Comparison of sugar intakes between vegetarian and non-vegetarian adolescent females

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A thesis submitted in partial fulfilment of the requirements for the degree of Master of Dietetics

At the University of Otago, Dunedin, New Zealand

[November 2019]
Abstract

**Background:** Sugar consumption has been associated with an increased risk of obesity and non-communicable diseases. Adolescents are high consumers of sugar in New Zealand (NZ), particularly added sugar. With NZ’s high obesity rates, a diet associated with lower weight status, such as that of a vegetarian diet, warrants further research. No known studies in NZ have compared the sugar intakes and food sources of sugar between vegetarian and non-vegetarian adolescent females.

**Objectives:** To gather data on the sugar intakes of vegetarian and non-vegetarian adolescent females using 24-hour diet recalls. To analyse and compare the food sources of sugar within vegetarian and non-vegetarian diets. To compare the sugar intakes of vegetarians and non-vegetarians with international recommendations.

**Design:** A convenience sample of females aged 15 to 18 years were recruited from schools across NZ to participate in this cross-sectional observational study between February and September 2019. Targeted recruitment of vegetarian females took place from July 2019. Thirty-one vegetarians (8 vegan) and 219 non-vegetarians, consented and had their sugar intakes assessed using 24-hour diet recall interviews. Telephone repeat recalls were collected from 85% of the population. Demographic, health, dietary habits, and attitudes and motivations towards food choice data were collected through self-administered online questionnaires. Data collectors recorded anthropometric measurements. Dietary data were entered into Foodworks which use NZ Food Composition Tables to calculate nutrient intakes and adjusted to reflect usual intake using the Multiple Source Method. Intakes of vegetarian and non-vegetarian total and individual sugars, and food sources of sugar were
analysed and compared. Total sugar was categorised into assumed added sugar and natural sugar. Added sugar was unavailable in the FOODfiles 2014 database so assumed as total sugar less maltose, lactose, and the sum of glucose and fructose adjusted by 0.67 to account for sucrose intrinsic to fruit. Natural sugar was total sugar less assumed added sugar.

**Results:** There were no differences in sugar intake between vegetarians and non-vegetarians when expressed as total sugar or assumed added sugar. Vegetarians consumed less lactose compared to non-vegetarians with a mean (95% confidence interval (CI)) difference of 3.1 (0.5, 5.6) grams/day. Non-vegetarians consumed more natural sugar than vegetarians with a mean (95% CI) difference of 9.4 (1.8, 17.0) grams/day. Fruit, non-alcoholic beverages, sugar/sweets, milk and cakes and muffins were the five top food sources of sugar for the study population. Vegetarians consumed a lower proportion of total sugar from non-alcoholic beverages (6.8% vs 12.5%), and a higher proportion from vegetables (8.7% vs 5.7%), than non-vegetarians. An estimated 82% of the population met the United States Department of Agriculture sugar recommendation that added sugar should be <10% total energy (TE), and 44% met the World Health Organisation recommendation that free sugars contribute < 5% TE when using added sugar intake as a surrogate marker.

**Conclusion:** The current study shows relative sugar intakes of vegetarians were no different to non-vegetarians, however, absolute intake of natural sugar and lactose were lower. The results of this research suggest neither a vegetarian or non-vegetarian diet for NZ female adolescents is associated with a superior sugar profile. Any favourable health benefits related to the sugar intakes of a vegetarian diet are likely attributed to the food
sources from which vegetarians obtain sugar, rather than their relative sugar intakes. In dietetic practice, this means a focus should be placed on the quality of sugar sources, rather than its total consumption.
Preface

This research is a part of the wider Survey of Nutrition Dietary Assessment and Lifestyle (SuNDiAL) Project conducted in Dunedin at the University of Otago by the second year Masters of Dietetics students of 2019. Clara Fergus (candidate) conducted this study under the supervision of Dr. Bernard Venn from the department of Human Nutrition.

Dr Meredith Peddie and Dr Jill Haszard were the principal investigators responsible for gaining ethical approval, registering the study, conceiving the study design, organising recruitment, and processing the results. Dr Bernard Venn supervised the thesis write-up.

The candidate was responsible for:

- Conducting a literature review on the topic of sugar intakes amongst vegetarian adolescents;
- Participant recruitment and engagement;
- Liaising with study stakeholders;
- Being an active member of the study data collection team; including arranging participant bookings, liaising with the school where the study took place, setting up and coordinating the testing days, conducting 24-hour diet recalls, collating the dietary data and entering it into Foodworks;
- Interpretation of the study results;
- Writing and assembling the thesis.

The candidate presented the findings of this research in an oral presentation at the SuNDiAL symposium on the 19th November 2019, before the submission of this thesis.
Acknowledgements

I would like to express many thanks first and foremost to the continuous support of my supervisor Dr Bernard Venn. Thank you for all of your proof-reading and ideas and for challenging me to always question and critique. This skill will go a long way in my future writing.

Thank you to the study coordinators Dr Meredith Peddie and Dr Jill Haszard, and to Tessa Scott for all the hours of effort behind the scenes designing, teaching, and coordinating the SuNDiAL project. A special thanks to Jill for the prompt delivery of data results. There is no way I would have been able to achieve all that I’ve managed throughout the thesis time-period without the support of all of you so I’m sincerely grateful.

To my data collecting companion Poppy Varley-Clapp, you made my time spent at data collection unforgettable. I am very lucky to have found such an extraordinary friend in you.

Thank you Liz Fleming for the time you dedicated both behind the scenes and in zoom meetings teaching us how to enter all our dietary data accurately.

Thank you to the team at Mt Aspiring College for facilitating our research project and to all the great participants we got to know along the way. All the best for your future pursuits.

Last but certainly not least, a sincere thanks to my amazing whanau for supporting me through the duration of thesis, eating my procrastination baking, and putting up with a rather boring housemate. To my friends, I apologise for all the outings I have missed and appreciate your ongoing encouragement and patience to get your fun friend back.

The contribution of numerous other people along the way has helped to make this thesis a successful one. Thank you to everyone involved.
Table of Contents

Abstract ............................................................................................................................ ii
Preface ............................................................................................................................ v
Acknowledgements ......................................................................................................... vi
Table of Contents ................................................................................................ .......... vii
List of Tables ............................................................................................................... ix
List of Figures ............................................................................................................. x
List of Abbreviations .................................................................................................... xi

1. Introduction .............................................................................................................. 1

2. Literature Review .................................................................................................... 3  
   Literature Review Search Methods ........................................................................ 3  
   Background .......................................................................................................... 3  
   1.1 History of intake and current mode of use ....................................................... 5  
   1.2 Sugar digestion and metabolism .................................................................... 6  
   1.3 Recommended intakes ................................................................................... 6  
   1.4 Health effects of high intakes ....................................................................... 8  
       1.4.1 Dental Caries .......................................................................................... 9  
       1.4.2 Body Weight ........................................................................................ 10  
       1.4.3 Other Health Conditions ...................................................................... 11  
   1.5 Target population ............................................................................................ 11  
   1.6 Definition of vegetarian diets .......................................................................... 12  
   1.7 Vegetarianism in New Zealand ........................................................................ 13  
   Main Review ........................................................................................................... 15  
   1.8 Intakes in Adolescent Females ....................................................................... 15  
       1.8.1 Sugar intakes within the general population .......................................... 15  
       1.8.2 Sugar intakes within adolescent vegetarian populations ........................... 19  
       1.8.3 Sugar intakes within other vegetarian populations ................................. 22  
   1.9 Rationale for Research .................................................................................... 23  

2 Objective Statement ............................................................................................... 25

3 Methods .................................................................................................................. 26  
   3.1 Study Design ................................................................................................... 26  
   3.2 Recruitment ...................................................................................................... 28  
       3.2.1 School-based recruitment ...................................................................... 28  
       3.2.2 Participant recruitment ........................................................................ 29  
       3.2.3 Targeted recruitment ............................................................................ 29  
   3.3 Study Procedure ............................................................................................... 30  
       3.3.1 Interrater reliability ............................................................................... 30  
       3.3.2 Data collection ....................................................................................... 30  
       3.3.3 Dietary Analysis ..................................................................................... 32  
       3.3.4 Categorisation of Sugar ....................................................................... 33  
   3.4 Statistics ............................................................................................................ 34  
       3.4.1 Sample size ............................................................................................ 34  
       3.4.2 Statistical food group methods ............................................................... 34
4 Results ........................................................................................................................................... 36
   4.1 Group Demographic Comparisons .......................................................................................... 38
   4.2 Dietary Sugar Intake Comparison ............................................................................................. 39
   4.3 Food Sources of Dietary Sugar ................................................................................................ 43
   4.4 Dietary Sugar Intakes Compared With Recommendations ...................................................... 45
5 Discussion and Conclusion ........................................................................................................... 47
   5.1 Conclusion ............................................................................................................................... 53
6 Application of Research to Dietetic Practice .............................................................................. 54
   6.1 Part A: Applicability and relevance to dietetic practice ............................................................ 54
   6.2 Part B: What has this research meant to you? ......................................................................... 55
7 References ..................................................................................................................................... 56
8 Appendices ..................................................................................................................................... 68
   Appendix A: Ethics Proposal .......................................................................................................... 69
   Appendix B: Māori Consultation Response .................................................................................... 71
   Appendix C: Participant Information Sheet ................................................................................... 73
   Appendix D: REDCAP Enrolment Questionnaire .......................................................................... 78
   Appendix E: Attitudes and Motivations for Food Choice Questionnaire ...................................... 89
   Appendix F Dietary Habits Questionnaire .................................................................................... 108
   Appendix G Anthropometric Measurements Protocol ................................................................. 129
   Appendix H: 24-Hour Diet Recall Protocol .................................................................................... 131
   Appendix I Data Collection Day Spread ...................................................................................... 136
List of Tables

<table>
<thead>
<tr>
<th>Table Number</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE 2.1</td>
<td>DEFINING SUGAR</td>
<td>4</td>
</tr>
<tr>
<td>TABLE 2.2</td>
<td>INTERNATIONAL SUGAR INTAKE RECOMMENDATIONS</td>
<td>7</td>
</tr>
<tr>
<td>TABLE 2.3</td>
<td>DEFINING VEGETARIAN DIETS</td>
<td>13</td>
</tr>
<tr>
<td>TABLE 2.4</td>
<td>SUGAR INTAKES WITHIN THE GENERAL POPULATION</td>
<td>16</td>
</tr>
<tr>
<td>TABLE 2.5</td>
<td>SUGAR INTAKES WITHIN ADOLESCENT VEGETARIAN POPULATIONS</td>
<td>20</td>
</tr>
<tr>
<td>TABLE 3.1</td>
<td>DESCRIPTION OF THE FOOD GROUPS</td>
<td>27</td>
</tr>
<tr>
<td>TABLE 4.1</td>
<td>BASELINE PARTICIPANT DEMOGRAPHICS (N = 250)</td>
<td>38</td>
</tr>
<tr>
<td>TABLE 4.2</td>
<td>SUGAR CONSUMPTION CATEGORISED BY TOTAL, NATURAL AND ASSUMED ADDED SUGAR AS A PROPORTION OF AVERAGE DAILY ENERGY CONTRIBUTION BY VEGETARIAN STATUS</td>
<td>43</td>
</tr>
<tr>
<td>TABLE 4.3</td>
<td>TOP DIETARY CONTRIBUTORS AS A MEAN PERCENTAGE (SD) OF TOTAL SUGAR INTAKE BY VEGETARIAN STATUS AND FOOD GROUP</td>
<td>44</td>
</tr>
<tr>
<td>TABLE 4.4</td>
<td>PROPORTION OF PARTICIPANTS ADHERING TO THE USDA, WHO, NAM AND ANSES SUGAR RECOMMENDATIONS</td>
<td>45</td>
</tr>
</tbody>
</table>
List of Figures

**Figure 1** Study Design and Participant Flow Diagram.................................................................37

**Figure 2** Comparison of Daily Dietary Glucose, Fructose, Sucrose, Lactose and Maltose Intake (Grams/day) by Vegetarian Status..................................................................................................40

**Figure 3** Mean Total, Natural and Assumed Added Sugar Intake (Grams/day) by Vegetarian Status..............................................................................................................................................42
# List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHA</td>
<td>American Heart Association</td>
</tr>
<tr>
<td>ANS</td>
<td>Adult Nutrition Survey</td>
</tr>
<tr>
<td>ANSES</td>
<td>French Agency for Food, Environmental and Occupational Health and Safety</td>
</tr>
<tr>
<td>BMI</td>
<td>Body mass index</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence interval</td>
</tr>
<tr>
<td>CVD</td>
<td>Cardiovascular disease</td>
</tr>
<tr>
<td>d</td>
<td>Day</td>
</tr>
<tr>
<td>EFSA</td>
<td>European Food Safety Authority</td>
</tr>
<tr>
<td>FFQ</td>
<td>Food frequency questionnaire</td>
</tr>
<tr>
<td>g</td>
<td>Grams</td>
</tr>
<tr>
<td>HFCS</td>
<td>High fructose corn syrup</td>
</tr>
<tr>
<td>hr</td>
<td>Hour</td>
</tr>
<tr>
<td>ICC</td>
<td>Intra-class correlation coefficients</td>
</tr>
<tr>
<td>ID</td>
<td>Identification</td>
</tr>
<tr>
<td>IOM</td>
<td>Institute of Medicine</td>
</tr>
<tr>
<td>MDiet</td>
<td>Master of Dietetic</td>
</tr>
<tr>
<td>MOH</td>
<td>Ministry of Health</td>
</tr>
<tr>
<td>n</td>
<td>Sample size</td>
</tr>
<tr>
<td>NAM</td>
<td>National Academy of Medicine</td>
</tr>
<tr>
<td>NZ</td>
<td>New Zealand</td>
</tr>
<tr>
<td>NZDep</td>
<td>New Zealand Index of Deprivation</td>
</tr>
<tr>
<td>NZEO</td>
<td>New Zealand European and Others</td>
</tr>
<tr>
<td>SACN</td>
<td>Scientific Advisory Committee on Nutrition</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>SSB</td>
<td>Sugar-sweetened beverage</td>
</tr>
<tr>
<td>TE</td>
<td>Total energy</td>
</tr>
<tr>
<td>T2DM</td>
<td>Type 2 Diabetes Mellitus</td>
</tr>
<tr>
<td>UL</td>
<td>Upper limit</td>
</tr>
<tr>
<td>U.S.</td>
<td>United States of America</td>
</tr>
<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
1. Introduction

