schools throughout New Zealand were recruited as participants. Participants completed self-administered questionnaires to assess demographics and vegetarian status. Dietary assessment was conducted using two 24-hour diet recalls which were adjusted for usual intake using the multiple source method [MSM]. Energy and fat intakes were calculated from dietary data
Results: The population comprised 87.6% non-vegetarians, and 12.4% vegetarians. The mean intake of total fat and MUFA was similar between diet groups and in the combined study population provided 36.9% [CI: 36.2, 37.6] and 13.7% [CI: 13.4, 14.1] of total energy intake [TEI] respectively. TEI from SAFA was 2.4% [CI: 1.4, 3.4] higher and TEI from PUFA was 1.7% [CI: -2.3, -1.1] lower in the non-vegetarian diet group compared to the vegetarian diet group. Sixty-six percent of the combined study population exceeded the acceptable macronutrient distribution range [AMDR] for total fat [20-35% TEI], while 90.4% exceeded the AMDR for SAFA [≤10% TEI]. A greater proportion of vegetarians were meeting these guidelines. The main food sources of total fat included: vegetables; nuts and seeds; and grains and pasta in the vegetarian group, compared to: poultry; potato, kumara and taro; and bread based dishes in non-vegetarian diet group.

Conclusion: Female adolescents in this study were consuming higher amounts of total fat and SAFA fat than is recommended. While total fat and MUFA intake among 15-18 year old females in New Zealand are similar between vegetarians and non-vegetarians, PUFA and SAFA intake differs and food sources of fat are variable. Favourable dietary fat profiles were found among the vegetarian participants, who consumed more energy from unsaturated FA, and less energy from SAFA. While these are promising findings that are in agreement with previous literature, larger studies are needed to confirm these results.
Preface

This Master of Dietetics [MDiet] thesis belongs to the multi-centred, cross sectional Survey of Nutrition, Dietary Assessment and Lifestyles [SuNDiAL] study, which has been performed across New Zealand. Dr. Jill Haszard and Dr. Meredith Peddie were the principal investigators [PIs] of this study. The study team comprised Tessa Scott [SuNDiAL coordinator], Chaya Ranasinghe [PhD candidate], Liz Fleming [Nutritionist] and Associate Professor Rachel Brown [Co-investigator].

Associate Professor Rachel Brown was also responsible for the supervision of the candidate throughout the conduction of this thesis.

The candidate, Bridget Murdoch, was responsible for:

- Completing a literature view on the topic of ‘dietary intakes and food sources of fat among female adolescents’.
- Recruitment of a high school in Whangarei, Northland.
- Creating and presenting a PowerPoint [Microsoft PowerPoint 2016] and recruitment video at Whangarei Girls High School.
- The recruitment of 49 participants at Whangarei Girls High School [WGHS].
- Completing data collection for each consented participant at WGHS. This included all, or a selection of the following:
  - Conducting one face to face, 24-hour diet recall.
  - Taking anthropometric measurements.
  - Administering accelerometers and accelerometer log-books.
  - Liaising with and supporting the phlebotomist during the collection of participants’ blood and urine samples.
Using the online data analysis programme FoodWorks 9 [Xyris Software, Australia Pty Ltd], to enter raw data from the 24-hour diet recalls.

Conducting statistical analyses on 251 participants, using Excel [Microsoft Excel 2016].

Writing of this thesis.
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Thank you to my supervisor, Associate Professor Rachel Brown. I am so grateful for your constant guidance and support over the past year. You have been a provider of calm and kindness during the challenging task of writing a thesis, and you always believed I could do this. You are a true role model in the world of research, and I am lucky to have learned from such an expert.

Thank you to my mum and dad. It is hard to express in words how grateful I am for your unwavering love and support during my thesis writing, [and life in general]. Thank you also to my brothers Lewis and William. I have felt very lucky to spend more time with you while I have been finishing my thesis writing from home. You all mean the world to me. To my fantastic friends and flatmates. My university life has been full of fun, laughter and excitement because of you. Thank you for your constant support and helping to maintain positive spirits. I am always so grateful to have such inspiring people so close to me.

To my research partner Abbie, thank you for welcoming me into your beautiful little corner of the world, Northland. It has been a true blessing to be around such a fun-loving and kind friend. And finally, to my lovely classmates. Thank you for a memorable two years. The challenge of this course was made easier because of the time we have shared together. It has been such a pleasure to experience this journey with you all. You are going incredible places and I am proud to call you future colleagues and lifelong friends.
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<th>Description</th>
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<tbody>
<tr>
<td>ALA</td>
<td>Alpha-linolenic acids</td>
</tr>
<tr>
<td>AMPM</td>
<td>Agriculture Automated Multiple Pass Method</td>
</tr>
<tr>
<td>AHA</td>
<td>American Heart Association</td>
</tr>
<tr>
<td>ANS</td>
<td>New Zealand Adult Nutrition Survey</td>
</tr>
<tr>
<td>AMDR</td>
<td>Acceptable macronutrient distribution range</td>
</tr>
<tr>
<td>BMI</td>
<td>Body Mass Index</td>
</tr>
<tr>
<td>CVD</td>
<td>Cardiovascular diseases</td>
</tr>
<tr>
<td>DHA</td>
<td>Docosapentaenoic acid</td>
</tr>
<tr>
<td>DPA</td>
<td>Docosahexaenoic acid</td>
</tr>
<tr>
<td>EPA</td>
<td>Eicosapentaenoic acid</td>
</tr>
<tr>
<td>FA</td>
<td>Fatty acids</td>
</tr>
<tr>
<td>FFQ</td>
<td>Food frequency questionnaire</td>
</tr>
<tr>
<td>HDL-C</td>
<td>High-density lipoprotein cholesterol</td>
</tr>
<tr>
<td>ICC</td>
<td>Intra-correlation coefficient</td>
</tr>
<tr>
<td>IHD</td>
<td>Ischemic heart disease</td>
</tr>
<tr>
<td>IRR</td>
<td>Inter-rater reliability</td>
</tr>
<tr>
<td>LDL-C</td>
<td>Low-density lipoprotein cholesterol</td>
</tr>
<tr>
<td>LOV</td>
<td>Lacto-ovo-vegetarian</td>
</tr>
<tr>
<td>MDiet</td>
<td>Master of Dietetics</td>
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<tr>
<td>MUFA</td>
<td>Cis-monounsaturated fatty acids</td>
</tr>
<tr>
<td>MSM</td>
<td>Multiple Source Method</td>
</tr>
<tr>
<td>NHANES</td>
<td>National Health and Nutrition Examination Survey</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>NZDep2013</td>
<td>New Zealand Deprivation Decile Index</td>
</tr>
<tr>
<td>NZEO</td>
<td>New Zealand European and Other</td>
</tr>
<tr>
<td>OM</td>
<td>Omnivore</td>
</tr>
<tr>
<td>PI</td>
<td>Primary investigator</td>
</tr>
<tr>
<td>PUFA</td>
<td>Cis-polyunsaturated fatty acids</td>
</tr>
<tr>
<td>RCT</td>
<td>Randomised control trials</td>
</tr>
<tr>
<td>REDCap</td>
<td>Research electronic data capture</td>
</tr>
<tr>
<td>SAFA</td>
<td>Saturated fatty acids</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>SV</td>
<td>Semi-vegetarian</td>
</tr>
<tr>
<td>SuNDiAL</td>
<td>Survey of Nutrition, Dietary Assessment and Lifestyles</td>
</tr>
<tr>
<td>TFA</td>
<td>Trans-fatty acids</td>
</tr>
<tr>
<td>TEI</td>
<td>Total energy intake</td>
</tr>
<tr>
<td>TTDM</td>
<td>Type two diabetes mellitus</td>
</tr>
<tr>
<td>VEG</td>
<td>Vegan</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
</tr>
<tr>
<td>95% CI</td>
<td>Ninety-five percent confidence interval</td>
</tr>
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</table>
1. Introduction

Adolescents are a unique subset of the population, experiencing hormonal, cognitive and emotional changes (1) during a critical and rapid period of growth and development (2, 3). Adolescence is a time of increased energy and nutrient requirements, to ensure that a healthy transition into adulthood is achieved (4). During adolescence, individuals are exploring how they want to identify within society (5), with increasing autonomy related to food choices (6). Although it is difficult to gain reliable data, it appears that vegetarianism is increasing in New Zealand and for reasons other than health (7). Adopting a vegetarian diet may be an expression of environmental concerns, animal welfare, religious practices, or food preferences (8, 9). The American Heart Association [AHA] endorses the adoption of vegetarian diets, provided they are appropriately planned, also indicating that vegetarian diets have the potential to improve diet choices from foods rich in saturated fatty acids [SAFA], to foods high in polyunsaturated fatty acids [PUFA] and monounsaturated fatty acids [MUFA] (10). The low saturated fat and high unsaturated fat content of traditional vegetarian diets may be one of the important health reasons that encourages the consumption of this dietary pattern (10). This in part, explains some of the favourable health benefits seen when comparing vegetarians to their non-vegetarian counterparts, particularly the lower incidences of cardiovascular diseases [CVD] (11-13). However, the healthier fat intakes observed with vegetarian diets are from the findings of studies that are somewhat dated. It is not known whether ‘new age’ vegetarians are adopting vegetarian diets of the same nutrient profile. In addition, most research has been conducted in adult as opposed to an adolescent population, yet it has
been recognised that the diets of adolescents tend to differ from that of adults, with adolescents often making poorer food choices (14) and selecting foods with low nutritional quality (15, 16). Therefore, we cannot presume that the same health outcomes from vegetarians in older age groups, can be translated to younger populations (17).

Female adolescents adhering to a vegetarian diet are an important, yet under-studied and vulnerable subset of the New Zealand population. Given that health may not be a factor motivating this group to follow a vegetarian diet, it is of interest to examine whether the food sources and dietary fat intakes among this group are healthful. The quality of dietary fat consumed during this period plays an important role in health and it has been recognised that adolescents who adopt healthful, high-quality diets, may have a reduced risk of developing CVD during adulthood (18). This indicates that within the critical age bracket of an adolescent, appropriately planned and nutritious diets may have the potential to influence future health outcomes. Improving our understanding of the dietary choices occurring among female adolescents is therefore, very important. With a notable lack of research conducted among female adolescents in New Zealand, the research findings from the SuNDiAL study will be highly valuable. These results will provide insight into the food and nutrient intakes of this population, and this information can be used to guide future research and public health initiatives.

The cardioprotective dietary FA profile of vegetarians is one of the hallmarks of traditional vegetarian diets (10). In an environment where processed food is more readily available, it is of interest to see if this profile persists today. Therefore, the aim of this thesis is to compare the current dietary intakes and food sources of dietary fat among vegetarian and non-vegetarian female adolescents in New Zealand.
2. Literature Review

2.1 Introduction

This literature review has been conducted to provide an overview of: the function of dietary fats; fat intakes in population surveys; vegetarianism and associated health benefits; and literature that compares female adolescent vegetarians and non-vegetarians.

2.2 Search Methods

Studies of relevance to this thesis topic were identified using the data bases Scopus, PubMed and Google Scholar. Literature searches were conducted between September 2018 and October 2019 using the key words, “female”, “adolescents”, “dietary fat”, “fat intakes”, “lipids”, “nutrient intakes”, “vegetarianism”, and “vegetarian”. Appropriate studies were also selected when analysing the reference list of other relevant articles. Any studies assessing participants at a minimum age of 19 years, were excluded from this literature review.

2.3 Overview of Dietary Fat

Dietary fats provide a concentrated source of energy (19), supplying 37.7 kilojoules [kJ] of energy per gram of fat consumed (20). Triacylglycerols account for approximately 95% of dietary fats (20) and they are made up of fatty acid [FA] molecules attached to a unit of glycerol (21). Fatty acids include SAFA, MUFA and PUFA (21). A subset of unsaturated FA are known as trans fatty acids [TFA] (20). Other types of dietary fats include phospholipids, phytosterols and cholesterol (20, 21).

2.3.1 Types of fat and common food sources

SAFA contain no double bond in their chemical structure (19). The most common forms of SAFA are lauric, myristic, palmitic and stearic acids (20, 22), however they are
not an essential component of our diet because our body can synthesise them (19). Dietary SAFA are found predominantly in animal foods, occurring naturally in dairy products and meats (19, 21). Non-animal based foods such as palm and coconut oils, pies, biscuits, cakes and pastries also contribute substantially towards the intake of dietary SAFA (19, 21). Coconut oil is a food source of SAFA which is increasing in popularity as a result of unsubstantiated claims of health benefits in the media (23). However, SAFA form 82% of the total fat that makes up coconut oil (23), making it a less healthy food choice (22, 24).