Sugar is a ubiquitous part of everyday diets. It is consumed as a naturally inherent component of food and as an addition to food and beverages by manufacturers and consumers. Besides delivering energy when ingested, sugars add sweetness, enhance the sensory properties of food, support structural and textural functions, and contribute towards colour, microbial growth prevention and mass of the food. (1 – 3)

Sugar is found in nutrient-rich foods like fruit, milk, and vegetables and in processed foods like confectionary, non-alcoholic beverages, and baked goods. The human body is incapable of distinguishing between natural and added sugar. (4) Nonetheless, sugar sources are an important consideration. Added sugar has been identified as a source of “empty calories”, meaning it may displace an appetite for an intake of more nutritious food. (5) When consumed in excess of 10% total energy (TE), added sugar has been linked to dental caries and associated with weight gain if the calories are not offset elsewhere in the consumer’s diet or lifestyle. (6)

New Zealand (NZ) public health recommendations are to ‘choose and/or prepare foods with little or no added sugars’. (7) Whether New Zealanders are meeting these recommendations is difficult to discern as free and added sugars were not reported in the most recent Adult Nutrition Survey (ANS). Fruit, non-alcoholic beverages, ‘sugar and sweets’ and milk were the major sugar sources in the diets of New Zealanders aged over 15 years in 2008/09. (8) Non-alcoholic beverages, sugar and sweets all provide concentrated sources of added sugar. As two main total sugar sources, this validates concern that the population is not selecting low added-sugar food items.
Quantitative recommendations have been made globally to restrict added sugar intakes. Perhaps the most applicable to NZ are the United States Department of Agriculture (USDA) recommendation to ‘consume <10% of calories per day from added sugars’ and the World Health Organisation (WHO) recommendation to further limit intake of free sugars to <5% TE for additional benefits. (6) Of the individual sugars, sucrose contributed the largest proportion of energy (13.3%) in the diets of NZ female adolescents 15-18 years from the most recent national ANS, a sugar primarily added to foods and beverages by manufacturers. (8, 9) This level of sucrose consumption suggests NZ female adolescents may be exceeding the USDA and WHO recommendations.

New Zealand has the third highest obesity rates in adults over the age of 15 years amongst the Organisation for Economic Co-operation and Development countries. (10) A lifestyle with the potential to reduce obesity rates is of interest to the wellbeing of NZ. Vegetarian diets have been associated with lower body mass indexes (BMIs), incident diabetes and obesity risk, favourable lipid profiles, and reduced risk of oesophageal, lung, stomach and colorectal cancers. (11) Whether low sugar intake amongst vegetarians is contributing to their favourable health profiles is of interest. No known studies in NZ have explored this matter. Worldwide studies frequently compare the entire diet, focusing on food sources of sugar, rather than sugar intakes specifically and hence yield mixed results. (12-16)

The aim of the present study was to analyse and compare the sugar intakes and food sources of sugar of vegetarian and non-vegetarian adolescent females aged 15 to 18 years enrolled in NZ secondary schools.
2. Literature Review

Literature Review Search Methods

Literature searches were conducted between September 2018 and November 2019 using the electronic databases Scopus and Google Scholar for relevant articles. Key search terms were sugar AND sucrose AND vegetarian. To identify articles which had not been identified in the electronic search, further literature was obtained from the reference lists of published articles that had been previously identified. The World Wide Web was also used to retrieve information on international sugar intakes and recommendations.

Background

Sugars are carbohydrates in the form of monosaccharides, disaccharides, and polyols (sugar alcohols). Glucose and fructose are the principal dietary monosaccharides while the principal disaccharides are sucrose, maltose, trehalose and lactose. Disaccharides are formed by the combination of two monosaccharide molecules. Glucose and fructose combine to form sucrose, glucose and glucose combine to form maltose or trehalase, and galactose and glucose combine to form lactose. Mono- and disaccharides are “glycaemic carbohydrates” meaning they provide carbohydrate for metabolism. (17) Sugars are found in fruits (raw/cooked/dried), berries, honey, fruit juices, some vegetables, milk and milk products, and foods containing sucrose and starch hydrolysates (e.g. high-fructose syrup (HFS), glucose sweetener). (18)

Various terms, described in Table 2.1, have been used to define sugar throughout the literature.
Table 2.1 Defining sugar

<table>
<thead>
<tr>
<th>Reference</th>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO 2015</td>
<td>Sugars</td>
<td>Intrinsic sugars, which are those incorporated within the structure of intact fruit and vegetables; sugars naturally present in milk (lactose and galactose); and free sugars, which are 'monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates. (6)</td>
</tr>
<tr>
<td></td>
<td>Total sugars</td>
<td>The sum of the individual monosaccharides and disaccharides. It does not include sugar alcohols which are present in small amounts in some fruits and is sometimes added to foods as a sweetener. It also does not include the maltodextrins which are easily digested and absorbed like other α-glucans and frequently added as sweeteners, fat substitutes, and to modify the texture of food products.</td>
</tr>
<tr>
<td></td>
<td>Free sugars</td>
<td>All monosaccharides and disaccharides added to foods by the manufacturer, cook and consumer, plus sugars naturally present in honey, syrups and fruit juice. (6)</td>
</tr>
<tr>
<td>Mann et al. 2014</td>
<td>Sugar/ table sugar</td>
<td>Sucrose mainly extracted from sugar cane or beet. (19)</td>
</tr>
<tr>
<td>EFSA 2010</td>
<td>Added sugars</td>
<td>Sucrose, fructose, glucose, starch hydrolysates (glucose syrup, HFS) and other isolated sugar preparations used as such or added during food preparation and manufacturing. (18)</td>
</tr>
<tr>
<td>NNR 2004</td>
<td>Refined sugars</td>
<td>Refined sugars include sucrose, fructose, glucose, starch hydrolysates (glucose syrup, HFS) and other isolated sugar preparations used as such or added during food preparation and manufacturing. (20)</td>
</tr>
<tr>
<td>Baghurst et al. 1989</td>
<td>Discretionary sugar</td>
<td>All refined sugars that are added to beverages or breakfast cereals at the table. (21)</td>
</tr>
<tr>
<td>Cummings et al. 2007</td>
<td>Intrinsic sugars</td>
<td>Sugars naturally integrated within the cellular structure of whole unprocessed foods, particularly fruit and vegetables. (22)</td>
</tr>
<tr>
<td></td>
<td>Milk sugars</td>
<td>Sugars found in milk that are not located within the cellular structure of a food. (22)</td>
</tr>
<tr>
<td></td>
<td>Non-milk extrinsic sugars</td>
<td>All sugars located outside of the cellular structure of food excluding milk sugars. This includes fruit juice, honey, and sugar added as a sweetener during processing, cooking or at the table. (22)</td>
</tr>
<tr>
<td>Glinsmann et al. 1995</td>
<td>Carbohydrate sweetener</td>
<td>Food ingredients composed of carbohydrates that contain sugars and are used for sweetening. Including sucrose, invert sugar, concentrated fruit juices, products derived from starch hydrolysis, honey and other edible syrups such as molasses and malt syrup. (23)</td>
</tr>
</tbody>
</table>

HFS = high fructose syrup

For the purpose of this review, all dietary sugars will be included to capture the broadest dietary sugar intake for analysis.
1.1 History of intake and current mode of use

Prior to the cultivation of sugar cane in Papua New Guinea as early as 10 000 years ago, honey was the main sweetener in the human diet. (19, 24) The machinery for extracting sugar beet was first put to use at the beginning of the nineteenth century and in the 1960s advancements in technology allowed for the production of high fructose corn syrup (HFCS). (24, 25) Currently, over 130 countries are growing sugarcane or sugar beet. (26) Sugar, which had for many centuries been regarded a luxury commodity, has become entirely accessible with global consumption of processed sugar now largely accounted for by developing countries. (26)

Sucrose is one of the purest raw materials available in large volumes for use by food manufacturers, caterers and households. (25) In NZ, it is the most significant contributor to total daily sugar intake. (8) From a sensory perspective, sugars cater to human’s innate taste preference for sweet food. (1) Primarily, sugars are used as a sweetener in food during manufacturing. Sucrose is the primary sweetener used in foods manufactured within NZ, whereas HFCS is more commonly used in the United States (U.S.). (9)

Sugars are added by food manufacturers during food preparation, production and in preservation for various functional properties. Sugars contribute to the structural development of foods as they transition through the states of liquid to solid. (2) Sugars retain water, add viscosity, lower the freezing point, and inhibit crystallization. (27) Sugars also contribute to the bulk of foods and inhibit microbial growth by reducing the water activity and increasing the osmotic pressure of food. (22) Non-enzymatic browning reactions, which occur when sugars are heated, result in caramel colours and flavours which produce brown colours in food. (2)
1.2 Sugar digestion and metabolism

Sugars are a rapidly absorbed carbohydrate existing as a ready source of energy. (3) Mechanical digestion begins in the mouth and stomach, though sugars are predominantly undigested until they enter the small intestine. (27) Disaccharidases, namely maltase, sucrase, trehalase, and lactase, are located on the brush-border of the small intestine and hydrolyse the disaccharides into their constituent monosaccharides. (28)

Sugars are absorbed into the epithelial cells by various diffusion mechanisms which utilise glucose transporters. (29) Once absorbed, sugars are transported to the liver where fructose and galactose are converted to glucose before they enter the general circulation. (17)

Digested sugars stimulate a rise in blood glucose concentration which facilitates glucose uptake by the cells. (17, 30) Glucose is the central fuel source for the human body, the brain and red blood cells require a constant supply for their daily function. (29) Glucose also powers muscle contractions, nerve impulses and chemical synthesis. (29) When consumed in excess of our immediate requirement, glucose is used by the liver to produce glycogen, a storage fuel which controls blood glucose levels in-between meals. (29) Glycogen is stored in the liver and the skeletal muscle as an energy reserve primarily for anaerobic exercise. Glucose may also be converted into fat via lipogenesis. The fat is stored for energy when glucose concentrations are depleted. (27)

1.3 Recommended intakes

Organisations around the world propose different reference values for limiting the maximum intake of added, free and total sugar intakes (Table 2.2).
Table 2.2 International sugar intake recommendations

<table>
<thead>
<tr>
<th>Organization</th>
<th>Target Population</th>
<th>Year</th>
<th>Recommendation</th>
<th>Type of Sugar</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Heart Association (AHA)</td>
<td>U.S.</td>
<td>2009</td>
<td>Limit intake of added sugars to &lt;50% discretionary energy allowance†.</td>
<td>Added</td>
<td>To achieve healthy weights, decrease CVD risk and ensure nutritional adequacy.</td>
</tr>
<tr>
<td>European Food Safety Authority (EFSA)</td>
<td>Europe</td>
<td>2010</td>
<td>No recommended UL.</td>
<td></td>
<td>Dental caries and obesity are multifactorial.</td>
</tr>
<tr>
<td>French Agency for Food, Environmental and Occupational Health &amp; Safety (ANSES)</td>
<td>France</td>
<td>2016</td>
<td>UL of 100 g/d of total sugars (excluding lactose and galactose) and not more than one sweetened beverage/d.</td>
<td>Total (excluding lactose and galactose)</td>
<td>An increase in blood triglyceride concentrations was observed at this level.</td>
</tr>
<tr>
<td>Ministry of Health (MoH)</td>
<td>NZ</td>
<td>2015</td>
<td>Choose and/or prepare foods with little or no added sugars.</td>
<td>Added</td>
<td>Insufficient evidence to recommend a suitable exact intake of added sugars.</td>
</tr>
<tr>
<td>National Health and Medical Research Council</td>
<td>Australia</td>
<td>2013</td>
<td>Limit intake of foods and drinks containing added sugars.</td>
<td>Added</td>
<td></td>
</tr>
<tr>
<td>National Academy of Medicine (NAM) / Institute of Medicine (IOM)</td>
<td>U.S.</td>
<td>2005</td>
<td>Limit added sugars to &lt; 25 % TE</td>
<td>Added</td>
<td>To ensure sufficient intake of essentials micronutrients is maintained.</td>
</tr>
<tr>
<td>Nordic Cooperation</td>
<td>Nordic Countries*</td>
<td>2012</td>
<td>Limit intake of added sugars to &lt;10% TE, limit SSB</td>
<td>Added</td>
<td></td>
</tr>
<tr>
<td>Scientific Advisory Committee on Nutrition (SACN)</td>
<td>UK</td>
<td>2015</td>
<td>Limit intake of free sugars to &lt;5% TE</td>
<td>Free</td>
<td>To reduce the risk of dental carries and obesity.</td>
</tr>
<tr>
<td>World Health Organisation (WHO)</td>
<td>Global</td>
<td>2015</td>
<td>Limit intake of free sugars to &lt;10% TE with an aim of &lt;5% TE.</td>
<td>Free</td>
<td></td>
</tr>
<tr>
<td>U.S. Department of Agriculture (USDA)</td>
<td>US</td>
<td>2015</td>
<td>Consume &lt;10% of calories per day from added sugars.</td>
<td>Added</td>
<td>To ensure food group and nutrient needs are met within calorie limits</td>
</tr>
</tbody>
</table>

U.S. = United States of America, UL = upper limit, NZ = New Zealand, UK = United Kingdom, g = grams, d = day, TE = total energy, CVD = cardiovascular disease, SSB = sugar-sweetened beverages

† Discretionary energy allowance is determined by estimating the number of calories needed to meet nutrient requirements and then subtracting this amount from the estimated energy requirement needed to maintain weight. It includes added sugars, solid fats, and alcohol (31).