PUFA are categorised based on the location of the double bond in either an n-3 or n-6 isometric configuration (23). Linoleic (n-6) and alpha-linolenic acids [ALA] (n-3) are both essential because they cannot be synthesised in the body. Both of these FA can be elongated and desaturated into long chain fatty acids (19). The most common long chain FA are eicosapentaenoic acid [EPA], docosapentaenoic acid [DHA] and docosahexaenoic acid [DPA] (19). Oily fish such as mackerel, herrings, sardines, salmon and tuna (19), and dietary supplements are rich sources of these fatty acids, however they contribute towards a small percentage of total energy intake [TEI] in the diet (23). Typical food sources of ALA include: legumes; soybean and canola oils; and walnuts and linseed products, while food sources of linoleic acid include: eggs; poultry; wholegrains; and sunflower, safflower and corn oils (19, 25).

MUFA contain one double bond between carbon atoms and like SAFA, they can be synthesised within the body (19). MUFA are derived predominantly from plant-based foods, and the richest sources of oleic acid, which is the most common fatty acid from within the MUFA subgroup (19, 20), come from sunflower, olive, canola and peanut oils.
5

(19, 24). Animal meats also contain MUFA and PUFA and therefore contribute to the
daily intake of these fatty acids (26).

TFA can be produced through food processing, in which polyunsaturated
vegetable oils become partially hydrogenated to form a trans fatty acid (19, 24), also
known as an industrial-TFA (23). A food manufacturing company may choose to use
TFA due to the functional appeal of an extended shelf life and ability to withstand
repeated heating (23). Processed foods are a typical source of TFA, particularly items
such as packaged, baked and deep fried foods (27). The production of TFA rich
margarines has declined in recent years as manufacturers have switched to healthier
margarine alternatives (22, 28). TFA also occur naturally in common ruminant animal
products such as meat and milk (19), and are referred to as ruminant-TFA (23).

2.3.2 Dietary fats and relation to health

Dietary fats provide the body with a rich source of energy (19), and important
nutrients such as the fat soluble vitamins A, D, E and K (29). Some of the many
important functions of dietary fats include creating precursors for various essential
hormones, dictating the properties of cell membranes (30), and modulating different
forms of cholesterol in our body (20). The various effects of dietary fats upon blood
cholesterol have been summarised in Table 2.1. Low-density lipoprotein cholesterol
[LDL-C] and high-density lipoprotein cholesterol [HDL-C] impact the transport and
deposition of cholesterol on the walls of our arteries (20, 23). HDL-C helps to move
cholesterol from peripheral tissues, back to the liver where it is either stored or broken
down (20). For that reason it is associated with positive health outcomes. However, LDL-
C has opposing effects and moves cholesterol to the peripheral tissues of our body. This
can influence the diameter of the arterial wall and the area by which blood can flow, and is referred to as the damaging disease, atherosclerosis (23, 31). Both SAFA and TFA increase LDL-C and are associated with negative health outcomes (24). However TFA has an additional negative effect of lowering HDL-C (24, 28). In comparison, unsaturated FA reduce LDL-C (19, 24), with PUFA exhibiting a stronger cholesterol-lowering effect than MUFA (22, 32). These findings are important due to the influence of cholesterol upon CVD.

A recent presidential advisory conducted by the AHA in 2017, summarised the impact of dietary fats on CVD (23). Overall, the replacement of SAFA with healthier unsaturated alternatives reduces the risk of CVD. Randomised control trials [RCT] analysed in this study concluded that the replacement of animal sources of SAFA with vegetable oil sources of PUFA will lower an individual’s risk of CVD. While observational studies revealed that lower SAFA intakes combined with higher PUFA and MUFA intakes will also improve cholesterol profiles and reduce CVD and mortality rates. This evidence suggests that shifting the focus from the total fat intake of an individual towards their overall fat profile, is more important in terms of cardiovascular disease risk. Traditionally, vegetarian diets have contained low levels of SAFA and high levels of unsaturated FA (10). However, it is unknown whether modern vegetarian diets still comprise the same healthful distribution of dietary fats. Research on these modern diets is needed to address this question.
Table 2.1: Dietary fat classification and effect upon blood cholesterol. Adapted from (20, 27, 32)

<table>
<thead>
<tr>
<th>Classification of dietary fat</th>
<th>VLDL</th>
<th>LDL</th>
<th>HDL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TFA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUFA [Oleic]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PUFA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[n-6] linoleic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[n-3]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALA</td>
<td>Decrease [+]</td>
<td>Increase*</td>
<td>Decrease*</td>
</tr>
<tr>
<td>EPA</td>
<td>Decrease [+]</td>
<td>Increase*</td>
<td>Decrease*</td>
</tr>
<tr>
<td>DHA</td>
<td>Decrease [+]</td>
<td>Increase*</td>
<td>Decrease*</td>
</tr>
</tbody>
</table>

[+] appreciable increase or decrease in blood cholesterol.

*HDL may increase if the specific dietary fat provides more than 10% of total energy intake [TEI].

*LDL may increase if initial blood LDL level is elevated.

*HDL may decrease if the specific dietary fat is provided in large quantities.

Fat is energy dense and when consumed in excess to our energy requirements, becomes stored in adipose tissue (24). Although fat profile is important, fat consumed in excess continues to contribute to the global overweight and obesity epidemic that New Zealand and other countries are currently experiencing (24). In New Zealand the current prevalence of overweight and obesity among those aged 15-17 years is 24.4% and 17.4% respectively (33). Unfortunately, obesity is associated with a variety of major health issues, particularly CVD (34). Obesity and its associated co-morbidities put immense
pressure on the New Zealand health system and a study conducted in 2006 estimated that the related expenses cost the government approximately $624 million (35).

2.3.3 Recommended fat intake

A set of recommendations have been developed to guide New Zealand and Australian populations towards an appropriate intake of a range of macronutrients, vitamins and minerals (36). An acceptable macronutrient distribution range [AMDR] indicates the suggested percentage of energy that should be derived from macronutrients (37). The range for total dietary fat is 20.0-35.0%, with an AMDR specific to SAFA and TFA intake that should equate to no more than 10% of TEI (37). It is also advised by some groups that TFA intake should remain less than 1.0% of total energy due to the harmful health effects that can result with excess consumption (27). This is similar to the recommendations endorsed by the World Health Organisation [WHO], who suggest that dietary fats should contribute to no more than 30.0% of TEI (38). The recommendations for SAFA and TFA intake are identical to the New Zealand and Australian AMDRs (38), indicating that international guidelines regarding dietary fat intake, are relatively uniform. These recommendations contribute towards improving general health outcomes, whilst ensuring that an adequate intake of all other nutrients are achieved (37).

2.3.4 Fat intakes and food sources in population surveys

National nutrition surveys collect data on the food choices and fat intakes of a population, providing respective governments and health providers with valuable information that can influence public health initiatives and health policies. Table 2.2 summarises a selection of population surveys that report on dietary fat intakes among age groups of interest.
Table 2.2: Summaries of population surveys reporting on dietary fat intakes.

<table>
<thead>
<tr>
<th>Study name</th>
<th>Country, year, participants</th>
<th>Method of dietary assessment</th>
<th>Percentage of total energy from dietary, [and dietary fat intake [grams]]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total fat</td>
</tr>
<tr>
<td></td>
<td>US, 2011-2012, females aged 12-19 years [n=567] (43).</td>
<td></td>
<td>33.0 [67.7]</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Age Range, Sample Size</td>
<td>Methodology</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>--------------------------</td>
<td>------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>National Diet and Nutrition Survey (45)</td>
<td>US, 2009-2010,</td>
<td>females aged 12-19</td>
<td>4-day food diary.</td>
</tr>
<tr>
<td></td>
<td>females aged 11-18</td>
<td>years [n=593] [44].</td>
<td></td>
</tr>
<tr>
<td></td>
<td>United Kingdom,</td>
<td>4-day food diary.</td>
<td>33.7 [58.5] 12.4 [21.4] n/a n/a</td>
</tr>
<tr>
<td>National Teens’ Food Survey (46)</td>
<td>United Kingdom,</td>
<td>4-day food diary.</td>
<td>33.7 [58.5] 12.4 [21.4] n/a n/a</td>
</tr>
<tr>
<td></td>
<td>2014/15 – 2015/16,</td>
<td>females aged 11-18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>females aged 11-18</td>
<td>years [n=272].</td>
<td></td>
</tr>
<tr>
<td>National Teens’ Food Survey (46)</td>
<td>Ireland, 2005/06,</td>
<td>7-day semi-weighed food diary.</td>
<td>35.7 [68.6] n/a n/a n/a</td>
</tr>
<tr>
<td></td>
<td>females aged 15-17</td>
<td>years [n=124].</td>
<td></td>
</tr>
<tr>
<td>Australian Health Survey (47)</td>
<td>Australia, 2011/12,</td>
<td>24-hour diet recall.</td>
<td>32.4 [73.1] 12.9 [29.5] 12.2 [27.5] 4.7 [10.4]</td>
</tr>
<tr>
<td></td>
<td>15-19 year olds, [n=648].</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>year olds, [n=401].</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: SAFA, saturated fatty acid; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; FFQ, food frequency questionnaire.
Data summarised in Table 2.2 indicate that the percentage of energy derived from total fat was relatively uniform when making comparisons between different countries. These intakes ranged between 32-36% of TEI, which exceeded the WHO recommendations and partially exceeded the AMDR recommendations (39, 41, 43-50). Dietary intake of SAFA was also relatively uniform on a global scale, contributing an average of 12.0-14.0% of TEI, again exceeding both AMDR recommendations and WHO guidelines. Given the adverse health consequences of SAFA, it is of concern that SAFA contributes equally and if not the greatest amount of energy, when compared to healthier classifications of dietary fats. Of interest, New Zealand exceeds SAFA recommendations to the greatest extent when compared to other countries in Table 2.2 (39). Of greater concern, is that the dietary intake of TFA is not known, nor incorporated into this value, likely increasing intakes further beyond the recommendations. Current estimates in New Zealand, are that TFA contribute 0.7% of TEI among those aged 15 years and above (51). PUFA contributes the least amount of energy towards TEI in comparison to both SAFA and MUFA. Interestingly, the PUFA intakes of Australian and New Zealand populations are considerably lower, contributing to approximately 4.0% of TEI, compared to NHANES data, which contributes approximately 8.0% of TEI. This likely reflects differences in food composition, choice and availability. The NHANES data are particularly valuable because it provides an indication of trends in dietary fat intakes over time. Although overall intakes have been relatively stable, there was a noticeable increase in fat intakes when comparing the 2013-14 and 2015-2016 NHANES surveys (41-42). This is potentially reflective of the increase in availability of processed foods (52, 53). While PUFA intakes have remained uniform throughout the years of 2009-2016, the
contribution of energy from MUFA and SAFA, increased from 11% to 12%, impacting the contribution of total fat towards energy, from 33% to 35%.

2.3.5 Food sources of fat from population surveys

Various population surveys reveal that energy received from total fat is at the upper end of recommendations, and saturated fat on average, provides a greater amount of TEI than recommended. Consequently, it is of interest to identify the foods and food groups which are contributing to the dietary fat intakes of female adolescents. The food groups that contribute the largest proportions of dietary fat to the diets of females aged 15-18 years in the 2008/09 ANS have been summarised in Figures 2.1-2.4. Data provided in Table 2.3 indicate the types of food items within these food group categories.

Figure 2.1: Food group contribution to total fat intake among New Zealand females aged 15-18 years in the 2008/09 Adult Nutrition Survey.
**Figure 2.2:** Food group contribution to total SAFA intake among New Zealand females aged 15-18 years in the 2008/09 Adult Nutrition Survey.

**Figure 2.3:** Food group contribution to total PUFA intake among New Zealand females aged 15-18 years in the 2008/09 Adult Nutrition Survey.
**Figure 2.4:** Food group contribution to total MUFA intake among New Zealand females aged 15-18 years in the 2008/09 Adult Nutrition Survey.

**Table 2.3:** Examples of food items belonging to the food group categories in the 2008/09 Adult Nutrition Survey (39).

<table>
<thead>
<tr>
<th>Food group</th>
<th>Examples of food items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread based dishes</td>
<td>Hamburgers, hotdogs, pizza, nachos.</td>
</tr>
<tr>
<td>Potatoes, kumara, taro</td>
<td>Hot chips, crisps, wedges.</td>
</tr>
<tr>
<td>Poultry</td>
<td>Chicken, duck, turkey, mutton-bird.</td>
</tr>
<tr>
<td>Butter and margarine</td>
<td>Butter, margarine, butter/margarine blends, reduced fat spreads.</td>
</tr>
<tr>
<td>Milk</td>
<td>All milk [cow, soy, rice, goat + flavoured milk], milkshakes, milk powder.</td>
</tr>
<tr>
<td>Cakes and muffins</td>
<td>All cakes and muffins, slices, scones, pancakes.</td>
</tr>
<tr>
<td>Dairy products</td>
<td>Cream, sour cream, yoghurt, dairy food.</td>
</tr>
</tbody>
</table>
The results from the 2008/09 ANS indicate that: bread based dishes; and potato, kumara and taro food groups, are significant contributors towards the intake of dietary fats within the New Zealand female adolescent population. The fats and oils added to, and used to prepare foods in these categories are therefore important contributors of dietary fat.

The intake of SAFA, which was the largest contributor of dietary fat in this survey, could be explained by the consumption of processed meats such as sausages, meat patties and mince, because they form important components of the bread based dishes food group. The food group: dairy products, which exclude dairy milk but include less healthy varieties of dairy such as creams; in combination with highly processed foods such as those found in the cakes and muffins food group, are also important providers of SAFA.

No food item or food group will provide a singular combination of dietary fat. Instead, a combination of dietary fats are provided, but in varying amounts. This is particularly evident in the: bread based dishes; and potato, kumara and taro food groups; which collectively contribute the greatest amount of total fat, SAFA, MUFA and PUFA in the diet. Food groups missing from the main sources of fat in this survey, yet contain a greater proportion of unsaturated FA, include: nuts and seeds; and fish and seafood. Including these sources could produce a more healthful diet in this population.
2.3.6 Dietary fat assessment

There are various methods by which dietary intake can be assessed, including diet records, diet recalls, diet histories and food frequency questionnaires [FFQ] (54). Diet records and diet recalls collect information on food and fluid intake that has occurred over a specified period of time, for example 24 hours (20). Whereas diet histories and FFQ provide an indication of the ‘usual’ food consumption (55), typically assessing the long-term food habits of an individual (20). Diet records are regarded as the most accurate measure of dietary assessment because information is recorded at the time of food consumption (20). This means that participants do not have to rely on their memory to recall detailed information, which improves the accuracy of data collected (54). Recording methods vary. Some studies may require participants to weigh all foods and fluids they consume, while other studies may use household measures and photographs to estimate food intake (20, 54). The disadvantage of this method is the high participant burden that results from the time required to record such detailed information (54). To be completed accurately, this method also relies on participant literacy, honesty and motivation.

In comparison, diet recalls require participants to recall in retrospect, the specific foods that they have eaten in the previous 24 hours (54). Participant burden is less than in a food record, however this method is reliant on memory to recall detailed information such as brand names, cooking methods and portion estimates. A skilled interviewer is needed to accurately conduct the multiple passes involved in diet recalls (56). In the interest of this thesis, are the following three passes: a quick list; a detailed description; and a review. This process may occur face-to-face or via phone or video call. A
disadvantage of this method is that unusual food intakes on the day the diet recall is conducted, may result in an inaccurate representation of dietary intake. This can be overcome by conducting more than one 24-hour recall, with the inclusion of both week days and weekend days to help to account for differences in intake that may occur across different days of the week. Different procedures such as the multiple source method [MSM] can be used to adjust for intra-individual variation to obtain usual intakes in the study population (57). In both diet records and diet recalls, participants may feel inclined to select or omit certain foods while being assessed. This may be to reduce the burden of recording difficult food items, or to give an impression of a healthy diet.

FFQ which offer a low participant burden, have the advantage of providing a practical, low-cost and time efficient method of data collection (58). However FFQ fail to capture the finer details of food intake, such as preparation techniques (54). Time frames may vary between different FFQ, with frequency of intake often referred to as either weekly, monthly or yearly. A diet history, although similar by collecting data on ‘usual’ intake, provides a more in-depth insight towards the dietary intake of participants. This method of dietary assessment is also conducted by a trained interviewer.

2.4 Vegetarianism

‘Vegetarian’ refers to a person who makes the decision to avoid consuming meat and meat products in their diet, and can expand to exclude other animal-derived foods (10, 13, 59). There are variances in this definition, depending on how strictly an individual decides to follow this pattern of eating and these have been summarised in Table 2.4. Additionally, there are ‘meat-reducers’ or ‘flexitarians’, and they may have
beliefs based around the overall reduction in animal products, but not necessarily the total exclusion of these foods (60).

**Table 2.4.** Various definitions of vegetarian eating patterns.

<table>
<thead>
<tr>
<th>Definition</th>
<th>Meat, &amp; fowl</th>
<th>Fish</th>
<th>Eggs</th>
<th>Dairy products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacto-vegetarian</td>
<td>x1</td>
<td>x</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>Ovo-vegetarian</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Lacto-ovo-vegetarian</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pescatarians</td>
<td>x</td>
<td>✓2</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Vegan</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

1 X indicates food group is typically avoided
2 ✓ indicates food group is typically accepted

Vegetarianism should be appropriately defined when conducting research, because depending on the period of abstinence from meat, or the frequency of meat consumption, differences in dietary fat intake and resulting health benefits and outcomes may result. Typical examples in research include asking participants’ how many times in the previous week, month, or year they have consumed meat products. Alternatively, participants may be asked how long they have been following a vegetarian diet, often categorised as: ‘less than 1 month’, ‘1-6 months’, ‘6-12 months’, ‘1-2 years’, ‘more than 2 years’. Sometimes participants will be grouped based on both of these questions.

The personal reasons for following a vegetarian diet may be related to a variety of motives and values. This may include concerns regarding health, environmental impacts, animal welfare, a religious belief, culture and taste preference (8, 9). Traditionally, vegetarianism was associated with a healthy lifestyle because it would usually
accompany other positive lifestyle behaviours such as a reduced consumption of alcohol, tobacco and caffeine (59). There is little evidence to compare how a traditional vegetarian lifestyle compares to the lifestyle exhibited by that of ‘new’ vegetarians, who may be more motivated by humanitarian and environmental reasons, opposed to health reasons (3, 61). Regardless, the growing popularity of vegetarianism makes research related to the nutritional status of this population important (7, 62).

2.4.1 Health Benefits of Vegetarianism

A vegetarian diet can offer favourable nutrient profiles compared to meat-based diets, with an opportunity to improve health outcomes, particularly related to chronic diseases (63). Vegetarians experience lower rates of ischemic heart disease [IHD], hypertension, obesity and certain cancers (64), and a reduced risk of type two diabetes mellitus [TTDM], when compared to their non-vegetarian counterparts (65). This may be attributed to the lower levels of SAFA and higher levels of MUFA and PUFA that typically result from the avoidance of meat. However, it must be reiterated that individuals following a vegetarian diet can still have unhealthy eating patterns and lifestyles, with unfavourable dietary fat intakes. This is due to the prevalence of convenient and processed foods which contain large amounts of SAFA, as discussed in section 2.3.5 of this literature review. Given the period of important growth and development experienced by female adolescents, it is essential that these diets are healthful and provide nutrients, in sufficient amounts. To achieve this, their dietary choices must be better understood.
2.4.2 Vegetarianism in Female Adolescents

Literature investigating and comparing the intake of dietary fats among female adolescent vegetarians and non-vegetarians is minimal, and there are no data specific to a New Zealand population. However other populations around the world have been studied and whilst they contain cultural and demographic differences, they still provide an indication of the fat intakes among these groups. Due to its very recent publication in 2019, the study by Segovia-Siapco et al is of particular interest. However the majority of literature relevant to this thesis topic was conducted between the years of 1996-2002, making the data notably dated. These studies have been summarised in Table 2.5. The reviewed studies collected information on the overall nutrient and energy profiles of these populations, which allowed for dietary fat intakes to be assessed. Following a cross-sectional survey design, participants varied in age from 12 to 20 years old. All studies except Segovia-Siapco et al, provided sex-specific results for dietary fat intakes. However males often consume greater quantities of fats when compared to their female counterparts and this may provide a means of overestimating fat intake in the Segovia-Siapco et al study (66, 67).

The study by Donovan et al was unique because it found no significant differences in total fat intakes between the vegetarian, semi-vegetarian and omnivorous diet groups (3). There was a wide range of fat intakes across all diet groups in this study, and unfortunately the composition of dietary fats were not reported on. However, the similarities in fat intakes are more likely explained by the key food sources of fat, which are cereal products and dairy as both of these food groups contain minimal amounts of flesh foods. This in part explains why there is little difference between the diet groups,
which are distinguished by the consumption or avoidance of meat. Comparatively, the
majority of studies related to this topic, suggest that vegetarian or vegan diets contain
lower total fat intakes than their non-vegetarian counterparts (58, 67-69).

The studies conducted by Perry et al, Larsson et al and Segovia-Siapco et al
gathered further information on SAFA, MUFA and PUFA intake. In these studies, intake
of SAFA and MUFA were significantly higher, and PUFA intake was lower among
omnivore participants, when compared against the vegetarian or vegan participants (58,
67, 69). These findings indicate a favourable dietary fat intake and fat composition
among subjects who excluded animal meats and/or animal products from their diets.
Caution must be exercised when interpreting the findings from the studies conducted by
Meirelles et al and Larsson et al, due to the small sample sizes of the diet groups. In both
of these studies a total of 60 participants were involved, and this reduces the precision by
which conclusions between diet groups can be made (70, 71).
The studies by Segovia-Siapco et al and Meirelles et al, are of interest as they recruited
participants belonging to Seventh Day Adventist groups. Previous research has shown
individuals who are devoted to Seventh Day Adventism experience 50% lower rates of
morbidity when compared to the general population (72). Therefore, when extrapolating
such data, additional healthy lifestyle behaviours that often accompany Seventh Day
Adventism, such as abstinence from cigarette smoking and alcohol consumption, should
be considered as confounding factors (68). Regardless, the results regarding the dietary
fat intakes in this study are uniform with the results from other literature.
Table 2.5: List of cross-sectional studies reporting on the fat intakes of vegetarian and non-vegetarian female adolescents.

<table>
<thead>
<tr>
<th>Author[s] &amp; year</th>
<th>Country of data collection, study design, sample size</th>
<th>Dietary assessment method</th>
<th>Percentage of total energy from dietary fat [%], [and dietary fat intake [grams]]</th>
<th>Diet group</th>
<th>Total fat</th>
<th>SAFA</th>
<th>MUFA</th>
<th>PUFA</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donovan et al. [1996] (3).</td>
<td>o Canada o 122 participants aged 14-19 years.</td>
<td>Three consecutive days of weighed food records [one weekend day].</td>
<td>LOV₁ [n=78] 33.0 [63.0] n/a n/a n/a</td>
<td>No significant differences in fat intakes between diet groups.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SV₂ [n=15] 30.0 [56.0] n/a n/a n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OM₃ [n=29] 32.0 [63.0] n/a n/a n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meirelles MS et al. [2001] (68).</td>
<td>o Brazil o 60 participants aged 15-18 years.</td>
<td>FFQ₅. 3-day food record [one weekend day].</td>
<td>LOV [n=24] 22.3 [45.8] n/a n/a n/a</td>
<td>%TEI from total fat significantly higher in OM compared to LOV [P = &lt;0.001].</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OM [n=36] 29.7 [71.4] n/a n/a n/a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larsson et al. [2002] (67).</td>
<td>o Sweden o 60 participants aged 16-20 years [30 females].</td>
<td>Two separate 1-2-hour diet history interviews conducted 1-2 weeks apart.</td>
<td>VEG [n=15] 24.0 [58.0] 6.2 [15.0] 8.3 [20.0] 14.0 [15.0]</td>
<td>%TEI from total fat and SAFA significantly higher, and PUFA significantly lower in OM compared to VEG.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OM [n=15] 29.0 [75.0] 13.2 [34.0] 10.5 [27.0] 3.3 [8.6]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Location</td>
<td>Participants</td>
<td>Methodology</td>
<td>LOV [n=193]</td>
<td>OM [n=2061]</td>
<td>TEI from total fat, SAFA and MUFA</td>
<td>TEI from total fat, MUFA and PUFA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Perry et al. [2002] (69).</td>
<td>4746 participants [2254 female]</td>
<td>Self-reported surveys + 149 item FFQ.</td>
<td>26.9 [n/a]</td>
<td>30.1 [n/a]</td>
<td>9.3 [n/a]</td>
<td>10.7 [n/a]</td>
<td>5.4 [n/a]</td>
<td>5.7 [n/a]</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: LOV, lacto-ovo vegetarians; SV, semi-vegetarians; OM, omnivores; n/a, specific data is not available; FFQ, food frequency questionnaire; VE, vegan.

1. This study presents combined data for female and male participants, sex specific data is not available.
As previously mentioned, it is important to consider how vegetarianism has been defined in each study, because this may influence the results. For example, an individual’s dietary pattern may be categorised based on the length of time they have adhered to that pattern of eating. Meirelles et al required vegetarian participants to follow a vegetarian diet for at least one year, whereas Larsson et al required vegan participants to follow a vegan diet for more than six months, with the intention of continuing. Due to the extended time frame indicated in the study by Meirelles et al, it is possible that data regarding dietary fat are more reliable and therefore more likely to be correlated with the pattern of diet that the participants were following. Alternatively, vegetarianism may be defined by how frequently animal products have been consumed in a given time frame. To be classified as a vegetarian in the study by Segovia-Siapco et al, participants needed to consume less than one serving of meat per week, while Donovan et al were more strict with their definition requiring vegetarian participants to consume less than one serving of meat per month. In this instance, the results produced in the study by Donovan et al may be more reliable when looking for relationships between the pattern of eating and resulting dietary fat intakes.