* Nordic Countries involve Denmark, Finland, Iceland, Norway, Sweden, and the Faroe Islands, Greenland, and Aland.
Different countries have a range of rationales to support a quantitative recommendation for the amount of sugar their population should be consuming. In the United States, guidelines are based on the proposal that there is no margin for high sugar intake in a healthy diet. An added sugar intake exceeding 25% TE risks displacing micronutrient dense food from the diet. (32) When aiming to meet all micronutrient and food group requirements, added sugar intake should be further restricted to <10% TE. (33) Other arguments for limiting added sugar are related to its influence in the development of dental caries and obesity. To support this rationale, organisations tend to agree on a goal of limiting free or added sugars to <10% TE, with an ultimate goal of <5%. (6, 30, 34)

New Zealand, Australia and European organisations concur that dental caries and obesity are multifactorial diseases and consequently, evidence to form recommendations is insufficient. (7, 35, 36) New Zealand and Australia instead have qualitative guidelines suggesting a limit on the intake of food high in added sugar. The European Food Safety Authority (EFSA) has refrained from making any recommendations whatsoever.

1.4 Health effects of high intakes

Strong and moderately consistent evidence identifies sugar as a contributing cause of dental caries. (37) The association between sugar intake and weight gain is not as clearly defined. Inconsistencies in study designs and weak observational data make it difficult to draw conclusions. When considering the health effects of consumption, the quantity of sugar consumed and the nutrients consumed alongside it, warrant the most attention rather than a physiological concern with the molecules themselves. Sugar has been consumed in considerable quantities of up to 20 portions of fruit a day in ‘fruit diets’ with no adverse
effects on blood pressure, blood glucose or weight status. (38) In fact on the contrary, improvements in blood pressure and weight status were observed.

Sugar, when added to food and beverages in the form of sucrose, provides a highly concentrated sugar source. If the calories are not offset elsewhere in the diet or lifestyle, added sugar will increase energy intake while decreasing the nutrient density of the diet. Individuals with the highest level of added sugar intake (>18% TE) have been found to consume the lowest intakes of vegetables, grains, fruit, milk and meat resulting in low intakes of micronutrients. (39)

1.4.1 Dental Caries

The relationship between sugar consumption and dental caries was identified as early as the 1700s where Berdmore wrote that ‘where sugar, tea, coffee and sweet-meats are used to excess, the people, even at an early age, are remarkable for the badness of their teeth’. (40) The form and combination of food, frequency of consumption, speed it passes the oral cavity, nutrient composition and ability to stimulate saliva production must all be considered in the occurrence of dental caries. Frequent consumption of sugar-containing food and drink increases the risk of dental caries and erosion; however, oral hygiene, genetic factors, and exposure to fluoride in drinking water and toothpaste must also be accounted for. (41) Moderate-quality evidence exists to link some measure of added sugars, free sugars, and total sugars with caries risk. (37) Evidence for the association mostly originates from studies examining restricted availability of sugar following the Second World War where a reduction in dental caries prevalence was observed, which increased again once the sugar restriction was lifted. (37) The most convincing data comes
from Japan in the 11 years before, during and post-World War II. A clear relationship between the average prevailing sugar intake and dental cavitation was evident when per capita sugar levels decreased from 15 kg per year to 0.2 kg and then back to 15 kg. (42)

Sugars are a fermentable carbohydrate, along with starch, they can be broken down by plaque bacteria producing organic acids and a consequent decrease in the dental plaque pH. (43) Low pH supports an increased solubility of calcium hydroxyapatite from the tooth surface and a lesion forms. (41, 43)

Intrinsic sugars have less harming potential than foods high in added sugars as they aren’t as available for metabolism by oral bacteria as extrinsic sugars. (44) Milk sugars are exempt from the cariogenic effect of extrinsic sugars due to the lower cariogenicity of lactose and cariostatic components of milk, namely calcium, phosphate and casein. (45)

Oral health care cost the NZ government $198 million in 2017/18, so these findings are not only biologically relevant, but financially significant. (46) Dental diseases generate pain, anxiety, impaired social functioning and difficulty consuming a varied diet. (30, 34, 41)

1.4.2 Body Weight

Obesity is a multifactorial, complex disease and evidence does not support sugar consumption as an isolated cause, however, a relationship between weight gain and sugar intake has been proposed by many researchers. Weight gain, and consequent obesity, ensues from an intake of calories in excess of energy expenditure. (47) The isoenergetic exchange of free sugars with other carbohydrates, or macronutrient
sources, does not bring about changes in body weight. (48) However, people consuming ad libitum diets who increase or decrease their sugar intakes see parallel weight changes as a result of the altered calorie intakes. (48)

Non-alcoholic beverages do not cause the same satiety effect as carbohydrate-containing foods, their consumption risks promoting positive energy balance. (49, 50) Individuals consuming energy from sugar are not always compensating for this calorie intake elsewhere in the diet. (34) High consumption of sugar-sweetened beverages (SSBs) has consistent associations with increased body weight and obesity as a result of how they are being used by the consumer. (51) Other diet and lifestyle factors cannot be ignored, the highest consumers of SSB have also been identified to order larger portion sizes, eat in front of the television, and to be less physically active (52, 53).

1.4.3 Other Health Conditions

Independent of the influence sugar intake has on weight changes, total free sugar intake has been found to have a relatively modest effect on blood lipids and blood pressure. (54) Type 2 Diabetes Mellitus (T2DM) is a multifactorial condition, contributed to by rising body weights and physical inactivity. (55) Weight gain also significantly increases Cardiovascular Disease (CVD) risk. (56) Supposing excessive intakes of sugar happen to be the cause of weight gain, then by association, sugar may be linked to the development of both T2DM and CVD.

1.5 Target population

Adolescent females aged 15 to 18 years, are the population of interest throughout this review. Though a well-planned vegetarian diet may provide all of the essential nutrients,
adolescents are undergoing one of the most rapid stages of physical and neuro-developement. (57) Late adolescence (15-19 years) is a time where physiological development and brain-maturation is paramount. Nutrient needs increase to meet growth demands, particularly iron, calcium, zinc, vitamin A and vitamin D (calcitriol). (58)

Of further interest is the driving force adolescents provide the vegetarian movement. Thirteen percent of New Zealanders aged 14 to 24 years identify as ‘always or mostly vegetarian’. (59) Females have fronted vegetarian movements for decades and are more inclined than males to want to become a vegetarian. (60)

Females of the target age are easily influenced and concerned with how their friends, social groups and families perceive them. (61) Increasing independence allows the exploration of new boundaries, a rise of new responsibilities, and changing expectations and social values. The context in which this development occurs will influence both current and future health.

1.6 Definition of vegetarian diets

The umbrella term ‘vegetarian’ encompasses a wide variety of eating patterns (Table 2.3) in which animal products are excluded partly or entirely. A large degree of variability exists among the different types of vegetarian diets and the extent to which animal products are restricted. Defining vegetarianism is important as prevalence depends on which definition is used. (62)
Table 2.3 Defining vegetarian diets

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetarian</td>
<td>An individual who refrains from consuming a form of animal product.</td>
</tr>
<tr>
<td>Vegan</td>
<td>An individual who refrains from consuming and utilising all animal products.</td>
</tr>
<tr>
<td>Lacto-ovo-vegetarian</td>
<td>An individual who refrains from consuming all meat* but includes dairy products and eggs.</td>
</tr>
<tr>
<td>Lacto-vegetarian</td>
<td>An individual who refrains from consuming all meat and eggs but includes dairy products.</td>
</tr>
<tr>
<td>Ovo-vegetarian</td>
<td>An individual who refrains from consuming all meat and dairy but includes eggs.</td>
</tr>
<tr>
<td>Pollo-vegetarian</td>
<td>An individual who refrains from consuming all red meat and fish but includes chicken.</td>
</tr>
<tr>
<td>Pesco-vegetarian/Pescatarian</td>
<td>An individual who refrains from consuming all red meat but includes fish, dairy and eggs.</td>
</tr>
<tr>
<td>Semi-vegetarian/Flexitarians</td>
<td>An individual who consumes little meat, or those who consume meat less than five times in a 60-day period. (62)</td>
</tr>
</tbody>
</table>

*meat refers to all red meat, chicken, pork and seafood.

In the past, individuals have reported confusion whether they should label themselves as vegetarians or semi-vegetarians. (62) For the purpose of this review, the generic use of the term vegetarian will define those who refrain from consuming a form of animal product.

1.7 Vegetarianism in New Zealand

The number of people choosing to follow a vegetarian or vegan diet is growing in popularity throughout the Western Countries. (63) Reporting of vegetarianism in NZ is limited, with the majority of data retrieved from a handful of non-peer-reviewed online surveys. (64-66) In 2002, a publication by the New Zealand Vegetarian Society reported 2% of the population to be vegetarian. (64) A survey of 1000 New Zealanders has shown a 1% annual increase from 2014-2017 in those who identify as “mostly or always meat-free”, with a jump from 7% to 10% in 2018. (65) Without definition of the term ‘mostly’, these statistics are difficult to interpret, however the upward trend supports an increase in
vegetarianism. The New Zealand Vegetarian Society Wellington centre president Caroline Jack believes these upward trends are related to an increased awareness of farming. Further anecdotal evidence supporting an increase in vegetarianism comes from Roy Morgan Research. A 2.2% rise in New Zealanders over the age of 14 identifying as ‘always or mostly vegetarian’ was observed from 8.1% in 2011 to 10.3% in 2015. (66) Differences in survey cohort sizes may from 11,936 in 2011 and 5,983 in 2015 mean this comparison should be interpreted with caution.

Food providers are having to adapt to the increased demand of vegetarian food products by purchasing more meat alternatives, and providing more vegetarian menu options. Five top NZ Chefs reported the demand for vegetarian dishes has quadrupled over the past five years. (67)

Despite the figures, adopting a vegetarianism lifestyle in NZ still puts individuals in the minority of what is historically identified as an animal-based agricultural population. Participants of a New Zealand cruelty-free survey commented that vegetarians remained marginalised in NZ culture. (68) Foreign participants have remarked that NZ is a step behind other developed countries when it comes to accommodating for vegetarianism. (68)
Main Review

1.8 Intakes in Adolescent Females

1.8.1 Sugar intakes within the general population

Table 2.4 presents the most recent sugar intake data of nine countries from across the world. Understanding national consumption levels and general trends is important to determine whether populations are meeting their dietary guidelines and to compare the sugar intakes of vegetarians with non-vegetarians.
Table 2.4 Sugar intakes within the general population

<table>
<thead>
<tr>
<th>First author, year</th>
<th>Sample n &amp; representative</th>
<th>Age (years)</th>
<th>Country/ Ethnicity</th>
<th>Assessment Method</th>
<th>Outcome</th>
<th>Percentage Contribution to TE*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Bureau of Statistics, 2011 (69)</td>
<td>353 F residing in private dwellings in Australia, covering about 97% of the population.</td>
<td>14-18</td>
<td>Australia</td>
<td>One 24-hr diet recall with a repeat telephone recall in a subgroup of participants.</td>
<td>Mean total sugar intake was 109.2 g/d. Mean intake of free sugars was 70.3 g/d Mean intake of added sugars was 62.8 g/d respectively. Non-alcoholic beverages (34.9%), cakes and cookies (13.3%), dairy (13.1%), confectionary &amp; muesli bars (12.9%) and sugar products &amp; dishes (11.5%) contributed the most to added sugars.</td>
<td>Total sugar: 21.4% Free sugar: 13.5% Added sugar: 12.4%</td>
</tr>
<tr>
<td>Health Canada, 2004 (70)</td>
<td>3 881 M &amp; F from the Canadian Community Health Survey 2004, representing ~ 98% of the Canadian population aged 12+.</td>
<td>9-18</td>
<td>Canada</td>
<td>One 24-hr diet recall with a repeat recall in 30% of participants. Considering plausible reporters† only, mean total sugar intake for F &amp; M was 119 g/d, 47% coming from food and 53% from beverages (71). Soft drinks (15.9%), sugars, syrups and confectionary (13.8%), milk (12.8%), fruit (11.7%), juice (11.5%), and fruit drinks (7.1%) contributed the most to total sugar.</td>
<td>Mean total sugar intake was 109.2 g/d. Mean intake of free sugars was 70.3 g/d Mean intake of added sugars was 62.8 g/d respectively. Non-alcoholic beverages (34.9%), cakes and cookies (13.3%), dairy (13.1%), confectionary &amp; muesli bars (12.9%) and sugar products &amp; dishes (11.5%) contributed the most to added sugars.</td>
<td>Total sugar: 21.4% Free sugar: 13.5% Added sugar: 12.4%</td>
</tr>
<tr>
<td>Health Canada, 2015 (72)</td>
<td>1 956 M &amp; F from the Canadian Community Health Survey 2015, representing ~ 98% of the Canadian population aged 12+.</td>
<td>9-18</td>
<td>Canada</td>
<td>One 24-hr diet recall with a repeat recall in 37% of participants. Considering plausible reporters† only, mean total sugar intake for F &amp; M was 116 g/d, 60% coming from food and 40% from beverages (71). Fruit (13.8%), sugars, syrups and confectionary (11.1%), milk (10.3%), juice (9.7%), baked goods and products (8.0%), regular soft drinks (7.0%), and frozen desserts (6.4%) contributed the most to total sugar.</td>
<td>Mean total sugar intake was 109.2 g/d. Mean intake of free sugars was 70.3 g/d Mean intake of added sugars was 62.8 g/d respectively. Non-alcoholic beverages (34.9%), cakes and cookies (13.3%), dairy (13.1%), confectionary &amp; muesli bars (12.9%) and sugar products &amp; dishes (11.5%) contributed the most to added sugars.</td>
<td>Total sugar: 22.5%</td>
</tr>
<tr>
<td>National Cancer Institute, 2015 (73)</td>
<td>727 F from the National Health and Nutrition Examination Survey (NHANES).</td>
<td>14-18</td>
<td>United States</td>
<td>Two 24-hr diet recalls.</td>
<td>Mean intake of added sugars was 70 g/d.</td>
<td>Added sugar: 16%</td>
</tr>
<tr>
<td>Perrar I, 2019 (74)</td>
<td>264 F with 838 diet records from the DONALD study</td>
<td>15-18</td>
<td>Germany</td>
<td>3d weighed dietary records</td>
<td>Total sugar intake decreased from 2005 – 2016, most notably after 2010 it dropped from 25 – 25.5% TE in those aged 15-18 down to 22 – 22.5% TE in 2016.</td>
<td>Total sugar: 22.3% Free sugar: 13.3% Added sugar: 10.3%</td>
</tr>
<tr>
<td>Study</td>
<td>Sample</td>
<td>Country/Region</td>
<td>Method</td>
<td>Sugar Intake</td>
<td>Sources of Sugar</td>
<td></td>
</tr>
<tr>
<td>-------</td>
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<tr>
<td>Public Health England, 2014 updated 2017 (75)</td>
<td>17 F from the National Diet and Nutrition Survey years 1-4 combined (2008/09 – 2011/12) residing in private dwellings in the UK.</td>
<td>United Kingdom</td>
<td>4d consecutive diet diary.</td>
<td>Mean total sugar intake was 90.4 g/d. Mean sucrose intake was 44.5 g/d. Mean glucose, fructose and lactose intakes were 15.7, 15.6 and 9.1 g/d respectively. Soft drinks (24%), milk and cream (8.2%), fruit juice (8.0%), fruit (7.6%), chocolate and confectionary (7.3%) and biscuits (5.1%) contributed the most to total sugars.</td>
<td>Total sugar 21.6% Sucrose 11.5%</td>
<td></td>
</tr>
<tr>
<td>Sánchez-Pimienta TG 2016 (76)</td>
<td>2056 M &amp; F from the National Health and Nutrition Survey (ENSANUT) 2012 representative of the national, state, and rural and urban levels of Mexico.</td>
<td>Mexico</td>
<td>One 24-hr recall.</td>
<td>Mean intake of added sugar was 52 g/d. Collectively adolescents had the highest intake of added and total sugars out of the Mexican population groups.</td>
<td>Added sugar 14.4%</td>
<td></td>
</tr>
<tr>
<td>López-Olmedo N 2016. (77)</td>
<td>373 F residing in private dwellings in NZ</td>
<td>New Zealand</td>
<td>One 24 hr diet recall with a repeat recall in 20% of participants.</td>
<td>Mean intake of total sugar was 118 g/d. Mean intake of sucrose was 62.7 g/d. Mean fructose and lactose intakes were 21.2 and 11.3 g/d respectively. Non-alcoholic beverages (27.4%), fruit (13.6%), sugar and sweets (12.5%), milk (6.8%), cakes &amp; muffins (5.4%) and dairy products (4.9%) contributed the most to total sugar.</td>
<td>Total sugar 25.1% Sucrose 13.3%</td>
<td></td>
</tr>
<tr>
<td>University of Otago, 2008-09. (46)</td>
<td>354 F of the Dutch National Food Consumption Survey.</td>
<td>Netherlands</td>
<td>Two 24hr phone diet recalls using computer directed interview program EPIC-SOFT.</td>
<td>Median intake of total sugar was 126 g/d. Median intake of free sugars was 89 g/d. Median intake of added sugar was 75 g/d. Non-alcoholic beverages (30.2%), sweets and candy (24.3%), dairy (17.8%), cakes and cookies (10.3%) and fruits, nuts and olives (7.9%) contributed the most to total sugar.</td>
<td>Total sugar 24.4% Added sugar 15.1% Free sugar 17.6%</td>
<td></td>
</tr>
</tbody>
</table>