A variety of assessment methods were used to collect information on dietary fat intakes, of which the advantages and disadvantages have been previously discussed. Segovia-Siapco et al and Perry et al used a FFQ to measure dietary intake, while Donovan et al used three days of weighed food records. Meirelles et al used a combination of food records and a FFQ. Diet history interviews were the primary method of data collection in the study by Larson et al, with two interviews conducted between one and two weeks of one another. This means that some studies assessed the ‘usual’
intake and food patterns of individuals, whilst others were collecting information from a specific period of time (55). Under-reporting is common when assessing dietary intakes (73, 74), and this is an especially important consideration when studying vegetarian populations, particularly females (75). This is because participants may want to give an impression of a healthy lifestyle, or they may be using a vegetarian diet as a method of weight loss (76-78). Larsson et al identified that energy intake was under-reported in 12% of omnivores and 14% of vegans, with an underestimation of ~1.93MJ of energy per day (67). With such deficits in energy intake, it is likely that fat intakes are also under-reported.

The study by Perry et al, compared the intakes of vegetarian and non-vegetarian subjects, against the ‘The Healthy Eating 2010 Objectives’. Two objectives were of particular interest to dietary fat intakes: the percent of participants consuming less than 30% of calories from total fat; and the percent of participants consuming less than 10% of calories from SAFA. These objectives align with the WHO recommendations (38). Significantly more vegetarians than non-vegetarians achieved these objectives, with 70% and 65% of vegetarians compared to 48% and 39% of non-vegetarians achieving the objectives for total fat and SAFA intake respectively (69). Segovia-Siapco et al revealed that 49% of vegetarian participants consumed less than 10% of their total energy intake from SAFA compared to 25% of non-vegetarian participants (58).

2.5 Summary

Dietary fats are responsible for many important physiological functions throughout the human body (23). However, the impact of unfavourable dietary fat intakes upon overweight and obesity, and CVD is also well recognised in current literature (24).
Overall, research related to this thesis suggests that a vegetarian diet may provide a more favourable profile of dietary fats when compared to non-vegetarian diet groups (58, 67-69). Achieving an optimal balance in dietary fat intake can only be attained when the dietary patterns of the population are investigated and understood. With considerably dated research, and no studies conducted in relevance to a New Zealand female adolescent population, the SuNDiAL study will help provide information where there is a considerable absence of literature.
3. **Objective Statement**

The aim of the SuNDiAL study was to compare the dietary intakes and habits, nutritional status, health status, motivations, attitudes, and lifestyles of vegetarian and non-vegetarian adolescent females in New Zealand.

The aim of this thesis was to investigate and compare the dietary intakes and food sources of dietary fat among vegetarian and non-vegetarian female adolescents in New Zealand.

The objectives of this study were to:

- Describe and compare the dietary intakes of total fat, SAFA, MUFA and PUFA in a sample of vegetarian and non-vegetarian adolescent females in New Zealand.
- Describe and compare the food sources of total fat, SAFA, MUFA and PUFA in a sample of vegetarian and non-vegetarian adolescent females in New Zealand.
4. Methods

4.1. Study design and participants

The SuNDiAL study is a cross-sectional survey comparing data on the dietary intakes and habits, nutritional status, health status, motivations, attitudes and lifestyles of vegetarian and non-vegetarian adolescent females throughout New Zealand. This multi-centered study recruited schools within the designated locations of the research team, which included Whangarei, Tauranga, New Plymouth, Wellington, Nelson, Christchurch, Dunedin and Wanaka. The research team at each site comprised of at least one pair of second year MDiet students. Initially, in February 2019, recruitment was school-based only, however due to the small number of vegetarian participants recruited after the first semester of data collection [n=9], targeted recruitment was introduced from July 2019 onwards. This was to ensure statistical comparisons could be made between the vegetarian and non-vegetarian subjects. This MDiet thesis assesses and compares the dietary intakes and food sources of fat among vegetarian and non-vegetarian adolescent females throughout 13 New Zealand secondary schools, using data collected from both phases, [February-March 2019 and July-August 2019] of the SuNDiAL study. The SuNDiAL study will continue until December 2020.

4.1.1 Ethical approval

The study was approved by the University of Otago Human Ethics Committee in February 2019 [Health]:H19/004 [Appendix A], and is registered with the Australian New Zealand Clinical Trials Registry: ACTRN12619000290190. The Ngāi Tahu
Research Consultation Committee also acknowledged that the findings of the SuNDiAL study would be of future benefit to Māori health [Appendix B].

4.1.2 Inclusion /exclusion criteria

All students identifying as females, aged 15-18 years, who spoke and understood English and who were enrolled at an eligible secondary school or identified as vegetarian and living in Dunedin, were deemed eligible to participate in the SuNDiAL study. Provision of consent was then required from students, and also by the parents or guardians of students aged 15 years. Pregnant students were deemed ineligible to participate in the study.

4.1.3 School recruitment and enrolment

Initially, the eligibility criteria for schools to participate in the study was determined by features such as a large school roll (>400 students co-ed, <200 single sex) and the location of the school in an area that the research team were residing. Low socio-economic status schools were also preferentially targeted. In November 2018, the PIs circulated an email to the eligible schools which provided an overview of the study, an outline of the importance of the study and information on how to enroll [Appendix C]. If no response was received within two weeks, a second email was sent, followed by a phone call. A maximum of three schools, per pair of data collectors were contacted. This process was repeated for ‘follow-up recruitment’, meaning that schools who did not meet the initial eligibility criteria were contacted. This included schools with a smaller school roll and a range of deciles, however it remained essential that the school location was in
reasonable proximity to the research team. If this method of recruitment was unsuccessful, word of mouth recruitment was initiated by data collectors, PIs, SuNDiAL coordinators and university liaison officers. This process involved school visits, phone calls and emails sent to any number of schools in a suitable location. Following the successful recruitment of a school, the research team scheduled a suitable date and time to visit the school.

4.1.4 School Consent

Informed consent was required from each participating school. The consent form [Appendix D], was signed by a school staff member, and submitted to the SuNDiAL coordinator.

4.1.5 Participant recruitment

In July 2019, the SuNDiAL PowerPoint [Microsoft PowerPoint 2016] presentation [Appendix E] and recruitment video [https://www.otago.ac.nz/sundial/index.html] was presented at a whole school assembly. The presentation was designed and presented by the research team, under the guidance of PIs, and provided an overview of the SuNDiAL study. At the end of the school assembly, students were given an opportunity to talk to the research team and if desired, enroll for the study. This involved the student providing their name, age, personal email address if they were 16-18 years of age, and parent or caregivers email address if they were 15 years of age. Printed information regarding the finer details of the study were also circulated [Appendix F] and students were encouraged to visit the SuNDiAL website.
During the same school visit, suitable dates and times for data collection were agreed upon and the facilities and spaces designated for data collection, and blood and urine sample collections were confirmed.

4.1.6 Targeted participant recruitment

In the second semester of data collection, targeted participant recruitment was introduced. Any females aged 15-18 years, who identified as vegetarian and lived in Dunedin at the time of recruitment, were deemed eligible to participate in the study. Local newspapers, Facebook and Instagram were used for advertising purposes. Interested respondents were directed to visit the SuNDiAL website to access further information regarding the study and were given the opportunity to provide their contact details as per standard recruitment.

4.1.7 Participant enrolment and consent

Interested participants who provided an email address were assigned an ID number and received an email from the PIs. If the student was aged under 16 years, they were sent the email after the parent or primary guardian had provided consent. The email included a weblink to an online application tool called Research Electronic Data Capture [REDCap, Vanderbilt University, Tennessee]. REDCap is used in research to collect, store and disseminate scientific data (79), and has been used for the development of questionnaires in the SuNDiAL study. By clicking on the link, students were directed to complete an enrolment questionnaire which included an online consent form and demographic and health questions [Appendix G]. Before participants provided consent,
they were able to review the details of the study by visiting the SuNDiAL website. If students decided to participate in the study, they could click the ‘agree’ button and this would indicate that they had provided informed consent. At the same time that consent was provided, participants were able to select the components of the study that they would like to contribute their data to. Four components were compulsory: 1. Dietary habits, motivations and attitude online questionnaires; 2. 24-hour diet recall conducted in person; 3. Anthropometric measurements; 4. 24-hour diet recall via phone or video call. The remaining components, 5. Spot urine sample; 6. Spot blood sample; 7. Accelerometry for seven days, were selected at the preference of the participant. An opportunity for samples to be disposed of with a karakia [Māori prayer], was also provided during the consent process. Students were informed that they could withdraw from the study at any given time, and voluntary involvement was reiterated. To encourage students to enroll in the SuNDiAL study, supermarket vouchers for either Pak’n’Save or New World were offered as an incentive. A $5 supermarket voucher was offered for completing the following sections: online questionnaire; each 24-hour recall; the blood sample; the urine sample; and wearing the accelerometer. A total of $30 could be earned if the participant consented to all of these study sections. Due to a shortage in supply, not all participants were assigned an accelerometer, however those who consented were still reimbursed.
4.2. **Study procedures**

4.2.1 **Data collection**

This section details the process of data collection throughout the study. Information that was collected from participants included online questionnaires, 24-hour diet recalls, anthropometric measurements, spot urine samples, spot blood samples and accelerometry data. Of relevance to this thesis, only the methods for demographic information, 24-hour diet recalls, and anthropometry have been provided in detail.

4.2.2 **Demographic Information**

The enrolment questionnaire included questions on age, school of attendance, and ethnicity. Ethnicity is a measure of cultural affiliation, therefore participants were able to select multiple ethnicities in this section (80). The ethnicities available for selection were: New Zealand European [NZEO]; Māori; Samoan; Cook Island Māori; Tongan; Niuean; Chinese; Indian; and other. If ‘other’ was selected, participants were asked to specify an ethnicity. When collating results, the above ethnicities were then categorised into: New Zealand European and Other; Māori; Pacific; and Asian.

4.2.3 **Vegetarian Status**

The REDCap enrolment questionnaire was also used to determine the vegetarian or vegan status of the student, with the following questions; ‘Are you vegetarian or vegan?’, and, ‘Are you vegan?’, of which students could answer by selecting ‘yes’ or ‘no’. Students were also asked to indicate which foods they consumed, with the following options available for selection: ‘Egg’, ‘Milk [not plant milk like soy milk]’, ‘Fish or
seafood’, ‘Chicken or poultry’, ‘Meat/red meat occasionally’ and/or ‘None of the above’. Students were then asked how long they had been following this pattern of eating, by selecting one of the following options; ‘Less than a month’, ‘Between 1 and 6 months’, ‘Between 6 months and 1 year’, ‘Between 1 and 2 years’, ‘More than 2 years’, or ‘My whole life’.

4.2.4 NZDep2013 Index of Deprivation

The New Zealand Deprivation Decile Index [NZDep2013] categorises deprivation throughout New Zealand using data collected in the 2013 census (81), and was used to determine the deprivation score of each participant involved in the SuNDiAL study, based on their home address. NZDep2013 scores range from one to ten with a score of one indicating the top 10% least deprived areas, and a score of ten indicating the top 10% most deprived areas in New Zealand. In the SuNDiAL study, these scores were classified as: one, low deprivation [scores between 1-3]; two, moderate deprivation [scores between 4-7]; and three, high deprivation [scores between 8-10].

4.2.5 Twenty-four-hour diet recalls

The first 24-hour diet recall was conducted face-to-face on a weekday. If the participant belonged to a school-based recruitment group, this diet recall was scheduled to occur during school hours, and if they belonged to the targeted recruitment group it was scheduled to occur at the Dunedin Dietetic clinic after school. The students were informed that the process would take a maximum of one hour to complete. The research team followed a strict protocol when performing this recall [Appendix H]. Information
was collected based on food and fluid intake from midnight to midnight on the previous day, meaning that a 24-hour diet recall conducted on a Tuesday, would be detailing all food and fluid consumed on the Monday. The 24-hour diet recall method used in this study was an adaptation from the US Department of Agriculture Automated Multiple Pass Method [AMPM] (56). The multiple-pass recall used in the SuNDiAL study consisted of three passes. The first pass was called a ‘quick list’, which involved asking the participant to recall all of the things they ate and drank within the indicated 24-hour time frame. The second pass involved asking for a ‘detailed description’ of the foods and fluids consumed. Household measures, food models and photographs were used to probe and assist the participant to provide information in appropriate detail. The third pass was a ‘review’, in which any further additions were checked for, and added as necessary. The second 24-hour diet recall was conducted via phone or video call, on a day of the week different to that of the initial 24-hour diet recall. To reflect the diversity in food choices often occurring throughout different days of the week, efforts were made to complete one of the recalls on a weekend day, either a Saturday or Sunday.

For every participant that completed two non-consecutive 24-hour diet recalls, a means of estimating ‘usual intake’ was provided. This was achieved using the MSM programme, which adjusts for the variation in dietary intake that can occur within each participant, this is also known as intra-individual variation (57). This was also applied to participants who did not complete a second recall.