n = sample number, TE = total energy, F = female, hr = hour, g = grams, d = day, M = male, UK = United Kingdom, NZ = New Zealand

* Percentage energy was calculated using an Atwater factor of 16.7 kJ/g of carbohydrate.
† Plausible reporters were categorised based on a comparison of their total predicted energy expenditure and reported energy intake using a method designed by Goldberg and modified by Black and McCroy (79).
As presented in Table 2.4, the record of sugar consumption across the world is diverse, ranging from a mean total sugar intake of 90.4 g/d in the United Kingdom (UK) to a median intake of 126 g/d in the Netherlands. Variations in the presentation of consumption data prevent comprehensive comparisons. Australia and the Netherlands report on the consumption of total, added, and free sugars, the UK and NZ report total and individual sugars, and Italy reports on the consumption of soluble carbohydrates.

Compared with global consumption, NZ adolescent females are consuming higher amounts of total sugar than English and Australians adolescents, similar amounts to the Canadians and less than the Dutch. Most surveys describe female and male intakes separately with the exception of Canada and Mexico. Consequently, with males consuming a greater quantity of sugar than females, reported sugar consumption is higher than what may otherwise be expected for females adolescents from these countries. (71, 80)

Sugar intakes reported as a proportion of total energy range from 21.4% in Australia to 24.4% in the Netherlands. Added sugars contributed between 12.4% in Australia to 16% in the US. Different data collection methods were used, with 24h diet recalls the most common (Australia, Canada, US, Mexico, NZ & the Netherlands) and diet records of 3 and 4-day duration in Germany and Italy and the UK respectively. Survey sizes and age ranges surveyed also differ, only the NZ and German population has an age range representative of our target population.
1.8.2 Sugar intakes within adolescent vegetarian populations.

The adolescent vegetarian population is understudied and publications to date are limited with variable findings. As shown in Table 2.5, food sources are commonly reported, yet accurate figures on total and added sugar intakes are lacking.
Table 2.5 Sugar intakes within adolescent vegetarian populations

<table>
<thead>
<tr>
<th>First author, year</th>
<th>Sample n &amp; representative</th>
<th>Age (years)</th>
<th>Country/Ethnicity</th>
<th>Assessment Method</th>
<th>Intake Results</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donovan UM, et al, 1996 (12)</td>
<td>122 F, 35% of whom were seventh day Adventists and 65% were 'new vegetarians'</td>
<td>14-19</td>
<td>Southern Ontario, Canada</td>
<td>3d weighed diet record.</td>
<td>Semi-vegetarians, consumed the least sweets with a mean intake of 129 g/d followed by lacto-ovo vegetarians (149 g) and omnivores (214 g/d).</td>
<td></td>
</tr>
<tr>
<td>Larsson C, et al. 2002 (13)</td>
<td>15 F vegans with age and height-matched omnivores. Volunteers recruited through advertising &amp; school visits.</td>
<td>16-20</td>
<td>Sweden</td>
<td>Two 12hr diet recalls 1-2 weeks apart.</td>
<td>Vegans had significantly higher intakes of monosaccharides (65 g/d) than omnivores (vs 48 g/d) and significantly lower disaccharide intakes (72 g/d vs 100 g/d). No significant differences were noted in mean sucrose intakes (69 g/d for both groups).</td>
<td>Vegans had significantly lower intakes of cake and cookies and candy and chocolate than omnivores. No significant differences were observed for fruit or soft drinks.</td>
</tr>
<tr>
<td>Neumark-Sztainer D, et al. 1997 (14)</td>
<td>107 vegetarian &amp; 214 nonvegetarians matched at a 2:1 ratio for sex, ethnicity &amp; age who had completed the Minnesota Adolescent Health Survey (MAHS).</td>
<td>12-20</td>
<td>Minnesota – US</td>
<td>FFQ with 11 types of food or food groups.</td>
<td>Consumption of fruit was significantly higher amongst vegetarians while sweet and salty snack foods was lower.</td>
<td>Vegetarians were one third as likely to consume sweets compared with nonvegetarians.</td>
</tr>
<tr>
<td>Perry CL, et al. 2002 (15)</td>
<td>4258 meat-eating and 262 vegetarian M and F from public middle schools and high schools in Minnesota from the Project EAT (Eating Among Teens).</td>
<td>11-18</td>
<td>Minnesota, US</td>
<td>149-item Youth and Adolescent FFQ.</td>
<td>Vegetarians had significantly higher intakes of fruit (2.7serves/d vs 2.3serves/d) and significantly lower intakes of regular soda (1.2 serves/d vs 1.4 serves/d) and fruit drinks (0.4serves/d vs 0.5 serves/d) than non-vegetarians.</td>
<td></td>
</tr>
<tr>
<td>Segovia-Siapco G, et al. 2019 (16)</td>
<td>137 M and F vegetarians compared with 397 non-vegetarians. Recruited from public middle and high schools largely composed of Adventists. 12-18</td>
<td>Michigan &amp; Southern California – US</td>
<td>Validated 151-item self-administered semi-quantitative online FFQ. Vegetarians had lower mean intakes of added sugars (37.15 g/d vs 40.73 g/d) however the result was insignificant (p-value 0.077). Vegetarians had significantly higher intakes of fruits (2.71 g/d vs 2.17 g/d p-value 0.001) and significantly lower intakes of sugar-sweetened beverages (0.41 g/d vs 0.62 g/d p-value &lt;0.0001).</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( n = \) sample number, \( F = \) female, \( d = \) day, \( g = \) gram, \( hr = \) hour, \( M = \) male, FFQ = food frequency questionnaire, US = United States of America
The five reported studies each had different methods to collect dietary sugar data. Two of the five reported studies reported quantitative sugar intake data. One of the two studies, conducted in Swedish vegan adolescents, reported on the intakes of mono- and disaccharides, while the other or the two studies, originating from the U.S., reported on added sugar intakes.

Vegetarians had significantly lower intakes of sweets and confectionary than non-vegetarians in three of the five studies, with authors of one study reporting vegetarians to be one third as likely to consume sweets than non-vegetarians. (14) Vegetarians also had significantly lower intakes of SSBs than non-vegetarians in two of the five studies, a third found no significant differences between groups. Fruit intakes were significantly higher in vegetarians compared with non-vegetarians in two of the five studies.

1.8.3 Sugar intakes within other vegetarian populations.

With a limited number of studies in the target population, in particular with quantitative results, it is worth investigating the sugar intakes of vegetarians from other age groups. This allows for the opportunity to identify trends in differences or similarities between the diet groups.

Whether vegetarians in other populations have higher intakes of sugar than their non-vegetarian counterparts is unclear. Total intake of sugar has been reported as around 10g lower in vegetarians aged 7 to 11 years than non-vegetarians. (81) In males and females aged 20 to 59 years, Clarys et al. found mean sugar intakes were highest in vegetarians (162 g/d) and lowest in omnivores (149 g/d). (82) In the
Adventist Health Study 2, there was no difference in total sugar intake between any form of vegetarian diet and non-vegetarians. (83)

When comparing dietary sugar sources, vegetarians have been found to consume lower amounts of food high in free sugar. (84) Where one study has found vegetarians to have significantly lower sucrose intakes (16.5 g/d) than those eating meat more than three times a week (19.9 g/d), another has had contrasting results. (85, 86) In the NutriNet-Santé Study and National Health and Nutrition Examination Survey 1999-2004 study, Farmer et al. reported added sugar intakes were highest in vegetarians across the entire population, dieters and non-dieters. (86)

1.9 Rationale for Research

The average female adolescent in the 2008/09 NZ ANS had a sucrose intake that contributed 13.3% towards their daily TE and non-alcoholic beverages were the primary source of sugar. (8) These findings indicate a high consumption of added sugar in the target population which may be exceeding international recommendations (Table 2.2). Globally, sugar consumption has increased 22 million metric tonnes since the most recent NZ nutrition survey. (87) No record subsequent to the NZ ANS 08/09 exists to inform whether NZ adolescent female sugar intakes are following the same trend.

Since the NZ ANS 08/09 publication, the WHO have published a conditional recommendation to reduce the energy from free sugars to <5% TE. (6) No published nutrition studies in NZ have measured adherence to this recommendation.

Studies from international populations suggest most vegetarians are consuming lower intakes of foods high in added sugars (Table 2.5). Vegetarian adolescents may therefore
have closer adherence to sugar recommendations than their omnivore counterparts. No studies comparing the diet composition and/or sugar intakes of vegetarians from any age or gender group have been conducted across Australasia. Findings from studies of the U.S., UK and a select few European countries inform the greater part of our current knowledge.
2 Objective Statement

The aim of the present study was to analyse and compare sugar intakes of vegetarian and non-vegetarian adolescent females aged 15-18 years enrolled in New Zealand secondary schools.

The study objectives are:

- To gather data on the sugar intake of vegetarian and non-vegetarian adolescent females using 24-hour diet recalls.
- To analyse and compare food sources of sugar in vegetarian and non-vegetarian diets.
- To compare sugar intakes of vegetarians and non-vegetarians with international recommendations.
3 Methods

Data collection took place across 13 secondary schools throughout New Zealand and through from February – April 2019 and again from July – September 2019 with the inclusion of targeted vegetarian recruitment. The University of Otago Human Ethics Committee provided approval for this study on 4th February 2019 (reference number H19/004) (Appendix A). The study is registered with the Australian New Zealand Clinical Trials Registry: ACTRN12619000290190. Māori consultation was obtained by submitting a consultation form to Ngāi Tahu (Appendix B). Information on the study is included in the participant information sheets (Appendix C). Study participants were informed of the purpose and requirements of the study and provided with the opportunity to ask questions. Participants willing to enrol provided written informed consent prior to the commencement of data collection.