24-hour dietary recall data were entered onto an online programme called FoodWorks 9 [Xyris Software, Australia Pty Ltd], to calculate nutrient intakes.
FoodWorks 9 was programmed with recipes calculated in the 2008/09 ANS, and food composition tables from New Zealand FOODfiles 2014 [The New Zealand Institute for Plant & Food Research Limited]. This provided a means of estimating total energy, macronutrient and micronutrient intakes. A SuNDiAL codebook was provided to all research teams, on an Excel spreadsheet [Microsoft Excel 2016]. This codebook covered a range of important information to assist with data entry into FoodWorks 9. This included: codebook instructions; food weight estimation rules; food weight estimation defaults; default foods SuNDiAL; default foods bread matches; substitutions SuNDiAL study; and default foods and substitutions from previous research studies. Only participants who completed at least one 24-hour diet recall were included in the analysis of dietary intakes and food sources of fat. Liz Fleming conducted an audit upon the first 24-hour diet recall that every MDiet student completed. This was to ensure that data had been entered to a sufficient and uniform standard.

4.2.6 Anthropometry

Following the procedures detailed in the study protocol manual [Appendix I], anthropometric measures of height [cm] and weight [kg] were measured in duplicate, to the nearest 0.1 unit. Body weight was measured using Seca Alpha 770 electronic scales [Seca, Hamburg, Germany] which had been calibrated in Dunedin by the PIs prior to dispatch. Participants were asked to empty the contents of their pockets, remove shoes, heavy jackets or clothing items. Height was measured using a Seca 213 portable stadiometer [Seca, Hamburg, Germany]. Shoes remained off and participants were asked to adjust any hair or hair accessories so that the head piece was not obstructed.
duplicate measures differed by more than 0.5 units, a third measurement was taken. If requested by the participant, they were provided with the results of their anthropometry measurements.

### 4.2.7 Body mass index [BMI] z-score classification

Using the available weight and height measurements of each participant, a body mass index [BMI] score was calculated using the equation:

\[
\text{BMI} [\text{kg/m}^2] = \frac{\text{weight in kilograms [kg]}}{\text{the square of the persons height, in metres [m]}}
\] (82)

All BMI scores were expressed in the units [kg/m²] and then converted to z-scores. During adolescence, z-scores are used to represent the BMI classification of an individual because of the period of rapid growth that is typically experienced by this age group (83). Z-scores were calculated and body weight categories used in the thesis are summarized in **Table 4.1**.

**Table 4.1**: Z-scores and corresponding body mass index [BMI] classification.

<table>
<thead>
<tr>
<th>z-score</th>
<th>BMI classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;-2</td>
<td>Underweight</td>
</tr>
<tr>
<td>≥-2 to +1</td>
<td>Healthy</td>
</tr>
<tr>
<td>&gt;1 to +2</td>
<td>Overweight</td>
</tr>
<tr>
<td>&gt;+2</td>
<td>Obese</td>
</tr>
</tbody>
</table>
4.2.8 Post data collection procedures

At the completion of data collection, participants were thanked via email for their participation and efforts during the study. The study components that each participant had completed were confirmed by the research team and the corresponding gift vouchers were sent by post, to the participants home address in September 2019. Vouchers were not sent to participants until they had returned their accelerometers to the research team.

4.2.9 Training data collectors

All research teams received extensive training before initiating data collection. The first training took place during semester two, 2018, for a total of eight weeks. This involved the teaching of methods required for collecting anthropometry measurements. A convenience sample of twelve female high school students aged 15-18 years volunteered their time so that this process could be completed. The student volunteers provided consent, and with adherence to a standardised protocol developed by the PIs, the MDiet students measured height, weight and ulna length. Every MDiet student conducted each of these measurements on four different volunteers, on two non-successive occasions, recording data on two separate recording sheets.

An inter-rater reliability [IRR] study was undertaken during this training of which 27 of the MDiet students were able to complete. This revealed intra-correlation coefficients [ICC] of 1.00 for weight, 0.92 for height and 0.86 for ulna length, indicating uniform measurement techniques among data collectors. For the taller student volunteers, variances in measure were present. This resulted in the allocation of step stools for future...
data collection procedures. A second block of training occurred via Zoom [Zoom Video Communications, 2019] sessions during July 2019, for a total of two weeks. The purpose of this was to introduce FoodWorks 9 and other important procedures such as entering 24-hour diet recall data, recipes and calculating retention factors. Other training related to recruitment methods and school presentations were also provided. The SuNDiAL PIs coordinated both of these trainings, ensuring there was consistency in the collection and measurement of all data collected by the research teams.

4.3 Statistical analysis

4.3.1 Sample size calculation

Biostatistician Dr. Jill Haszard, from the Human Nutrition Department at the University of Otago, was responsible for calculating the sample size and statistical power required for this study. It was determined that 300 high school students from 14 different secondary schools, would provide 80% power to the [α=0.05] level. This would detect a [0.5] standard deviation difference in continuous outcome variables between vegetarian and non-vegetarian participants. This analysis was conducted under the assumption of a 20% prevalence of vegetarianism in the study population, and a design effect of [1.5].

Dr. Jill Haszard performed statistical analyses using Stata 16.0 [StataCorp. 2017. *Stata Statistical Software: Release 15*. College Station, TX: StataCorp LLC]. Excel [Microsoft Excel 2016] was used to conduct additional statistical analyses by both Dr. Jill Haszard and the candidate. Prevalence or mean and standard deviation [SD] values were calculated by the candidate to determine demographic information. For total dietary fat, SAFA, MUFA and PUFA, the means and ninety-five percent confidence interval [95%
CI] values were calculated for absolute intake and fat intake as a percent of total energy. Analyses were conducted upon the total cohort, the vegetarian diet group and the non-vegetarian diet group. Results were also compared against the relevant AMDR and then an unpaired t-test was used to determine differences between the two diet groups. This was also completed through Stata 12.0, by Associate Professor Rachel Brown. Stata 12.0 was then used to calculate the mean difference in values [95% CI] between the vegetarian and non-vegetarian diet groups. For the food group results, the proportion of each participants intake of total fat, SAFA, MUFA and PUFA was calculated for 33 different food groups by Dr. Jill Haszard. These were the same 33 food groups that were used in the 2008/09 ANS. The food groups that contributed the highest average intakes of dietary fats in the combined study population has been reported on in this thesis. A SuNDiAL data dictionary codebook and a 2008/09 ANS food groups codebook was supplied to the candidate during the process of statistical analyses.
5. Results

5.1 Participant characteristics

The participants in the SuNDiAL study were 282 female’s aged 15-18 years, who attended high schools throughout New Zealand. The distribution of participants throughout the study is shown in Figure 5.1. All participants that completed at least one of the two 24-hour diet recalls have been included in the dataset of this thesis. The data of 251 participants have been analysed for diet fat intakes and food group contributions towards fat intake. One of these participants did not complete the initial demographic questionnaire and so her dietary status is not known. However, she completed both of the 24-hour diet recalls and has therefore been included in the ‘combined’ results presented in Table 5.3.

Table 5.1 displays the dietary patterns of the study population. Two-hundred and nineteen participants self-identified as non-vegetarian, and 31 participants self identified as vegetarian, of whom 8 identified as following a vegan diet.

<table>
<thead>
<tr>
<th>Dietary pattern</th>
<th>n [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-vegetarian</td>
<td>219 [87.6]</td>
</tr>
<tr>
<td>Vegetarian [n=31]</td>
<td></td>
</tr>
<tr>
<td>Non-vegan</td>
<td>23 [9.2]</td>
</tr>
<tr>
<td>Vegan</td>
<td>8 [3.2]</td>
</tr>
</tbody>
</table>
Figure 5.1: Flow of participants throughout study.
Table 5.2 displays the characteristics of the participants included in this dataset [n=251]. The mean [SD] age of the combined participants was 16.8 [0.86] years, and the ethnicity of the study population was predominantly NZEO. Using the NZDep2013 scale as a measure of socioeconomic status, 36.7% of participants lived in areas of low deprivation, while 46.0% and 17.2% lived in areas of moderate and high deprivation.

Z-scores were used to classify the weight category of participants. In the vegetarian diet group, 77.4% of participants had a z-score that indicated a healthy weight range, with 22.6% classified as overweight or obese. In comparison, 63.9% of participants in the non-vegetarian diet group were within the healthy weight range, and 35.6% were classified as overweight or obese. In the combined SuNDiAL study population, the prevalence of overweight participants was 23.5% and the prevalence of obese participants was 10.5%. (85).

5.2 Twenty-four-hour diet recalls

Of the 251 participants included in the dataset of this thesis, 84.9% completed both of the 24-hour diet recalls. Around 15% of participants declined to complete the second diet recall, which was conducted over the phone.

5.3 Fat intakes and AMDRs

Total dietary fat, SAFA, MUFA and PUFA intakes among all participants and by vegetarian status is presented in Table 5.3.
Table 5.2: Demographic characteristics of the total population and by vegetarian status.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Combined [n=250]</th>
<th>Vegetarian [n=31]</th>
<th>Non-Vegetarian [n=219]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n [%]</td>
<td>n [%]</td>
<td>n [%]</td>
</tr>
<tr>
<td>Age, years [n=250]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>88 [35.2]</td>
<td>9 [29.0]</td>
<td>79 [36.1]</td>
</tr>
<tr>
<td>18</td>
<td>15 [0.1]</td>
<td>3 [9.7]</td>
<td>12 [5.5]</td>
</tr>
<tr>
<td>Weight category [n=247]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>1 [0.4]</td>
<td>0 [0]</td>
<td>1 [0.5]</td>
</tr>
<tr>
<td>Healthy weights</td>
<td>162 [65.6]</td>
<td>24 [77.4]</td>
<td>138 [63.9]</td>
</tr>
<tr>
<td>Ethnicity [n=246]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NZ European + Other</td>
<td>193 [78.5]</td>
<td>24 [77.4]</td>
<td>171 [78.4]</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>5 [2.0]</td>
<td>0 [0]</td>
<td>6 [2.6]</td>
</tr>
<tr>
<td>Asian</td>
<td>9 [3.7]</td>
<td>0 [0]</td>
<td>9 [4.1]</td>
</tr>
</tbody>
</table>
\[\text{NZDep2013} \, [n=250]\]

<table>
<thead>
<tr>
<th></th>
<th>Low⁸</th>
<th>Mod⁹</th>
<th>High¹⁰</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>92 [36.8]</td>
<td>115 [46.0]</td>
<td>43 [17.2]</td>
</tr>
<tr>
<td></td>
<td>80 [36.5]</td>
<td>100 [45.7]</td>
<td>39 [17.8]</td>
</tr>
</tbody>
</table>

¹Weight category has been presented as \(z\)-scores. These \(z\)-scores refer to the following WHO classifications: Underweight \(<-2\), Healthy \([-2 \text{ to } +1]\), Overweight \([+1 \text{ to } +2]\), Obese \([>+2]\)

²NZ Deprivation decile: Low deprivation [NZDep2013 1-3], Moderate deprivation [NZDep2013 4-7], High deprivation [NZDep2013 8-10]
<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Mean [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All subjects [n=251]</td>
</tr>
<tr>
<td><strong>Total fat</strong></td>
<td></td>
</tr>
<tr>
<td>%TEI</td>
<td>36.9 [36.2, 37.6]</td>
</tr>
<tr>
<td>grams/day</td>
<td>79.4 [76.6, 82.3]</td>
</tr>
<tr>
<td><strong>SAFA</strong></td>
<td></td>
</tr>
<tr>
<td><strong>PUFA</strong></td>
<td></td>
</tr>
<tr>
<td>%TEI</td>
<td>5.6 [5.4, 5.8]</td>
</tr>
<tr>
<td><strong>MUFA</strong></td>
<td></td>
</tr>
<tr>
<td>grams/day</td>
<td>29.6 [28.4, 30.8]</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; %TEI, percent of total energy intake; SAFA, saturated fatty acids; PUFA, polyunsaturated fatty acids; MUFA, monounsaturated fatty acids.
The percentage of energy derived from total fat and SAFA, has also been calculated for each participant and then compared to the AMDR recommendations. These findings have been presented in Table 5.4.

5.5.1 Dietary intake of total fat

The mean contribution of total fat towards TEI in the combined study population, was 36.9% [CI: 36.2, 37.6]. This exceeds the AMDR recommendation that total fat should contribute between 20-35% of TEI. Overall, 33.1% of the study population had total fat intakes falling within the suggested AMDR, while 65.7% of participants had total fat intakes which exceeded these guidelines. A greater proportion of the vegetarian diet group fell within the AMDR [45.2%], compared to their non-vegetarian counterparts [31.1%]. Total fat, as a percent of energy intake, did not differ between vegetarians [36.2%] and non-vegetarians [37.0%], [CI: -1.4, 2.9].

5.5.2 Dietary intake of SAFA

The combined study population derived 13.9% [CI: 13.5, 14.2] of TEI from SAFA. There was a statistically significant difference in SAFA between the two diet groups, of which the non-vegetarian diet group received 2.4% more TEI from SAFA, when compared to their vegetarian counterparts [CI: 1.4, 3.4]. The AMDR for SAFA, is that it should contribute to less than 10% of TEI. Approximately 90% of the combined study population exceeded this AMDR. These guidelines were met by a greater proportion of the vegetarian diet group [32.3%], compared to the non-vegetarian diet group [6.4%].
5.5.3 Dietary intake of MUFA

The mean contribution of MUFA towards TEI in the combined study population was 13.7% [CI: 13.4, 4.1] (39). There were no statistically meaningful differences in the MUFA intakes of the vegetarian and non-vegetarian diet groups [CI: -1.4, 0.7].

5.5.4 Dietary intake of PUFA

The combined study population consumed 5.6% of their TEI from PUFA [CI: 5.4, 5.8]. (39). A statistically significant difference of 1.7% [-2.3, -1.1] was found when comparing the contribution of PUFA towards TEI in the vegetarian diet group [7.1%], with the non-vegetarian diet group [5.4%].

Table 5.4: Percent of participants below, meeting and exceeding the AMDR recommendations for total dietary fat and SAFA intakes.

<table>
<thead>
<tr>
<th>MOH AMDR (37)</th>
<th>Combined [n=251]</th>
<th>Non-vegetarian [n=219]</th>
<th>Vegetarian [n=31]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Fat [AMDR 20-35% TE]</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below AMDR</td>
<td>3 [1.2]</td>
<td>3 [1.4]</td>
<td>0 [0]</td>
</tr>
<tr>
<td><strong>Within AMDR</strong></td>
<td>83 [33.1]</td>
<td>68 [31.1]</td>
<td>14.0 [45.2]</td>
</tr>
<tr>
<td>Above AMDR</td>
<td>165 [65.7]</td>
<td>148 [67.6]</td>
<td>17.0 [54.8]</td>
</tr>
<tr>
<td><strong>SAFA: [AMDR &lt;10% TE]</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below AMDR</td>
<td>24.0 [9.6]</td>
<td>14.0 [6.4]</td>
<td>10.0 [32.3]</td>
</tr>
</tbody>
</table>
5.6 Food group contributions towards dietary fat intake

The food groups that provide the greatest sources of total fat, SAFA, MUFA and PUFA, have been presented in Tables 5.6-5.9. These values have been expressed as the mean percent contribution towards fat intake. The food groups contributing the largest amounts of dietary fat from the combined SuNDiAL study population have been selected and included in these tables.

5.6.1 Food group sources of total fat

The largest contributors of dietary fat in the combined study population were the food groups: potatoes, kumara and taro [6.4%]; bread based dishes [6.2%]; and nuts and seeds [6.0%]. When making comparisons between the two SuNDiAL diet groups, the vegetarian diet received a greater proportion of total fat from the food groups: vegetables [10.2%], nuts and seeds [9.6%]; grains and pasta [8.4%]; fruit [6.5%]; and milk [5.8%]; and a lower intake of poultry [0.4%] compared to their non-vegetarian counterparts.

Other notable contributors of fat in the non-vegetarian diet group were: biscuits [4.6%]; bread [4.2%]; and savoury sauces [4.0%]. The food groups containing flesh meats such as: beef and veal [3.1%]; sausages and processed meats [2.8%]; pork [2.1%] and lamb and mutton [1.1%] provided fat in minor amounts in the non-vegetarian diet group.
**Figure 5.2:** Top food groups contributing to total fat intakes.
5.6.2 Food group sources of SAFA

The food group cheese, was the largest contributor of SAFA across both diet groups in the SuNDiAL study, providing 8.4% of total SAFA intake in the combined study population. A range of food groups including: bread-based dishes; biscuits; cakes and muffins; milk; grains and pasta; dairy products; and poultry; contributed between 4.5-6.5% of SAFA intake in the combined study population. When comparing the two diet groups in the SuNDiAL study, the majority of food groups provided SAFA in similar amounts, contributing between 4.5%-8.5% of total SAFA intake. Poultry contributed substantially more SAFA in the non-vegetarian group compared to the vegetarian group. In the vegetarian diet group, other notable sources of SAFA included: vegetables [6.9%]; nuts and seeds [6.0%]; and butter and margarine [5.1%].

5.6.3 Food group sources of MUFA

The food groups: potato, kumara and taro [7.7%]; nuts and seeds [7.6%]; and poultry [7.4%], were the largest contributors of MUFA in the combined SuNDiAL population. All other food groups listed in the table, supplied similar amounts of MUFA for the two different cohorts. The three richest sources of MUFA in vegetarian diet group were the food groups: nuts and seeds [12.8%]; vegetables [11%]; and fruit [8.9%], compared to poultry [8.4%]; potatoes, kumara and taro [7.8%]; and nuts and seeds [6.9%] in the non-vegetarian diet group. When making comparisons between these two diet groups, the vegetarians received greater amounts of MUFA from the food groups: milk [5.4%]; snacks and sweets [4.7%]; and butter and margarine [4.8%].
Figure 5.3: Top food groups contributing to SAFA intakes.
Figure 5.4: Top food groups contributing to MUFA intake.
Whereas other notable contributors of MUFA in the non-vegetarian diet group, which provided MUFA in small amounts in the vegetarian group, were: poultry [8.4%]; savoury sauces and condiments [5.1%]; and bread based dishes [6.3%]. MUFA intakes of the food group: potatoes, kumara and taro were similar between diet groups.

5.6.7 Food group sources of PUFA

The largest contributors of PUFA in the combined SuNDiAL population was the food groups: nuts-seeds [8.9%]; bread [8.0%]; and potato, kumara and taro [7.6%]. This differed to the findings from the 2008/09 ANS, of which nuts and seeds provided considerably less PUFA [2.0%], while bread based dishes provided considerably more PUFA [12.3%]. When making comparisons between the two SuNDiAL diet groups, the vegetarian diet group received a greater proportion of PUFA from the food groups: vegetables [13.7%], nuts and seeds [11.5%]; and grains and pasta [10.9%], compared to their non-vegetarian counterparts. The non-vegetarian diet group derived considerably more PUFA from poultry [6.7%] and savoury-sauces-and-condiments [6.1%], compared to the vegetarian diet group.
Figure 5.5: Top food groups contributing to PUFA intake.
6. **Discussion**

This is the most recent study to compare the dietary intakes and food sources of fat among vegetarian and non-vegetarian female adolescents in New Zealand. Although total fat intake was not different, fatty acid composition was different between the two groups. Vegetarians consumed a greater proportion of energy from PUFA, and less from SAFA than their non-vegetarian counterparts. Despite the lack of difference in total fat and MUFA intake between groups, the food sources of these nutrients differed, indicating that the two diet groups were making different food choices. Due to the small sample size of the vegetarian diet group in this study, these results should be interpreted with caution.

6.1 **Total fat**

Total fat intakes among vegetarians and non-vegetarians were not meaningfully different. These findings were similar to the study by Donovan et al, who also found no differences in fat intake between Canadian adolescents identifying as LOV, SV and OM (3). It is difficult to interpret the causes of these non-significant findings in the Donovan et al study because the composition of dietary fats were not assessed. The results from both Donovan et al, and the SuNDiAL study, are not in agreement with the majority of literature in this area, which reports statistically significant differences in total fat intake between vegetarians and non-vegetarians (58, 67-69). These contrasting findings are likely explained by the different compositions of fat across the different cohorts. For example intakes of MUFA and PUFA among vegetarians in the SuNDiAL study were higher compared to other studies (58, 67-69) and this increased the vegetarian diet groups overall fat intake. Differences in dietary assessment techniques may also explain some of the different findings. Previous research has predominantly used FFQ and diet histories,
whereas the SuNDiAL study used a 24-hour diet recall. FFQ may overestimate intakes and are most useful for categorising individuals into broad categories of dietary intakes, while diet histories are useful for assessing dietary patterns opposed to nutrient intakes (55). Also the small sample of vegetarians in the SuNDiAL study is likely to affect the precision of these estimates (70, 71). Despite similar fat intakes, food sources of total dietary fat differed between the two groups. The top three fat sources for vegetarians were: vegetables [10.2%]; nuts and seeds [9.6%]; and grains and pasta [8.4%]; compared to: poultry [6.6%]; potato, kumara and taro [6.4%]; and bread based dishes [6.4%] for non-vegetarians. It was interesting that other meat based dishes such as beef and veal; lamb and mutton; and pork, did not provide substantial amounts of fat for the non-vegetarian diet group. This suggests that within this study population, convenience and processed meat foods could be taking precedence over healthier meat-based choices in the non-vegetarian diet group. The SuNDiAL study population on average consumed more energy from dietary fat [36.9% TEI] compared to any other population survey and relevant literature. Of concern, is that the contribution of fat towards total energy is 3.3% higher than reported in the 2008/09 ANS (39). While the causes of overweight and obesity are multifactorial (86, 87), fat intake has been associated with overweight and obesity (88) and these findings reiterate the need to reduce the quantity of dietary fat consumed within this population.

6.2 SAFA

Despite limited differences in total fat intake, it appears that there were considerable variations in the composition of dietary fat intakes between the two diet groups in the SuNDiAL study. Of particular interest was the meaningful difference in
SAFA intake, with vegetarians consuming less than their non-vegetarian counterparts. These results are consistent with previous studies (58, 67, 69). This is possibly related to the worldwide prevalence and affordability of convenience and processed meats in modern society (52, 53). The food group data also provides insight into why there may be differences in SAFA intake between these two diet groups. Interestingly, cheese provided the largest amount of SAFA in both diet groups in the SuNDiAL study. This indicates that while the vegetarian diet group avoided meat products containing poultry, beef, lamb and fish, they continued to select other animal derived foods such as dairy. Vegans, who omit all animal derived products (89), formed a small percentage of the SuNDiAL vegetarian population, which in part, explains the high prevalence of food items such as cheese, in this diet group. Other rich sources of SAFA in the vegetarian diet group included: biscuits [7.5%]; and milk [6.8%] compared to: bread based dishes [6.6%]; and cakes and muffins [6.2%], in the non-vegetarian diet group. This suggests that in terms of meat consumption, non-vegetarians tend to receive SAFA from processed meat sources. While vegetarians consumed SAFA in more favourable quantities compared to their non-vegetarian counterparts, population data suggests that difficulty in reducing SAFA to less than 10% of TEI is a problem experienced on a global scale by both diet groups. It is difficult to know what other lifestyle factors and motivations accompany vegetarianism and it is possible that meat avoidance is more motivated by ethical and environmental reasons opposed to health concerns. This could provide an explanation for the prevalence of highly processed foods in this diet group, and why SAFA intake, despite the avoidance of meat, is still on average, consumed in excess. While it is promising that the intake of SAFA in the New Zealand population has remained stable since the 2008/09 ANS (39), it
is problematic that the average SAFA intake is almost 4% above the recommended AMDR for the combined study population. Again, this is higher than reported in other countries. This suggests that food sources of SAFA comprise an affordable, readily available and socially accepted feature of the food culture and food environment in New Zealand (90). These elevated SAFA intakes warrant concern due to the negative CVD consequences that are associated with elevated SAFA consumption (24).

6.3 MUFA

The MUFA intakes of the two diet groups in the SuNDiAL study were similar. This was different to the findings in the studies by Perry et al and Segovia-Siapco et al, which concluded that vegetarian diet groups consumed greater amounts of energy from MUFA when compared to the non-vegetarian diet groups (58, 69). In addition to the small sample size of vegetarians in the SuNDiAL study, this difference could be explained by the fact that non-meat based foods are generous contributors of MUFA in the non-vegetarian diet group. The consumption of meat-based foods differentiate the two diet groups in the SuNDiAL population. If the non-vegetarian diet group are receiving considerable amounts of MUFA from other food groups that do not contain large amounts of meat, such as: potatoes, kumara and taro; and nuts and seeds; this may reduce the differences in MUFA consumption between the two diet groups. Despite the lack of differences in dietary MUFA intakes between vegetarians and non-vegetarians, there were notable variances in food sources of MUFA between diet groups. The vegetarians in the current study tended to consume healthier food sources of MUFA compared to non-vegetarians, as evidenced by the high contribution to MUFA intake from: nuts and seeds [12.8%]; vegetables [11.0%] and fruit [8.9%]. In comparison, the main sources of MUFA
in the non-vegetarian group were: poultry [8.4%]; potatoes, kumara and taro [7.8]; and nuts and seeds [6.9%]. The latter groups provide different nutrients, with some foods associated with higher intakes of SAFA. These differences highlight the importance of examining mean MUFA intakes in combination with food sources.