3.1 Study Design

This is a cross-sectional observational study on a convenience sample of healthy adolescent females between the ages of 15 and 18 years participating in the Survey of Nutrition Dietary Assessment and Lifestyle (SuNDiAL) Project. All participants were requested to complete three online questionnaires (Appendix D, E and F) and two 24-hour (hr) diet recalls. Dietary data were recorded in FoodWorks. All food items were categorised into food groups (Table 3.1) by study staff.
Table 3.1 Description of the food groups

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Examples of Food Items Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcoholic beverages</td>
<td>Wine, beer, spirits, liqueurs and cocktails, ready-to-drink alcoholic sodas (RTDs), cider, sherry</td>
</tr>
<tr>
<td>Beef &amp; veal</td>
<td>All muscle meats (steak, mince, corned beef, roast, schnitzel, etc), stews, stir-fries</td>
</tr>
<tr>
<td>Biscuits</td>
<td>Sweet biscuits (plain, chocolate coated, fruit filled, cream filled), crackers</td>
</tr>
<tr>
<td>Bread (inc rolls &amp; speciality breads)</td>
<td>All types of bread (rolls, pita, foccacia, garlic), bagels, crumpets, sweet buns</td>
</tr>
<tr>
<td>Bread based dishes</td>
<td>Sandwiches, filled rolls, hamburgers, hotdogs, pizza, tortillas, dim sims, nachos, doner kebabs, wontons, spring rolls, stuffings</td>
</tr>
<tr>
<td>Breakfast cereals</td>
<td>All types (muesli, wheat biscuits, porridge, puffed/flaked/extruded cereals, French toast)</td>
</tr>
<tr>
<td>Butter and Margarine</td>
<td>Butter, margarine, butter/margarine blends, reduced-fat spreads</td>
</tr>
<tr>
<td>Cakes and muffins</td>
<td>All cakes and muffins, slices, scones, pancakes, doughnuts, pastry</td>
</tr>
<tr>
<td>Cheese</td>
<td>Cheddar, edam, specialty (blue, brie, feta, etc), ricotta, cream cheese, cottage cheese, processed cheese</td>
</tr>
<tr>
<td>Dairy products</td>
<td>Cream, sour cream, yoghurt, dairy food, ice-cream, dairy-based dips</td>
</tr>
<tr>
<td>Eggs &amp; egg dishes</td>
<td>Poached, boiled, scrambled and fried eggs, omelettes, self-crusting quiches, egg stir-fries</td>
</tr>
<tr>
<td>Fats &amp; oils</td>
<td>Canola, olive, sunflower and vegetable oils, dripping, lard</td>
</tr>
<tr>
<td>Fish/Seafood</td>
<td>All fish (fresh, frozen, smoked, canned, battered, fingers, etc), shellfish, squid, crab, fish/seafood dishes (pies, casseroles and fritters), fish/seafood products</td>
</tr>
<tr>
<td>Fruit</td>
<td>All fruits, fresh, canned, cooked and dried</td>
</tr>
<tr>
<td>Grains &amp; Pasta</td>
<td>Rice (boiled, fried, risotto, sushi, salad, products), flour, pasta/noodles, bran, cereal-based products and dishes (pasta and sauce, lasagne, pasta salad, noodle soup, chow mein)</td>
</tr>
<tr>
<td>Lamb/Mutton</td>
<td>All muscle meats (chops, roast, mince, etc), stews, stir-fries, curries</td>
</tr>
<tr>
<td>Milk</td>
<td>All milk (cow, soy, rice, goat and flavoured milk), milkshakes, milk powder</td>
</tr>
<tr>
<td>Non-alcoholic beverages</td>
<td>All teas, coffee and substitutes, hot chocolate drinks, juices, cordial, soft drinks, water, powdered drinks, sports and energy drinks</td>
</tr>
<tr>
<td>Nuts &amp; Seeds</td>
<td>Peanuts, almonds, sesame seeds, peanut butter, chocolate/nut spreads, coconut (including milk and cream), nut-based dips (pestos)</td>
</tr>
<tr>
<td>Other meat</td>
<td>Venison, rabbit, goat, liver (lamb's fry), paêlé (liver), haggis</td>
</tr>
<tr>
<td>Pies and pasties</td>
<td>All pies including potato top, pasties, savories, sausage rolls, quiche with pastry</td>
</tr>
<tr>
<td>Pork</td>
<td>All muscle meats (roast, chop, steak, schnitzel, etc), bacon, ham, stews, stir-fries</td>
</tr>
<tr>
<td>Potatoes, kumara and taro</td>
<td>Mashed, boiled, baked potatoes and kumara, hot chips, crisps, hash browns, wedges, potato dishes (stuffed, scalloped potatoes), taro roots and stalks</td>
</tr>
<tr>
<td>Poultry</td>
<td>All chicken, duck, turkey and muttonbird muscle meats and processed meat, stews and stir-fries</td>
</tr>
<tr>
<td>Puddings/desserts</td>
<td>Milk puddings, cheesecake, fruit crumbles, mousse, steamed sponges, sweet pies, pavlova, meringues</td>
</tr>
<tr>
<td>Sausages &amp; processed meats</td>
<td>Sausages, luncheon, frankfurters, saveloys/cheerios, salami, meatloaf and patties</td>
</tr>
<tr>
<td>Savoury sauces &amp; condiments</td>
<td>Gravy, tomato and cream-based sauces, soy, tomato and other sauces, cheese sauces, mayonnaise, oil &amp; vinegar dressings, chutney, marmite</td>
</tr>
<tr>
<td>Snack foods</td>
<td>Corn chips, popcorn, extruded snacks (burger rings etc), grain crisps</td>
</tr>
<tr>
<td>Snacks sweet</td>
<td>Muesli bars, wholemeal fruit bars, puffed cereal bars, nut and seed bars</td>
</tr>
<tr>
<td>Soups and stocks</td>
<td>All instant and homemade soups (excluding noodle soups), stocks and stock powder</td>
</tr>
<tr>
<td>Sugar/sweets</td>
<td>Sugars, syrups, confectionery, chocolate, jam, honey, jelly, sweet toppings and icing, ice-blocks, artificial sweeteners</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Supplements providing energy</td>
<td>Meal replacements, protein supplements (powders and bars)</td>
</tr>
<tr>
<td>Vegetables</td>
<td>All vegetables (fresh, frozen, canned) including mixes, coleslaw, tomatoes, green salads, legumes and pulses, legume products and dishes (baked beans, hummus, tofu), vegetable dishes</td>
</tr>
</tbody>
</table>

3.2 Recruitment

3.2.1 School-based recruitment

High schools were selected to be invited to participate based on their location (limited to schools accessible for data collectors) and female roll number (a preference for schools with higher rolls: those with rolls greater than 400 for co-educational, or 200 for girls-only). The first round of invitations was sent to up to three schools that met the criteria per pair of data collectors in the location (e.g. there were four data collectors in Dunedin, so six schools were selected for initial invitation). Lower decile schools were preferentially selected for this first round of invitation. Study coordinators initiated contact via email from November 2018. Schools that did not respond to the email within two weeks were sent a second email and received a follow-up phone call. If email and phone contact did not result in the required number of schools enrolling in the study (one school per pair of data collectors) a second round of school recruitment targeted high schools that were not initially selected (i.e. they may have been higher decile, or had a lower roll). Following this, if schools were still required in certain locations, recruitment visits, phone-calls, and emails were initiated by data collectors, study coordinators, or university liaison officers, utilising known points of contact at schools.
3.2.2 Participant recruitment

Data collectors visited the enrolled schools at the beginning of the school term, to commence participant recruitment. Presentations were delivered to the school or year group assembly and schools were supplied participant information sheets (Appendix C). Students who self-identified as female, were aged between 15 and 18 years, enrolled in a recruited secondary school, could speak and understand English, and could complete an online questionnaire, were eligible to participate. Pregnant students were excluded.

Students willing to participate had their name, age and email address recorded following the recruitment presentation or signed up online at the study website. An identification (ID) number was assigned to each participant and the students were emailed a link to the REDCap questionnaire (Appendix D) to complete their online consent and answer questions on demographics and health. Participants below the age of 16 years were asked to provide a parent or guardian’s email address who was then contacted via email to provide consent for their daughter to participate.

3.2.3 Targeted recruitment

After six months of data collection, 145 participants had completed the study and a decision was made by study coordinators to begin targeted recruitment of vegetarians. Targeted recruitment of vegetarian female adolescents through local papers and social media was conducted in the Dunedin region. Interested females were directed to the study website to view the study promotional video, read the information sheet, and provide their name, age and email address for a consent form to be sent out.
3.3 Study Procedure

3.3.1 Interrater reliability

Prior to the commencement of the SuNDiAL project, an interrater reliability study was conducted to demonstrate consistency among data collectors in recording anthropometric measurements. A convenience sample of twelve girls between the age of 15 and 18 years gave consent. Each data collector measured four of the girls twice. These repeats were not successive, and data were recorded on a fresh page for each repeat. A standard protocol (Appendix G) was provided to all data collectors. Interrater reliability was assessed using mixed effects intra-class correlation coefficients (ICC).

3.3.1.1 Interrater Reliability Results

Twenty-seven of the 30 data collectors participated in the interrater reliability study. Twelve girls (convenience sample) between the ages of 15 and 18 years gave consent. The ICC for weight was 1.00; the ICC for height was 0.92; and the ICC for ulna length was 0.86. All ICC indicated excellent agreement among data collectors. Of note, variation in measures for height was greatest when measuring the tallest girls. In response to this, a step stool was provided to all data collectors and instructions to use safely when needed.

3.3.2 Data collection

Data collection were conducted by Master of Dietetic (MDiet) Students over two three-month periods (February – April 2019 and July – September 2019). During this time, MDiet Students visited the schools to collect information on anthropometric measurements and dietary intakes via a face-to-face 24-hr diet recall interview.
Demographic and health information, dietary habits and attitudes and motivations towards food choices data were collected by the use of online questionnaires. A second 24-hr diet recall was conducted over the telephone or by video-call in a convenience subset of the population. If the initial diet recall was on a weekend day, the repeat recall captured a weekday to ensure variation in dietary intake was accounted for. Completion of the second dietary recall took participants approximately 20-30 minutes.

3.3.2.1 Anthropometry

All data collectors were trained to measure height, weight and ulna length according to the anthropometrical protocol (Appendix G). Standing heights were measured in duplicate using Seca 213; and Wedderburn stadiometers and weight in duplicate using scales (one of Medisana PS420; Salter 9037 BK3R; Seca Alpha 770; or Soehnle Style Sense Comfort 400) calibrated by the research team. Ulna length was measured in duplicate from the point of the elbow to the midpoint of the prominent wrist bone. Anthropometric data were used to categorise participants into overweight (BMI z-score > 1SD), obese (BMI z-score > 2SD), thin (BMI z-score < -2 SD) or healthy (BMI z-score ≥ - 2SD & ≤ 1SD) based on their BMI-for-age z-scores (88).

3.3.2.2 Questionnaires

An online questionnaire (Appendix D) was used to assess demographics (age, school, address, ethnicity, NZDep2013 Index of Deprivation), health status and vegetarianism. Online questionnaires used REDCap software. Ethnicity was prioritised in the following order: Māori, Pacific, Asian, NZ European & Other.
NZDep2013 is an index of socioeconomic deprivation of an area in NZ, a score of 1 represents the areas with the least deprived scores and a score of 10 represents an area with the most deprived score. (89) NZDep was determined according to the participant’s household address. A second online questionnaire assessed attitudes and motivations for food choices (Appendix E) and a third assessed dietary habits (Appendix F).

3.3.2.3 Interview day procedure

Participants were contacted (over phone or email) by data collectors to schedule a visit at school during school time (if they were part of the school-based recruitment group), or at the clinic after school (if they were part of the targeted recruitment group). During this visit, participants performed a 24-hr diet recall with one of the M Diet students according to the 24-hr diet recall protocol (Appendix H). The 24-hr diet recall was comprised of three steps, a ‘quicklist’ of food and drink consumed, a detailed follow up, and a final check for forgotten foods. Photos and measurement aids were on hand to assist in estimating the portion sizes. The Countdown online website was available to assist the recall of specific brands and package sizes. Height, weight and ulna length were measured in duplicate. Data collection visits took approximately 30-60 minutes to complete.

3.3.3 Dietary Analysis

M Diet students were trained in the use of Foodworks 9 (Xyris Software Australia Pty Ltd) by study coordinators. Following the completion of a 24-hr recall, M Diet students entered the food and portion sizes of that participant’s data into Foodworks to calculate the energy, macronutrients and micronutrients contained in the recalled
diet. Food items were aligned with the food groups of the 2008/09 ANS (Table 3.1) by study staff. Major dietary contributors to total sugar intake were defined as food groups contributing greater than 2.5% of total sugar intake.

FoodWorks uses the most up-to-date and comprehensive food composition tables for New Zealand (FOODfiles 2014) which was enhanced by the inclusion of the 2008/09 NZ ANS recipe calculated foods. Dietary intake data were adjusted for usual intake using the Multiple Source Method. This estimates the day-to-day variation in nutrient intake using those participants with two days of diet recall data and applies this information to the whole dataset to give an adjusted estimate of usual intake for each participant. This adjustment was made separately for vegetarians and non-vegetarians.

3.3.4 Categorisation of Sugar

The dataset used by Foodworks did not contain values for added and free sugars. Therefore, for the purpose of this thesis, the candidate created the variables ‘Natural sugar’ and ‘Assumed added sugar’. Assumed added sugar was calculated as the total sucrose intake less an adjustment to account for sucrose naturally present in fruit and vegetables. To estimate the amount of sucrose derived from fruit and vegetables, it was assumed that one-third of the sugar in fruit and vegetables was sucrose. This estimate of one-third was based on the average proportion of total sugar from sucrose in four common fruits (banana, apple, orange and kiwifruit). The monosaccharides present in fruit and vegetables (fructose and glucose) were then each divided by 0.67 for each girl’s diet. Natural sugar was then defined as an adjusted sum of fructose and
glucose, plus lactose and maltose. Assumed added sugar was the difference between Total sugar intake and Natural sugar.

All sugar intakes were calculated as a proportion of total daily energy intake, to enable comparison of sugar intake between the vegetarian and non-vegetarian groups as well as with recommended intake limits.

3.4 Statistics

3.4.1 Sample size
The SuNDiAL project is an ongoing survey aiming to recruit a sample size of at least 300 female adolescents, including a minimum of 60 vegetarians, from 14 secondary schools. This gives the study 80% power to the $\alpha=0.05$ level to detect a 0.5 standard deviation difference (a “moderate” difference) in continuous outcome variables between vegetarians and non-vegetarians, assuming a prevalence of vegetarianism of 20% and a design effect (for school clusters) of 1.5. To date, the study has recruited 250 female adolescents, including 31 vegetarians.

3.4.2 Statistical food group methods
Total amounts of sugar intake from each of the 33 food groups was calculated for each participant. This information was then used to calculate the proportion of each participant’s total sugar intake from each of the 33 food groups. Mean and 95% confidence intervals of these proportions were calculated for the whole group. Stata 15.1 (StataCorp, Texas) was used for these calculations.

The differences in sugar consumption between vegetarian and non-vegetarian participants were determined using an equation provided by the study
Biostatistician which calculated the confidence intervals for two independent samples. All descriptive statistics were generated on Microsoft Excel.
4 Results

Participant flow can be seen in Figure 1. Two-hundred and fifty-one SuNDiAL participants completed at least one 24-hr recall. One participant did not identify as either vegetarian or non-vegetarian and was removed from the analysis leaving 250 participants included in the study. Data collection were spread across week and weekend days (Appendix I).
Wave 1: February – April 2019

Schools recruited (n=8)

No response (n=1619)

Asked to participate (n=1882)

Wave 2: July – September 2019

Schools recruited (n=5)

Targeted recruitment

No response (n=1834)

Asked for consent (n=2054)

Asking to participate (n=1882)

Consent

Asked for consent (n=263)

n=87 incomplete consent
n=22 no parental consent
n=9 incomplete enrolment

n=145

Asking to participate (n=2054)

Asking for consent (n=220)

n=71 incomplete consent
n=17 no parental consent
n=2 incomplete enrolment

n=130

Consent and enrolled to participate (n=282)

Participants analysed (n=274)

n=1 participant withdrew
n=7 participants dropped out

Analysis

Complete questionnaire data (n=248)

n=272 complete demographics & health
n=253 complete attitudes & motivations
n=248 complete dietary habits

Complete Diet Recall Data (n=251)

Complete anthropometric data (n=248)

n=219 non-vegetarians
n=31 vegetarians
n=1 did not identify as either diet status & was excluded

Complete Repeat Diet Recall Data (n=213)

Figure 1 Study design and participant flow diagram
4.1 Group Demographic Comparisons

Table 4.1 displays the baseline demographics of the total study population and by vegetarian status.

Table 4.1 Baseline participant demographics (n = 250)

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Total Population (n = 250)</th>
<th>Vegetarian (n = 31)</th>
<th>Non-vegetarian (n = 219)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)*</td>
<td>16.8 (0.86)</td>
<td>17.1 (0.80)</td>
<td>16.7 (0.94)</td>
</tr>
<tr>
<td>NZDep‡</td>
<td>1.8 (0.71)</td>
<td>1.7 (0.68)</td>
<td>1.8 (0.71)</td>
</tr>
<tr>
<td>Low (1 – 3)</td>
<td>92 (36.80)</td>
<td>12 (38.71)</td>
<td>80 (36.53)</td>
</tr>
<tr>
<td>Medium (4 – 7)</td>
<td>115 (46.00)</td>
<td>15 (48.39)</td>
<td>100 (45.66)</td>
</tr>
<tr>
<td>High (8 – 10)</td>
<td>43 (17.20)</td>
<td>4 (12.90)</td>
<td>39 (17.81)</td>
</tr>
<tr>
<td>Ethnicity §</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NZEO</td>
<td>195 (78.31)</td>
<td>24 (77.42)</td>
<td>171 (78.44)</td>
</tr>
<tr>
<td>Māori</td>
<td>39 (15.66)</td>
<td>7 (22.58)</td>
<td>32 (14.68)</td>
</tr>
<tr>
<td>Asian</td>
<td>9 (3.61)</td>
<td>9 (4.13)</td>
<td></td>
</tr>
<tr>
<td>Pacific</td>
<td>6 (2.41)</td>
<td>6 (2.75)</td>
<td></td>
</tr>
<tr>
<td>Weight Status ¶</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy</td>
<td>163 (65.99)</td>
<td>24 (77.42)</td>
<td>139 (64.35)</td>
</tr>
<tr>
<td>Overweight</td>
<td>58 (23.48)</td>
<td>5 (16.13)</td>
<td>53 (24.54)</td>
</tr>
<tr>
<td>Obese</td>
<td>26 (10.53)</td>
<td>2 (6.45)</td>
<td>24 (11.11)</td>
</tr>
</tbody>
</table>

n = sample size, BMI = body mass index, NZDep = New Zealand Index of Deprivation, NZEO = New Zealand European and Others (all other ethnicities mainly Latin American and African), SD = standard deviation

* Results are presented as mean (SD)
‡ Results presented as n (%).
§ One non-vegetarian did not specify their ethnicity.
¶ Weight status is missing for three non-vegetarian participants who did not have their anthropometric measurements recorded.

Participants were aged between 15 and 18 years. The majority were New Zealand European and Others and within the healthy BMI range (BMI z-score \( \geq -2 \) & \( \leq 1 \)) (Table 4.1).
Among the vegetarian population group, 8 participants (25%) identified as vegan. Around half (48%) of the vegetarian population had been following their vegetarian diet for greater than 2 years, 23% of the population for 1-2 years, 13% for 1-6 months, 10% for 6-12 months, and 6% for less than a month.

School-recruited vegetarian and non-vegetarian participants came from a reasonable spread of decile 3 – decile 10 schools. Overall, 13 schools were recruited, 7 through initial email and phone contact and 6 through other means.

4.2 Dietary Sugar Intake Comparison

Figure 2 presents a comparison of the daily intake of individual sugars consumed by the overall study population, and by vegetarian status.
Figure 2 Comparison of daily dietary glucose, fructose, sucrose, lactose and maltose intake (grams/day) by vegetarian status.

Error bars represent the standard error of the mean. Red shading represents the sucrose in grams/day allocated to fruit. The asterisk symbol represents a difference in intakes between vegetarians and non-vegetarians.

Vegetarians had significantly lower intakes of lactose than their non-vegetarian counterparts with a mean (95% CI) difference of 3.1g/d (0.5, 5.6). When vegans were separated from the vegetarian diet group, the mean difference in lactose intakes between vegetarians and non-vegetarians was no longer meaningful. From the survey questionnaire
(Appendix F), vegetarians consumed cow’s milk an average of once monthly and non-vegetarians 2 – 4 times/weekly. Similarly, non-milk dairy products were reportedly consumed an average of 2-3 times/monthly for vegetarians and 5-6 times/weekly for non-vegetarians. There were no between group mean differences for the intakes of glucose [1.8 (-0.1, 3.6)] g/d, fructose [2.2 (-0.8, 5.2)] g/d and sucrose [4.7 (-0.8, 10.3)] g/d, with non-vegetarians having a higher mean intake of maltose compared with the vegetarians [0.5 (0.1, 0.9)] g/d.

The mean total, natural and assumed added sugar intakes of the vegetarian and non-vegetarian diet groups are presented in Figure 3. Assumed added sugar represents total sugar less maltose, lactose and the sum of glucose and fructose adjusted by 0.67 to account for the sucrose in fruit and vegetables.
**Figure 3** Mean total, natural and assumed added sugar intake (grams/day) by vegetarian status.

Error bars represent the standard error of the mean. The asterisk symbol represents a difference in intakes between vegetarians and non-vegetarians.

The mean (95% CI) between group difference for the intake of total sugar was 8.9 (-1.5, 19.3) g/d; natural sugar 9.4 (1.8, 17.0) g/d; and assumed added sugar -0.5 (-7.1, 6.0) g/d, with non-vegetarians consuming more natural sugar than vegetarians.

The mean (95% CI) differences for total, natural and added sugar when expressed as a proportion of average total energy contribution for vegetarians and non-vegetarians are presented in Table 4.2.
Table 4.2 Sugar consumption categorised by total, natural and assumed added sugar as a proportion of average daily energy contribution by vegetarian status.

<table>
<thead>
<tr>
<th>Sugar</th>
<th>Vegetarians (n = 31)</th>
<th>Non-Vegetarians (n = 219)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (95% CI)</td>
<td></td>
</tr>
<tr>
<td>Total Sugar*</td>
<td>20.9 (5.1)</td>
<td>21.1 (6.1)</td>
<td>0.1 (-7.7, 8.0)</td>
</tr>
<tr>
<td>Natural Sugar†</td>
<td>14.7 (3.8)</td>
<td>15.4 (5.4)</td>
<td>0.8 (-4.7, 6.3)</td>
</tr>
<tr>
<td>Assumed Added Sugar‡</td>
<td>6.3 (3.4)</td>
<td>5.7 (4.2)</td>
<td>-0.6 (-3.0, 1.7)</td>
</tr>
</tbody>
</table>

n = sample size, CI = confidence interval
* Results presented as average percentage of total daily energy intake.
† Natural sugar encompasses lactose and maltose; and sugars derived from glucose and fructose adjusted as per section 3.3.3 of the methods.
‡ Assumed added sugar is the average total sugar intake minus the natural sugar as per section 3.3.3 of the methods.

When the intakes of total, natural or assumed added sugar were expressed as a proportion of average daily energy contribution, no between-group differences were found.

4.3 Food Sources of Dietary Sugar

Table 4.3 presents the major dietary contributors to total sugar intake assorted by food groups. Food group definitions are the same as those used in the 2008/09 NZ ANS (Table 3.1).
Table 4.3 Top dietary contributors as a mean percentage (SD) of total sugar intake by vegetarian status and food group

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Vegetarians (n=31)</th>
<th>Non-vegetarians (n=219)</th>
<th>Mean Difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td>23.9 (19.4)</td>
<td>21.9 (19.8)</td>
<td>2.0 (-5.3, 9.3)</td>
</tr>
<tr>
<td>Non-alcoholic beverages</td>
<td>7.0 (11.0)</td>
<td>12.5 (16.8)</td>
<td>-5.5 (-10.0, -1.0)</td>
</tr>
<tr>
<td>Sugar/sweets</td>
<td>12.1 (15.6)</td>
<td>10.2 (13.3)</td>
<td>1.9 (-3.9, 7.6)</td>
</tr>
<tr>
<td>Milk</td>
<td>7.6 (9.2)</td>
<td>7.3 (10.2)</td>
<td>0.3 (-3.2, 3.9)</td>
</tr>
<tr>
<td>Cakes and muffins</td>
<td>7.9 (11.7)</td>
<td>6.6 (12.5)</td>
<td>1.4 (-3.1, 5.8)</td>
</tr>
<tr>
<td>Vegetables</td>
<td>8.7 (7.4)</td>
<td>5.7 (7.6)</td>
<td>3.0 (0.2, 5.8)</td>
</tr>
<tr>
<td>Biscuits</td>
<td>5.4 (9.2)</td>
<td>5.3 (8.3)</td>
<td>0.2 (-3.2, 3.6)</td>
</tr>
<tr>
<td>Dairy products</td>
<td>3.3 (9.5)</td>
<td>4.3 (8.6)</td>
<td>1.0 (-4.5, 2.6)</td>
</tr>
<tr>
<td>Bread (inc rolls &amp; speciality breads)</td>
<td>3.3 (3.7)</td>
<td>3.8 (6.4)</td>
<td>-0.6 (-2.1, 1.0)</td>
</tr>
<tr>
<td>Snacks sweet</td>
<td>4.0 (10.7)</td>
<td>3.5 (6.2)</td>
<td>0.5 (-3.4, 4.3)</td>
</tr>
<tr>
<td>Savoury sauces &amp; condiments</td>
<td>3.6 (5.0)</td>
<td>2.8 (5.5)</td>
<td>0.9 (-1.1, 2.7)</td>
</tr>
</tbody>
</table>

n = sample size, CI = confidence interval, SD = standard deviation, inc = including
Bolded results represent a significant difference between groups.

Fruit was the main source of sugar in both vegetarian and non-vegetarian diets. In the vegetarian group, sugar/sweets and vegetables were the next major food groups contributing 12.1% and 8.7% of total sugar respectively. For the non-vegetarian group, non-alcoholic beverages (12.5%) and sugar/sweets (10.2%) ranked as the second and third major sugar sources. Milk was a main sugar source for both vegetarian and non-vegetarian, contributing approximately 7% of total sugar in both diet groups. Minor contributors to
total daily sugar intakes contributing less than 2.5% were bread based dishes, supplements providing energy, grains & pasta and alcoholic beverages.

Non-alcoholic beverages and vegetables were the only food sources where intakes contributed remarkably different amounts of sugar between diet groups. Non-vegetarians consumption of non-alcoholic beverages contributed almost double the amount of sugar than for vegetarians (12.5% vs 7.5%). Vegetarians had a significantly larger portion of their sugar intake coming from vegetables (8.7%) than non-vegetarians (5.7%).

4.4 Dietary Sugar Intakes Compared With Recommendations.

Table 4.4 presents the proportion of participants in the study by vegetarian status adhering to the USDA, WHO, NAM and ANSES sugar recommendations.

<table>
<thead>
<tr>
<th></th>
<th>USDA</th>
<th>WHO</th>
<th>NAM</th>
<th>ANSES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consume &lt;10% TE from added sugars.</td>
<td>Limit free sugars to &lt;5% TE (conditional recommendation)*</td>
<td>Limit added sugars to &lt;25% TE.</td>
<td>UL of 100 g/d total sugar (excluding lactose &amp; galactose) †</td>
</tr>
<tr>
<td>Total Population</td>
<td>82.1%</td>
<td>43.8%</td>
<td>98.4%</td>
<td>64.9%</td>
</tr>
<tr>
<td>Vegetarians</td>
<td>78.1%</td>
<td>31.3%</td>
<td>100%</td>
<td>71.9%</td>
</tr>
<tr>
<td>Non-Vegetarians</td>
<td>82.6%</td>
<td>45.7%</td>
<td>98.2%</td>
<td>63.9%</td>
</tr>
</tbody>
</table>

USDA = United States Department of Agriculture, WHO = World Health Organization, NAM = National Academy of Medicine, ANSES = French Agency for Food, Environmental and Occupational Health & Safety, TE = total energy, g/d = grams/day, UL = upper limit
* Adherence to guidelines is reported as added sugar intake not free sugar intake.
† Galactose intakes were not analysed in the study therefore were not excluded from the total sugar intake when reporting adherence to guidelines.