6.4 PUFA

The literature is consistent in suggesting that dietary intakes of PUFA are higher among vegetarian compared to non-vegetarian diet groups (58, 67, 69). The SuNDiAL study results are in agreement with this research, revealing that the vegetarian diet group consumed a greater proportion of their TEI from PUFA food sources when compared to their non-vegetarian counterparts [7.1% vs 5.4%]. The differences in intake in the two diet groups may be explained by the dominant food sources of PUFA in the vegetarian diet group. These included: vegetables [13.7%]; nuts and seeds [11.5%]; and grains and pasta [10.9%]. These types of foods groups which may be consumed in smaller amounts, offer PUFA in greater proportions than do the food groups providing PUFA in the non-vegetarian diet group, such as: poultry [6.7%]; and savoury sauces and condiments [6.1%]. Although findings are consistent between studies, the overall contribution of PUFA towards TEI differs between countries. PUFA intakes can positively impact blood cholesterol profiles, eliciting a stronger effect than that of MUFA (22, 32). Interestingly the results from the SuNDiAL study, and those conducted by Perry et al and Segovia-Siapco et al, suggest that PUFA contributes the smallest amount of energy compared to any other dietary fat, with ranges between approximately 4% and 8% of TEI. This may be explained by the fact that foods providing some of the richest sources of PUFA such as: oily fish; and fats and oils (37) were not important contributors of PUFA in the
present study. Other rich sources of PUFA such as nuts and seeds were still included in
the diet of the SuNDiAL population, but are perhaps consumed in small quantities.
Sweden, the country in which the study by Larsson et al was conducted, reveals a more
favourable contribution of PUFA in the vegan diet group [14.0% TEI] (67). This is
possibly explained by the elevated consumption of foods rich in PUFA such as nuts,
seeds, and legumes and the use of dietary supplements. When evaluating the findings of
the SuNDiAL study against the 2008/09 ANS survey, it would appear that the fat intakes
of female adolescents are higher [+3.3%] than reported in 2008/09 (39). This is likely a
reflection of the consumption of a greater amount of unsaturated fats. PUFA and MUFA
intakes were higher than the intakes consumed in the 2008/09 ANS, whereas intakes of
SAFA, although remaining at a concerningly elevated level, were similar.

6.4 strengths and Limitations

The small sample size in the vegetarian diet group is a notable limitation of this
study, influencing the precision of our estimates. However, the prevalence of vegetarians
in the present study was 12.4%, which is similar to that estimated at a national level
[~10%] (7). The 24-hour diet recalls were self-reported which can result in over- and
under-estimation of dietary intake, however, steps were taken to optimise the quality of
dietary data collected. All research teams received intensive training regarding the
methodology of both data collection and FoodWorks9 [Xyris Software, Australia Pty
Ltd] data entry. Including two 24-hour diet recalls and adjusting for intra-individual
variation using MSM, allowed for the assessment of usual intakes (57), although not all
days of the week were equally represented in the 24-hour diet recalls. The study did not
represent all regions in NZ, however, the multi-centred recruitment method in this study
provided more generalisable findings. There was diversity in deprivation status and ethnicity, although it was not entirely reflective of national statistics (81, 84). Collecting information on dietary intakes and food sources of SAFA, MUFA and PUFA was an important strength, allowing researchers to better understand the composition of dietary fats comprising the diet of the study population. It also provided a means of identifying the food groups that were providing the largest quantities of dietary fat.

6.5 Conclusion

This study indicates that while total fat intakes among 15-18 year old females in New Zealand are similar between vegetarians and non-vegetarians, fatty acid composition differs. Traditionally vegetarian diets are characterised by lower intakes of saturated fat and higher intakes of unsaturated fats. This still appears to be true in this group of vegetarian adolescents, who consumed less energy from SAFA, and more from PUFA compared to their non-vegetarian counterparts. Such a profile is associated with positive health outcomes in relation to CVD risk (13). Vegetarians were consuming more of their fat from healthful food groups such as: nuts and seeds; grains and pasta; and vegetables, in comparison to non-vegetarians, whose main sources included bread based dishes; and potato, kumara and taro. Where meat consumption is concerned, this study suggests that processed meats were the dominating category of meats selected by the non-vegetarians, indicating the need for a shift in the quality of meat they consume. However, a considerable proportion of participants in both diet groups exceeded the AMDR for total fat, and particularly SAFA intake. Given that CVD is a major contributor to morbidity and mortality in New Zealand, these high SAFA intakes need to be addressed in order to reduce chronic disease risk (23).
7. Application of Research to Dietetic Practice

7.1 Applicability and relevance to dietetic practice

Female adolescents experience a critical period of growth and development as they transition into women and it is important that as dietitians, the dietary patterns and requirements of this vulnerable population are well understood. It is also essential, that as the prevalence of vegetarianism continues to rise in light of environmental and ethical concerns, dietitians have sound knowledge regarding this pattern of eating. Being familiar with the health benefits and concerns associated with this diet, will dictate the quality of nutrition advice that can be provided to vegetarian patients and clients. This is especially important for young females during a time of increased nutrient and energy demands. Personally, the most important learning from this thesis resulting from spending considerable time researching this topic, and working in partnership with the female adolescent population. As a result of this experience I feel as though I have developed a true understanding for some of the challenges faced by this group.

After completing this thesis, I have also learned in depth about the unhealthy and concerning amount of dietary fat they consume. It is evident that action must be taken to improve the damaging food environment that persists in New Zealand, if there is any chance of reducing the prevalence of overweight and obesity in this country. To achieve change, dietitians who are highly trained in the area of nutrition are important advocates. Previously public health was an area that stimulated very little interest, however my research experience has motivated me to engage in health promotion, inspiring me to work in this field. As a next step I hope to become more involved in the public health initiatives active in my community so that I can enhance my learning.
7.2 A reflection of my personal research experience

As a practical learner, I did anticipate that writing my thesis would pose a massive challenge and I often questioned my capabilities. At the completion of this research experience I realised that that when I work on my own, I place unnecessary expectation and pressure upon myself to complete the tasks that are required of me. However during both data collection and thesis writeup, I was made aware of the strong support network that surrounded me. I had the guidance of my supervisor, my family and my friends and I could draw on the knowledge of past students who had also completed their theses. The utilisation of a support network is essential to me as a future practitioner, because I will constantly face challenges that I cannot overcome in isolation. Feeling comfortable asking for help when I am uncertain or lost, will be very important to me as a new graduate because I will be entering a new job with a lot of unknown territory. Completing my Master of Dietetics has been a rewarding journey and I am grateful for the lifelong skills and personal development that has resulted from this research experience.
8. References


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9. **Appendices**

**Appendix A:** University of Otago Human Research Ethics Committee: ethical approval document.

**Appendix B:** Ngai Tahu Research Consultation Committee, Te Komiti Rakahau Ki Kai Tahu.

**Appendix C:** SuNDiAL recruitment email distributed to schools.

**Appendix D:** SuNDiAL school consent form.

**Appendix E:** PowerPoint presentation [presented at WGHS].

**Appendix F:** SuNDiAL participant information sheet.

**Appendix G:** SuNDiAL 2019 Enrolment Questionnaire.

**Appendix H:** Protocol manual [24-diet recall].

**Appendix I:** Protocol manual [anthropometry].
Appendix A: University of Otago Human Research Ethics Committee: ethical approval document.

Dr J Haszard  
Department of Human Nutrition  
Division of Sciences  

Dear Dr Haszard,

I am writing to let you know that, at its recent meeting, the Ethics Committee considered your proposal entitled “SuNDIAL Project 2019: Survey of Nutrition Dietary Assessment and Lifestyle Phase 1: Adolescent Females”.

As a result of that consideration, the current status of your proposal is: Approved

For your future reference, the Ethics Committee’s reference code for this project is: H19/004.

The comments and views expressed by the Ethics Committee concerning your proposal are as follows:–

While approving the application, the Committee would be grateful if you would respond to the following:

Information Sheet

A typing error was noted on the Information Sheet, under the heading “Is there any risk of discomfort or harm from participation?”, line 3, “some” should read “someone”.

Consent Form

Please amend the Consent Form to include an option for participants to indicate whether they would prefer for their blood samples to be disposed of using standard methods or with a Karakia.

Please provide the Committee with copies of the updated documents, if changes have been necessary.

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.
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

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

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.farrondiaz@otago.ac.nz

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.

The Human Ethics Committee (Health) asks for a Final Report to be provided upon completion of the study. The Final Report template can be found on the Human Ethics Web Page http://www.otago.ac.nz/council/committees/committees/HumanEthicsCommittees.html

Yours sincerely,

[Signature]

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
Appendix B: Ngai Tahu Research Consultation Committee, Te Komiti Rakahau Ki Kai Tahu.

Monday, 17 December 2018

Dr Meredith Peddie
Department of Human Nutrition

Tēnā Koe Dr Meredith Peddie


The Ngāi Tahu Research Consultation Committee (the Committee) met on Tuesday, 11 December 2018 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 outlined 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 considers the research to be of importance to Māori health.

As this study involves human participants, the Committee strongly encourages that ethnicity data be collected as part of the research project as a right to express their self-identity.

The Committee suggests researchers consider the Southern District Health Board's Tikaka Best Practice document, in particular patient engagement. The document also covers the collection, storage and disposal of blood and tissue samples. This document is available on the Southern District Health Board website. The Committee also refers researchers to Te Mana Raranga Māori Data Audit Tool, which gives an overview of key Māori Data Sovereignty terms and principles.

The Ngāi Tahu Research Consultation Committee has membership from:

Te Rūnanga o Ōtāko Incorporated
Kāti Horoaka Rūnanga o Pukerewi
Te Rūnanga o Mawatere
We wish you every success in your research and the Committee also requests a copy of the research findings.

This letter of suggestion, recommendation and advice is current for an 18-month period from Tuesday, 11 December 2018 to 3 June 2020.

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.

Nīhaku noa, nā

Claire Porima
Kaiwhakahaere Pūtere
Senior Project Manager
Office of Māori Development
Te Whare Wānanga o Otago
Ph: +64 3 479 7461
Email: claire.porima@otago.ac.nz
Web: www.otago.ac.nz
Appendix C: SuNDiAL recruitment email distributed to schools.

Subject: Healthy Eating: What does this look like for girls at <insert school name>?  

To the Senior Management/Leadership Team,

This year the Department of Human Nutrition & Dietetics at the University of Otago is conducting a research project called SuNDiAL (Survey of Nutrition, Dietary Assessment, and Lifestyles). SuNDiAL is a nationwide survey of girls aged 15-18 years, to be carried out in high schools around the country.

We are writing to invite your school to participate in this survey. Participation at a school level involves allowing our research team to come into the school and collect information on the dietary intakes and lifestyle habits of girls who choose to participate. In return we will provide you with information about the dietary and lifestyle habits of New Zealand female adolescents. We will even provide you with a report tailored to show how your school compares to others across the country.

Research teams will be operating in your area in July to September.

To find out more about participation, please visit our website:  
www.otago.ac.nz/sundial

If you are interested in your school being involved please contact us at sundial@otago.ac.nz.

If you would like to talk to one of our lead researchers, you are welcome to ring Dr Meredith Peddle on: (03) 479 8157. Or we can arrange to ring you at a time convenient to you.

We look forward working with you and the girls at <insert school name> this year.

Kind regards,
Tessa Scott
SuNDiAL Coordinator
Appendix D: SuNDiAL school consent form.

I confirm that Whangarei Girls’ High School has agreed to be a participating school in the SuNDiAL project.

As part of this project a research team will be collecting data from 15-18 year old female adolescents enrolled at Whangarei Girls’ High School. Participating students will be completing a series of questionnaires about their diet and lifestyle, as well as their attitudes and motivations around food choices and have their height, weight and forearm length measured. Participants may also provide a blood and urine sample and wear an accelerometer for 7 days to monitor their activity patterns if they choose to. The majority of the questionnaires will be completed in a visit conducted during school time, in which researchers from the Department of Human Nutrition, University of Otago will be based at Whangarei Girls’ High School. The times of these visits will be organised in consultation in the research team to limit the disruption to our timetable. There are also two or three questionnaires that participating students will be asked to complete in their own time.

In supporting students from our school to participate in the SuNDiAL project we will provide space for the research team to conduct data collection, and access to the school wi-fi.

I understand that this research will be conducted in accordance with the declaration of Helsinki and will be approved by the University of Otago Human Ethics Committee (Health) before data collection begins.

Signature: __________________________

Name: (please print) __________________________

Title: __________________________

Date: __________________________
Appendix E: PowerPoint presentation [presented at WGHS].

Slide One: SuNDiAL
University of Otago
Abbie Fuller + Bridget Murdoch

Slide Two: WHO?
WHAT?
WHY?

We are Dietetics students from the University of Otago and we are looking for female high school students aged 15 – 18 years.

We need participants for a nationwide study that is looking at the food intakes and lifestyles of New Zealand females.

We need your help so that we have a better understanding of the food habits and patterns of females your age.
You will receive up to $30 in vouchers for your involvement in the study.

We would love to have you on board. Enroll with us after assembly today or visit:

www.otago.ac.nz/sundial
Appendix F: SuNDiAL participant information sheet.