Within the NZ female adolescent population studied, there was greatest adherence to the USDA guidelines to consume <10% TE from added sugars with 82.1% of the total population (n= 206) had an added sugar intake less than 10% of their daily TE. Regarding
the WHO conditional recommendation to consume < 5% TE from free sugars, the proportion of the population achieving this was approximately halved to 43.8% (n=110). Overall, non-vegetarians were more likely to adhere to guidelines involving added and free sugars as a proportion of total energy consumed, particularly the conditional WHO recommendation to limit free sugars to <5% TE. Vegetarians were more likely to achieve the ANSES guideline, involving an absolute sugar intake limit.
5 Discussion and Conclusion

The purpose of the current study was to compare the sugar intake of vegetarian and non-vegetarian adolescent females aged between 15 and 18 years. Dietary data were collected and analysed from 250 adolescent females, comprising 31 vegetarians and 219 non-vegetarians, from secondary schools across NZ. There were no differences in sugar intake between vegetarians and non-vegetarians when expressed as a percent of total energy. When measured as grams per day, vegetarians ingested less lactose compared with non-vegetarians; and non-vegetarians ingested more natural sugar than vegetarians. Food sources contributing to total sugar were mostly consistent across diet groups, although vegetarians consumed a lower proportion of total sugar from non-alcoholic beverages, and a higher proportion from vegetables, than non-vegetarians. A vegetarian diet did not appear to directly impact the sugar intake of the population.

Total sugar comprises glucose, fructose, sucrose, lactose, and maltose. Within this population, no difference in total sugar intake was observed between vegetarians and non-vegetarians when expressed as a proportion of TE. This finding aligns with the work of Rizzo et al. who reported no difference in total sugar intake between any form of vegetarian diet and non-vegetarians in the Adventist Health Study 2. (83) Few other population studies have reported on vegetarian and non-vegetarian total sugar consumption. A study in children reported lower total sugar intakes in vegetarians while a study in adults reported lower total sugar intakes in non-vegetarians. (81, 92)

Total mean sugar intake in the current study was 101 g/d, 93 g/d for vegetarians and 102 g/d for non-vegetarians. Total sugar intake in the nationally representative ANS sample
of 15 to 18 year old females was 118 g/d. (8) Although the sugar intakes of the two cohorts may not be directly comparable due to differences in sampling, the data are suggestive of a decrease in intakes among NZ female adolescents over the past decade. Downward trends in total sugar consumption have been identified in Germany, Australia, Denmark and Norway. (74, 93, 94) This finding has positive public health implications as sugar intake in adolescence is related to dental caries, weight gain and obesity. (37, 48, 95, 96)

Nevertheless, challenges arise when comparing absolute sugar intakes to that of other countries due to diverse data analysis methods, sugar definitions and methods of estimations. Food group data exhibit more consistency for comparison.

In the current study, non-alcoholic beverages contributed 7.0% of total sugar intake for female adolescent vegetarians and 12.5% for non-vegetarians. Again while not directly comparable, this is suggestive of a decrease in non-alcoholic beverage consumption amongst adolescent females since the 08/09 ANS sample; in that survey the proportion of sugar from non-alcoholic beverages was 27.4%. (8) A decrease in SSB intakes of children in the US has been reported from 2003 to 2016. (97, 98) Other food groups including sugar and sweets, milk, cakes and muffins, and dairy products all feature as main sugar contributors in both the current study and NZ ANS 08/09. Unique to the current study was the inclusion of vegetables and biscuits as main sugar sources.

Vegetables contributed a greater proportion of total sugar for vegetarians than for non-vegetarians, indicating higher vegetable consumption amongst vegetarians. Diets rich in vegetables and fruit are protective of ischaemic heart disease and stroke and contain fibre which assists the maintenance of regular digestive function and may have a role in obesity prevention (99, 100). A higher intake of vegetables amongst adolescent vegetarians and
vegans when compared with non-vegetarians has been reported in the literature. (12-14, 16, 101) This supports the notion that vegetarians may be at lower risk of CVD and obesity. In contrast, fruit consumption in the current study did not differ between vegetarians and non-vegetarians. As a main source of fructose and total sugar, this may explain why no differences in fructose and total sugar were seen between vegetarians and non-vegetarians. Despite fruit also being a main source of natural sugar, a difference was still seen in absolute natural sugar intakes between vegetarian and non-vegetarians. This may be partially due to the difference in lactose intakes between the groups.

Lactose is a marker of dairy intake. (102) Mean lactose intake in the current study was 6.2 g/d for vegetarians and 9.2 g/d for non-vegetarians. Vegans have not been differentiated from vegetarians in the reported lactose intakes. Therefore, lactose intakes of the vegetarian group are expectantly lower than non-vegetarians as vegans mainly restrict dairy products. When vegans were separated from the vegetarian diet group, the mean (95% CI) difference of 1.4 (-1.7, 4.5) g/d in lactose intakes between vegetarians and non-vegetarians was no longer meaningful. Thus it can be assumed low lactose consumption of the vegan population accounts for the overall lower lactose intakes when vegetarians are compared with non-vegetarians.

Lactose is one of the several individual sugars analysed in the current study. Individual sugars were categorised into either ‘Natural sugar’, or ‘Assumed added sugar’. Assumed added sugar was estimated from sucrose intakes, however, sucrose is not only added to processed food but is found very widely in fruit and vegetables which do not contribute to added sugars. (22) The FOODfiles 2014 database used in the current study reported total sucrose but did not account for sugar intrinsic to fruit. To prevent a
consequent overestimation of added sugar, one third of sucrose was allocated to natural sugar to represent sucrose intrinsic to fruit, and the remainder attributed to added sugar as per the methodology in section 3.3.4.

Natural sugar intake was of the same magnitude (g/d) across both diet groups though relative intakes (% TE) were higher in non-vegetarians than vegetarians. Fruit, milk, vegetables and dairy products were all major contributors to natural sugar intakes of both vegetarian and non-vegetarians, with vegetables contributing the only between-group difference. Fruit has been considered a particularly important contributor to natural sugar in restrictive diets, such as that of a vegan diet, therefore to find no difference between diet groups was unexpected. (103) However, the observation aligns with findings from earlier studies in adolescents and children. (104, 105) Contrasting results were seen in adolescent vegetarians in the U.S. who were twice as likely to consume fruit than non-vegetarians. (14) This suggests the adolescent vegetarian population studied may not be as health conscious as the U.S. vegetarians. Nonetheless, a consideration must be made for high standard deviations of sugar intake in the present study, indicating the data are largely varied. While some female adolescents are making healthy dietary choices, others are not.

Foods contributing to assumed added sugar intakes in the vegetarian population studied support the theory that the vegetarian population studied is not as health conscious as the U.S. vegetarians. Assumed added sugars were calculated as the sum of total sugars less Natural sugars. Sugar and sweets, cakes and muffins, and biscuits were all major contributors to both vegetarian and non-vegetarian added sugar intakes and did not differ in their contribution of total sugar between groups. This indicates the convenience aspect of food is important to the adolescent females studied despite vegetarian status. In saying that,
a finding related closely to healthful behaviour in the vegetarian population group that
aligns with U.S. results was non-alcoholic beverages contributed almost half the amount of
sugar than for non-vegetarians. (16, 101) With nutrition-related habits started or reinforced
during adolescence following into child-bearing years, this puts the vegetarian group at
lower risk of dental carries and weight gain. (37, 48, 106)

Overall when compared with international sugar recommendations, the NZ female
adolescents studied were mostly compliant. Across adolescents in the U.S., Europe and
Australia, the NZ population had consistently lower assumed added sugar intakes. (107-
109) An estimated 82% of the study population met the USDA recommendation that added
sugar contributes <10% TE, and 44% met the WHO conditional recommendation that free
sugars contribute < 5% TE. These estimations are encouraging to consider when remarks
that the WHO <5% TE from free sugar guideline is “likely too restrictive and unachievable”
have been made for both American and Australian intakes. (110, 111) Caution must be
exercised when comparing the current study findings to WHO guidelines as assumed added
sugar was used as a proxy for free sugars. Assumed added sugar may overestimate the
proportion of NZ female adolescents reported as compliant with the WHO guidelines as it
underestimates free sugar by not accounting for all intrinsic sugars.

While some researchers propose the use of sucrose as a surrogate marker for added
sugar when comparing intakes to international guidelines, a strength of the current study
was the adjustment made to account for sucrose intrinsic to fruit. (112) This adjustment
prevents an overestimation of added sugar intakes however also risks compromising the
accuracy of assumed added sugar estimates. The current study reports on analytically
determined sugar intakes including glucose, fructose, lactose and maltose, allowing for a
direct comparison of these sugar intakes with international guidelines without estimations compromising the certainty of results.

Another strength in the current study was the use of repeat 24-hr diet recalls in 85% of the population. An individual’s diet varies from day to day, the use of repeat 24-hr diet recalls helps to account for some intra-individual variability. (113) Diet recalls favour short term memory and therefore yield more accurate quantitative and qualitative data than a food frequency questionnaire (FFQ). (114) The inclusion of a FFQ in the dietary habits questionnaire of the current study also provided a means for corroborating the findings of the 24-hr diet recall data.

A limitation of the current methodology is that food manufacturers are constantly updating food formulations making it difficult to keep up-to-date. (104, 115) This research used data from FOODfiles 2014 meaning the nutrient composition of some food items may be outdated, or the food may have been reformulated, changing the sugar content. A second limitation of the methodology is underreporting, particularly of beverages and snack foods, which characteristically contain substantial amounts of added sugar. (116) Under-reporting occurs more frequently in female populations than in males. (117) However, as vegetarians and non-vegetarians may both be prone to under-reporting, this may not have caused a bias between the groups

This study is limited by the size of the study population and is not demographically representative of the NZ adolescent female population. A lack of representation of lower decile schools might impact the results of the current study as those attending schools in more affluent areas may have varying food access, perceptions and choices to those attending schools in more deprived areas. Nonetheless, this study contains the only available
data on vegetarian and non-vegetarian adolescent females in NZ over the past decade. When the full recruit of the SuNDiAL project is achieved, a difference in absolute total sugar intake may be observed between vegetarian and non-vegetarian groups. When sugar intake as a proportion of total energy intake is considered, it is less likely a larger sample size would result in a between-group difference.

5.1 Conclusion

This study fills a gap in the current literature, offering insight into female adolescent vegetarian sugar consumption and providing a benchmark to compare the sugar intakes of NZ female adolescents with global recommendations. Relative sugar intakes of vegetarians were no different to non-vegetarians, however, absolute intakes of natural sugar and lactose were lower. Lower sugar intake is therefore an unlikely contributor to the favourable health profiles associated with vegetarian diets. Health benefits that may relate to vegetarian sugar intakes are likely attributed to the food from which vegetarians obtain their sugar, namely a greater contribution from vegetables and lower contribution from non-alcoholic beverages, rather than the amount of sugar consumed. Differences in sugar intake between vegetarian and non-vegetarian diets in the current study appeared to have no relation to the exclusion of meat from the diet. Further research is warranted to explore what drives the differences in intakes of sugar-containing food between diet groups. Finally, the current study indicates NZ female adolescents are mostly adhering with dietary sugar recommendations to limit energy from added sugars to <10%, except for the WHO’s tighter recommendation to limit free sugars to <5% TE. Further research involving a larger sample size will improve confidence in the finding that current sugar intakes of NZ female adolescents support positive health outcomes in the long-term.
6 Application of Research to Dietetic Practice

6.1 Part A: Applicability and relevance to dietetic practice

Sugar is scrutinised under the public eye for its detrimental influence on weight, diabetes prevalence and dental health. Levels of added sugar in particular are considered by many health professionals a central focus for control in the pursuit of good health. The sugar intakes and the food sources of sugar of this population of female adolescents suggest current sugar consumption is predominantly from natural sources and that the mean amount of added sugar intake falls below the current WHO recommended upper intake. Though these result must be interpreted with caution, the apparent downward trend in sugar intake is reassuring for dietitians and public health experts. It provides insight on the progress of interventions at individual and public health levels.

This research highlights neither a vegetarian nor non-vegetarian diet for NZ female adolescents is associated with a superior sugar profile. Any sugar-related impacts on the favourable health profiles of a vegetarian diet are likely related to the food sources from which vegetarians obtain their sugar, rather than their absolute or relative intakes of sugar. Vegetarians may be more likely to reap positive long-term health benefits associated with consuming a lower proportion of total sugar from non-alcoholic beverages and a higher proportion from vegetables than non-vegetarian. Non-vegetarians on the other hand adhered more closely to global sugar recommendations to limit added and free sugars (6, 33). In both clinical and public health settings, this research supported by further investigation, should be used to impart knowledge to those wishing to transition between vegetarian and non-vegetarian diets. It can also be used to highlight the focus that should be placed on the quality of sugar sources, rather than its total consumption.
Finally, the present study suggests current NZ dietary guidelines based on a positive affirmation of which foods to choose i.e. ‘choose and/or prepare foods with little or no added sugars’ may be effective although it should not be overlooked that according to the current study around 60% of the NZ female adolescents were not meeting the WHO conditional recommendation to limit free sugar to <5% TE. Continued efforts at both a public health and policy level are recommended to achieve optimal health for this population.

6.2 Part B: What has this research meant to you?

This research project has given me deeper insight into the inequalities that exist among adolescent females, the pressures these produce, and the impact this has on diet. In the process of interviewing these girls, I was astounded by the diversity in life pressures for a group from the same age and life stage. Some interviewed were working to provide for themselves, some were without jobs skipping breakfast and lunch, others were fully supported and a select few adolescent’s food choices were entirely controlled by their parents. I presume that as a qualified practitioner collecting this data, the fine balance between taking a non-judgemental approach to diet recalls and being able to show support and assistance if required, would be challenging to achieve. Some data were collected in a decile 10 school, which raises concern as to the inequalities at lower decile schools. Firstly this experience has highlighted the importance of discussing with your supervisor the boundaries for intervening as a practitioner or data collector. Secondly this experience has emphasised the importance of being equipped with a tool-box of resources and facilities for support, especially when working outside your local area, so should a situation of concern arise, the appropriate people are on hand to refer on to.
7 References


40. Berdmore T. A treatise on the disorders and deformities of the teeth and gums ... The whole illustrated with cases and experiments, intended for general use. By Thomas Berdmore. Dublin: Gale Ecco, Print Editions; 1769.