Participant Information Sheet

<table>
<thead>
<tr>
<th>Study title:</th>
<th>The SuNDiAL Project 2019: A survey of nutrition, dietary assessment and lifestyle</th>
</tr>
</thead>
</table>
| Principal investigators: | Names Dr Jill Haszard & Dr Meredith Pedgee  
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?

We don’t know much about teenage women’s food intakes and lifestyles in New Zealand. We suspect that they don’t get enough of some nutrients like iron sometimes, and that this can make them feel tired and affect their health. Teenagers often make their own decisions about what foods to eat, but we don’t know very much about why they choose the foods they eat. Therefore in 2019 the SuNDiAL project is going to investigate food intakes, nutrition, health, and why female high school students (aged 15-18 years) 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, and a Lottery Health Research Grant.
Who are we seeking to participate in the project?

We are looking for at least 300 female 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 a questionnaire that asks questions about your health and some general questions such as what ethnicity you identify with this questionnaire also asks you about your overall eating habits, and why you choose to eat the foods that you do. This questionnaire will take about 30 min to complete.

2) Attend a session at your school with our research team
   This visit will take about 60 minutes and you will be asked to:
   - Complete a face to face interview with one of our research team during which you will be asked to recall everything you ate and drank the day before.
   - At this session one of our research team will also measure your height, your weight, and the length of your lower arm – these measurements will be done 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 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 in which you will be asked to recall everything you ate and drank on a different day of the week than the first interview. This is important because sometimes you can eat quite differently 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 not 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 collect blood during the session at school), 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 whether you’re iron deficient or not. You can still take part in the rest of the study even if you don’t do this bit.
2) Provide a urine sample

We would also like you to give a urine ("pee") sample (which is easy for you collect yourself in the bathroom with the equipment we give you, during the session at school). You can still take part in the rest of the study even if you don’t do this bit.

3) Wear an accelerometer for a week

We would also 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 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.

After the completion of the study you will receive a $5 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, $5 for completing the second interview about what you ate; $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 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 minimize 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 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 nutrition status of female high school students in New Zealand. Information about why people eat the way they do will also be very helpful if 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 women in New Zealand.

If you provide a blood sample it will be divided into 3 separate parts. One part will be taken to a local laboratory where it will be analysed for Vitamin B12 concentrations and a complete blood count. The
other two parts of your blood sample will be transported to the Department of Human Nutrition at the University of Otago where they will be stored in a freezer until we have finished collecting all the blood samples from around the country. When all the blood samples have been collected, one part of your blood sample will be sent to Germany where it will be analysed for ferritin, soluble transferrin receptor, retinol binding protein, C-reactive protein and alpha-glycoprotein. We are sending this sample to Germany because they have a special machine that can measure these things on a much smaller amount of blood, at a smaller cost, than we can do in New Zealand. The remaining part of your blood sample will remain at the Department of Human Nutrition, where it will be analysed for plasma selenium and plasma zinc, thiamin, plasma folate, Vitamin B6, Leptin, Interukin-6 and blood lipids.

If you provide a urine sample it will also 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. On the consent form you can indicate to us if you would like your samples disposed of with a Karakia (Māori Prayer). **We will only test your samples for the things listed here, and won't test them for anything else.**

**What about anonymity and confidentiality?**

Your information will be identified with an ID number only in the database that contains the results of the study. 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 2019) 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:
<table>
<thead>
<tr>
<th>Name: Dr Jill Hazzard</th>
<th>Contact phone number:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position: Senior Research Fellow</td>
<td>03 479 5683</td>
</tr>
<tr>
<td>Department of Human Nutrition</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name: Dr Meredith Peddie</th>
<th>Contact phone number:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position: Research Fellow</td>
<td>03 479 8157</td>
</tr>
<tr>
<td>Department of Human Nutrition</td>
<td></td>
</tr>
</tbody>
</table>

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 gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Appendix G: SuNDiAL 2019 Enrolment Questionnaire.

Confidential

SuNDiAL 2019 Enrolment Questionnaire

Thank you for showing an interest in this project. Please read the information about 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 it.

Who are we seeking to take part in the project?
We are looking for female high school students who are 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 with three parts to it: (i) health & demographics; (ii) why you choose the food you eat; and (iii) your dietary habits.

2) Attend a session at your school with our research team. This visit will take about 60 minutes and you will be asked to recall the food and drink you've consumed over the last day. You will also have your height, weight, and length of your lower arm measured. These measurements will be done twice to make sure they are as accurate as possible. This will be done in a private space and you may ask for the measurements if you want them.

3) In the next week or two we'll ring or video call you to do a second food and drink recall.

Any questions?

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

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 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 02/07/2019 12:59pm www.projectredcap.org
You have had all your questions answered about the study and understand that you can ask for more information at any stage.

You know that when the project is completed all personal information that could be linked to you will be removed from the paper records and electronic files for the project, and that these will be placed in secure storage and kept for at least ten years.

You are a young woman who is 15 to 18 years old and isn't pregnant.

You know you can pull out of the study anytime before it finishes in October 2019.

If you don't want to take part in the SUNDIAL project, please click on the “disagree” button.

☐ AGREE
☐ DISAGREE
Thank you for agreeing to taking part in the SuNDIAL project! If you are female, aged 15-18 years of age and not pregnant, please answer the following two questions:

<table>
<thead>
<tr>
<th>What age are you as of today?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ 15</td>
</tr>
<tr>
<td>☐ 16</td>
</tr>
<tr>
<td>☐ 17</td>
</tr>
<tr>
<td>☐ 18</td>
</tr>
<tr>
<td>☐ None of the above</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What high school do you attend?</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Tauraroa Area School</td>
</tr>
<tr>
<td>☐ Mt Maunganui College</td>
</tr>
<tr>
<td>☐ Spotswood College</td>
</tr>
<tr>
<td>☐ Wellington Girls College</td>
</tr>
<tr>
<td>☐ Wairau College</td>
</tr>
<tr>
<td>☐ Hornby High School</td>
</tr>
<tr>
<td>☐ Columba College</td>
</tr>
<tr>
<td>☐ Kalkoral Valley College</td>
</tr>
<tr>
<td>☐ Queens High School</td>
</tr>
<tr>
<td>☐ Mt Aspiring College</td>
</tr>
<tr>
<td>☐ None of the above</td>
</tr>
</tbody>
</table>
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 not 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. On the consent form (below) you can tell us if you would like your blood sample disposed of with a Karakia (Māori Prayer).

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” button.

BLOOD SAMPLE:

We would like you to provide a blood sample (which would be collected by someone with extensive training in how to collect blood), but we understand that not everyone feels comfortable about this so it is entirely up to you if you do this. If you do provide a blood sample, we can tell you whether you’re iron deficient or not. 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 understand the risks of discomfort involved in providing a blood sample

☐ AGREE
☐ DISAGREE

Please click here if you want your samples disposed of with a Karakia (Māori Prayer)

☐ Yes
☐ No

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:

☐ 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 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.

☐ AGREE
☐ DISAGREE
<table>
<thead>
<tr>
<th><strong>Contact Information</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>What is your name?</td>
</tr>
<tr>
<td>(Preferred first name, Last name)</td>
</tr>
<tr>
<td>What is your date of birth?</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Phone number (mobile would be best - so we can text you reminders)</td>
</tr>
<tr>
<td>What is your home address? (This will be the address where we will send your voucher)</td>
</tr>
<tr>
<td>(number &amp; street, suburb, city, postcode)</td>
</tr>
<tr>
<td>Do you live at this address during school term?</td>
</tr>
<tr>
<td>Do you live in a boarding house during school term?</td>
</tr>
<tr>
<td>(Don't include private boarding)</td>
</tr>
<tr>
<td>Please put the name and/or address of the boarding house</td>
</tr>
<tr>
<td>(number &amp; street, suburb, city, postcode)</td>
</tr>
<tr>
<td>What is the address that you live at during school term?</td>
</tr>
<tr>
<td>(number &amp; street, suburb, city, postcode)</td>
</tr>
</tbody>
</table>

02/27/2019 12:59pm  www.projectredcap.org
### Health Information

If you know your height, please write it here:  

What unit is this measurement in?  

- centimetres  
- metres  
- feet and inches

If you know your weight (in kg) please write it here:
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you been diagnosed with diabetes?</td>
<td>○ Yes  ○ No</td>
</tr>
<tr>
<td>If so, which type?</td>
<td>○ Type 1 diabetes  ○ Type 2 diabetes  ○ Don't know</td>
</tr>
<tr>
<td>Do you avoid eating gluten?</td>
<td>○ Yes  ○ No</td>
</tr>
<tr>
<td>Have you been diagnosed with either coeliac disease or gluten intolerance?</td>
<td>○ Yes - coeliac disease  ○ Yes - gluten intolerant  ○ No diagnosis but suspected intolerance or coeliac  ○ No</td>
</tr>
<tr>
<td>Have you been diagnosed with a food allergy or intolerance? (not gluten)</td>
<td>○ Yes  ○ No</td>
</tr>
<tr>
<td>Which foods are you allergic or intolerant to? (Select as many as apply)</td>
<td>□ Eggs  □ Dairy  □ Nuts  □ Shellfish  □ Other</td>
</tr>
<tr>
<td>Other: please specify</td>
<td></td>
</tr>
<tr>
<td>Are you vegetarian or vegan?</td>
<td>○ Yes  ○ No</td>
</tr>
<tr>
<td>Which foods do you eat? (Select as many as apply)</td>
<td>□ Egg  □ Milk (not plant milk like soy milk)  □ Fish or seafood  □ Chicken or poultry  □ Meat/red meat occasionally  □ None of the above</td>
</tr>
<tr>
<td>Are you vegan?</td>
<td>○ Yes  ○ No</td>
</tr>
<tr>
<td>How long have you been following this way of eating?</td>
<td>○ Less than a month  ○ Between 1 and 6 months  ○ Between 6 months and 1 year  ○ Between 1 and 2 years  ○ More than 2 years  ○ My whole life</td>
</tr>
</tbody>
</table>
The following questions are a bit sensitive, but it is necessary for us to ask them because they can help us understand what nutrients are important for the health of young women your age.
### Confidential

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>How old were you when you had your first period?</td>
<td>11 years or younger, 12-14 years, 15 years or older, I haven't had a period yet</td>
</tr>
<tr>
<td>How long do you usually have from the start of one period to the start of the next?</td>
<td>Less than a week, 1-2 weeks, 3-4 weeks, 4-5 weeks, More than 5 weeks, I haven't had a period for 3 months, The timing of my periods is not regular</td>
</tr>
<tr>
<td>How many days does your period usually last? (count your light days as well as your heavy ones)</td>
<td>Less than 4 days, 4-8 days, 7-9 days, 10 days or more</td>
</tr>
<tr>
<td>Are your periods so heavy that they make it hard for you to go to school?</td>
<td>Yes - often, Yes - sometimes, No</td>
</tr>
<tr>
<td>Have you donated blood?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>When did you last donate blood?</td>
<td>In the last 4 months, Between 4 and 12 months ago, More than a year ago</td>
</tr>
<tr>
<td>Have you had a nosebleed in the last year?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Do you have nosebleeds regularly?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Over the last year, on average how often did you get nose bleeds?</td>
<td>More than once a week, Once a week, Every couple of weeks, Once a month, Every few months, Every 6 months, Once a year, Less than once a year</td>
</tr>
<tr>
<td>Do you use any of the following contraceptives:</td>
<td>No - I don't use those contraceptives, Yes - I use one of those contraceptives</td>
</tr>
<tr>
<td>- Oral contraceptive (eg 'the pill' or 'the mini-pill')</td>
<td>-</td>
</tr>
</tbody>
</table>
### Other Information

Which ethnic group do you belong to? (Mark those that apply)
- New Zealand European
- Māori
- Samoan
- Cook Island Māori
- Tongan
- Niuean
- Chinese
- Indian
- Other such as Dutch, Japanese, Tokelauan, please state...

Other: please state

---

Please let us know which type of gift card you would prefer:
- New World
- PaknSave

---

Thank you for enrolling in the SuNDIAL project!

What happens next?

We are now going to ask you to complete a questionnaire about why you eat the food you do. If you want to complete it at a later time, please click the Save and Return button at the bottom of this page (don’t forget to make a note of your code so that you can return to 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.
Appendix H: Protocol manual [24-diet recall].

24 Hour Recall

Introduce yourself to the participant, thank them for participating in the sundial project and ask them to take a seat.

“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.”

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. Sometime 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 xxx” [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)
Useful Prompts 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. 1/4 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
- Phytoestrols (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
Appendix I: Protocol manual [anthropometry].

ANTHROPOMETRIC MEASUREMENTS

Gain verbal consent from the participant for each measurement and explain fully what you will do to obtain them. Before beginning, gain consent from the participant to use non-permanent pen for marking anatomical landmarks.

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

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 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 (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:

Ulana length is measured between the point of the elbow and the midpoint of the prominent bone of the wrist using an anthropometric 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.

REPEAT ALL MEASUREMENTS

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 no 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.