8 Appendices

Appendix A: University of Otago Human Ethics Committee Ethical Proposal

Appendix B: Māori Consultation Response

Appendix C: Participant Information Sheet

Appendix D: REDCAP Enrolment Questionnaire

Appendix E: Attitudes and Motivations for Food Choice Questionnaire

Appendix F: Dietary Habits Questionnaire

Appendix G: Anthropometric Measurements Protocol

Appendix H: 24-Hour Diet Recall Protocol

Appendix I: Data Collection Day Spread
Appendix A: Ethics Proposal

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

cc. Assoc. Prof. L Houghton Department of Human Nutrition
Appendix B: Māori Consultation Response

NGĀI TAHU RESEARCH CONSULTATION COMMITTEE
TE KOMITI RAKAHU KI KĀI TAHU

Monday, 17 December 2018

Dr Meredith Peddie
Department of Human Nutrition

Tēnā Koe Dr Meredith Peddie

The SuNDiAL Project 2019: Survey of Nutrition, Dietary Assessment and Lifestyle.

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 outline in this policy provides no power of veto by Ngāi Tahu to research undertaken at the University of Otago". As such, this response is not "approval" or "mandate" for the research, rather it is a mandated response from a Ngāi Tahu appointed Committee. This process is part of a number of requirements for researchers to undertake and does not cover other issues relating to ethics, including methodology they are separate requirements with other Committees, for example the Human Ethics Committee, etc.

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

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

The Committee 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 Raraunga Māori Data Audit Tool, which gives an overview of key Māori Data Sovereignty terms and principles.
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.

Nīhau noa, nā

Claire Porima
Kaiwhakahaere Pūtere
Senior Project Manager
Office of Māori Development
Te Whare Wānanga o Otago
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Appendix C: Participant Information Sheet

Participant Information Sheet

| Study title: | The SuNDiAL Project 2019: A survey of nutrition, dietary assessment and lifestyle |
| Principal investigators: | Names: Dr Jill Haszard & Dr Meredith Peddie  
Department: Human Nutrition  
Position: Research Fellows |
| Contact phone number: | 03 479 5683  
03 479 8157 |

Introduction

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

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

What is the aim of this research project?

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, or you must live in Dunedin and be able to attend a clinic visit at the Department of Human Nutrition after school, 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, or at the Department of Human Nutrition 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, or at the Department of Human Nutrition, 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, or at the Department of Human Nutrition), 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, or at the Department of Human Nutrition). 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, or will arrange a time to collect it from you. 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 got 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, Interlukin-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 or 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 D: REDCAP Enrolment Questionnaire

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 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 take 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>Waimea College</td>
</tr>
<tr>
<td>Hornby High School</td>
</tr>
<tr>
<td>Columba College</td>
</tr>
<tr>
<td>Kaikorai 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 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.

☐ AGREE
☐ DISAGREE
## Contact Information

What is your name?  
(Preferred first name, Last name)

What is your date of birth?  

Age  

Phone number (mobile would be best - so we can text you reminders)  

What is your home address?  
(This will be the address where we will send your voucher)  
(number & street, suburb, city, postcode)

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

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

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

What is the address that you live at during school term?  
(number & street, suburb, city, postcode)
### 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</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>If so, which type?</td>
<td>Type 1 diabetes</td>
</tr>
<tr>
<td></td>
<td>Type 2 diabetes</td>
</tr>
<tr>
<td></td>
<td>Don't know</td>
</tr>
<tr>
<td>Do you avoid eating gluten?</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Have you been diagnosed with either coeliac disease or gluten intolerance?</td>
<td>Yes - coeliac disease</td>
</tr>
<tr>
<td></td>
<td>Yes - gluten intolerant</td>
</tr>
<tr>
<td></td>
<td>No diagnosis but suspected intolerance or coeliac</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Have you been diagnosed with a food allergy or intolerance? (not gluten)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Which foods are you allergic or intolerant to? (Select as many as apply)</td>
<td>Eggs</td>
</tr>
<tr>
<td></td>
<td>Dairy</td>
</tr>
<tr>
<td></td>
<td>Nuts</td>
</tr>
<tr>
<td></td>
<td>Shellfish</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>Other: please specify</td>
<td></td>
</tr>
<tr>
<td>Are you vegetarian or vegan?</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Which foods do you eat? (Select as many as apply)</td>
<td>Egg</td>
</tr>
<tr>
<td></td>
<td>Milk (not plant milk like soy milk)</td>
</tr>
<tr>
<td></td>
<td>Fish or seafood</td>
</tr>
<tr>
<td></td>
<td>Chicken or poultry</td>
</tr>
<tr>
<td></td>
<td>Meat/red meat occasionally</td>
</tr>
<tr>
<td></td>
<td>None of the above</td>
</tr>
<tr>
<td>Are you vegan?</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>How long have you been following this way of eating?</td>
<td>Less than a month</td>
</tr>
<tr>
<td></td>
<td>Between 1 and 6 months</td>
</tr>
<tr>
<td></td>
<td>Between 6 months and 1 year</td>
</tr>
<tr>
<td></td>
<td>Between 1 and 2 years</td>
</tr>
<tr>
<td></td>
<td>More than 2 years</td>
</tr>
<tr>
<td></td>
<td>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>
</table>
| How old were you when you had your first period?                        | ○ 11 years or younger  
○ 12-14 years  
○ 15 years or older  
○ I haven't had a period yet |
| How long do you usually have from the start of one period to the start of the next? | ○ 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 |
| How many days does your period usually last? (count your light days as well as your heavy ones) | ○ Less than 4 days  
○ 4-6 days  
○ 7-9 days  
○ 10 days or more |
| Are your periods so heavy that they make it hard for you to go to school? | ○ Yes - often  
○ Yes - sometimes  
○ No |
| Have you donated blood?                                                 | ○ Yes  
○ No |
| When did you last donate blood?                                         | ○ In the last 4 months  
○ Between 4 and 12 months ago  
○ More than a year ago |
| Have you had a nosebleed in the last year?                              | ○ Yes  
○ No |
| Do you have nosebleeds regularly?                                       | ○ Yes  
○ No |
| Over the last year, on average how often did you get nose bleeds?       | ○ 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 |
| Do you use any of the following contraceptives:                         | ○ No - I don't use those contraceptives  
○ Yes - I use one of those contraceptives |
| - Oral contraceptive (eg 'the pill' or 'the mini-pill')                 |                                                                         |
| - Depo Provera injection                                                 |                                                                         |
| - Implant (eg Jadelle)                                                  |                                                                         |
| - Hormonal IUD (eg Mirena)                                              |                                                                         |
### Other information

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

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

Other: please state

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.
## Attitudes and Motivations for Food Choice

For the following questions please think about the foods that you usually eat and the foods that you usually avoid - this is called your "dietary pattern". Please choose how strongly you agree or disagree with the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can be flexible and sometimes eat foods that go against my dietary pattern</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I view my dietary pattern as a way of making the world a better place for others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel that I have a moral obligation to follow my dietary pattern</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My dietary pattern is an important part of how I would describe myself</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concerns about social issues motivate me to follow my dietary pattern</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
For the following questions please think about the foods that you usually eat and the foods that you usually avoid - this is called your "dietary pattern". Please choose how strongly you agree or disagree with the following statements:

<table>
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<tr>
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<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>From time to time, I eat foods that go against my dietary pattern</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>My dietary pattern has a big impact on how I think of myself</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I am motivated to follow my dietary pattern because eating foods that go against my dietary pattern is immoral</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I follow my dietary pattern because I want to benefit society</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>A big part of my lifestyle revolves around my dietary pattern</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
For the following questions please think about the foods that you usually eat and the foods that you usually avoid - this is called your "dietary pattern". Please choose how strongly you agree or disagree with the following statements:

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel motivated to follow my dietary pattern because I am concerned about the effects of my food choices on other beings</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>I would eat a food product that goes against my dietary pattern if I were to hear that it tastes exceptionally good</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>My dietary pattern defines a significant aspect of who I am</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>I follow my dietary pattern because eating this way is good for the world</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>I follow my dietary pattern because eating this way is the morally right thing to do</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐</td>
</tr>
</tbody>
</table>
For the following questions please think about the foods that you usually eat and the foods that you usually avoid - this is called your "dietary pattern". Please choose how strongly you agree or disagree with the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Following my dietary pattern is an important part of who I am</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I am motivated to follow my dietary pattern because I want to help others</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Statement</td>
<td>Not at all important</td>
<td>A little important</td>
<td>Moderately important</td>
<td>Very important</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>----------------------</td>
<td>--------------------</td>
<td>----------------------</td>
<td>---------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contains a lot of vitamins and minerals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helps me relax</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is cheap</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is what I usually eat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has been produced in a way that animals have not experienced pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not at all important</td>
<td>A little important</td>
<td>Moderately important</td>
<td>Very important</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>----------------------</td>
<td>--------------------</td>
<td>----------------------</td>
<td>----------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is not forbidden in my religion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has been prepared in an environmentally friendly way</td>
<td></td>
<td></td>
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<td>Is easy to prepare</td>
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<tr>
<td>Is low in calories</td>
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<td>Smells nice</td>
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<td>Not at all important</td>
<td>A little important</td>
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<tr>
<td>Keeps me healthy</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Makes me feel good</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td></td>
</tr>
<tr>
<td>Has been produced in a way that animals’ rights have been respected</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Has been packaged in an environmentally friendly way</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Helps me control my weight</td>
<td>0</td>
<td>0</td>
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<td>Not at all important</td>
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<tr>
<td>Is familiar</td>
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<tr>
<td>Looks nice</td>
<td>○</td>
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<tr>
<td>Is easily available in shops and supermarkets</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<td></td>
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<tr>
<td>Is high in fibre</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cheers me up</td>
<td>○</td>
<td>○</td>
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<td>Not at all important</td>
<td>A little important</td>
<td>Moderately important</td>
<td>Very important</td>
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</tr>
<tr>
<td>Is not expensive</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has a pleasant texture</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is low in fat</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contains natural ingredients</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helps me cope with life</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<td></td>
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<td></td>
<td>Not at all important</td>
<td>A little important</td>
<td>Moderately important</td>
<td>Very important</td>
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</tr>
<tr>
<td>Is in harmony with my religious views</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is nutritious</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can be cooked very simply</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tastes good</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helps me cope with stress</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Please choose how important it is to you that the food you eat on a typical day:</td>
<td>Not at all important</td>
<td>A little important</td>
<td>Moderately important</td>
<td>Very important</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Takes no time to prepare</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contains no artificial ingredients</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is like the food I ate when I was a child</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Is high in protein</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Is good value for money</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<td></td>
<td>Not at all important</td>
<td>A little important</td>
<td>Moderately important</td>
<td>Very important</td>
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<tr>
<td>Can be bought in shops close to where I live</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is good for my skin/teeth/hair/nails etc</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
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<tr>
<td>Has been produced in a way which has not shaken the balance of nature</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
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<td></td>
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<tr>
<td>Contains no additives</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<td></td>
<td></td>
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<tr>
<td>Keeps me awake/alert</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Statement</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Somewhat disagree</td>
<td>Neither agree nor disagree</td>
<td>Somewhat agree</td>
<td>Agree</td>
<td>Strongly agree</td>
</tr>
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</tr>
<tr>
<td>It is only natural to eat meat</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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</tr>
<tr>
<td>It is necessary to eat meat in order to be healthy</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Not eating meat is socially unacceptable</td>
<td>○</td>
<td>○</td>
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<td>○</td>
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<td>○</td>
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<tr>
<td>Meat is delicious</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<td>○</td>
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<tr>
<td>It is unnatural to eat an all plant-based diet</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<td>○</td>
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<tr>
<td>Statement</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Somewhat disagree</td>
<td>Neither agree nor disagree</td>
<td>Somewhat agree</td>
<td>Agree</td>
<td>Strongly agree</td>
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</tr>
<tr>
<td>You cannot get all the protein, vitamins and minerals you need on an all plant-based diet</td>
<td>○</td>
<td>○</td>
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<td>○</td>
<td>○</td>
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<tr>
<td>It is abnormal for humans not to eat meat</td>
<td>○</td>
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</tr>
<tr>
<td>Meat adds so much flavour to a meal it does not make sense to leave it out</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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</tr>
<tr>
<td>Our human ancestors ate meat all the time</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Human beings need to eat meat</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Please let us know how strongly you agree or disagree with the following statements about eating meat:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>I would prefer not to answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most people I know eat meat</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>The best tasting food is normally a meat based dish</td>
<td>○</td>
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<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Human beings naturally crave meat</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>A healthy diet requires at least some meat</td>
<td>○</td>
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<td>○</td>
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</tr>
<tr>
<td>It is normal to eat meat</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Meals without meat would just be bland and boring</td>
<td>○</td>
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<td>○</td>
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<tr>
<td>Question</td>
<td>Options</td>
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</tr>
<tr>
<td>Are you currently trying to do any of the following?</td>
<td>Lose weight, Stay the same weight, Gain weight, No, not trying to do anything about my weight</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>How often do you usually brush your teeth?</td>
<td>More than 3 times a day, 3 times a day, Twice a day, Once a day, 3-6 times a week, 1-2 times a week, Less than once a week, Less than once a month, Never</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>How often do you use dental floss?</td>
<td>More than 3 times a day, 3 times a day, Twice a day, Once a day, 3-6 times a week, 1-2 times a week, Less than once a week, Less than once a month, Never</td>
<td></td>
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</tr>
<tr>
<td>When you brush your teeth, how much toothpaste do you use? (see image below)</td>
<td>I don't use toothpaste when I brush my teeth, A smear, A pea-sized amount, More than a pea-sized amount</td>
<td></td>
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</tr>
</tbody>
</table>
After you brush your teeth, do you:

- Spit into the basin, then swallow (straightaway or later on)
- Spit into the basin, rinse with water, and then spit into the basin again, then swallow (straightaway or later on)
- I don't spit into the basin

What brand of toothpaste do you use?

- Colgate
- Macleans
- Aim
- Oral B
- Ecotone
- Red Seal
- Sensodyne
- Other

If other, please specify: ____________________________
**Please answer the following questions:**

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you take PE as a subject at school?</td>
<td>□ Yes</td>
</tr>
<tr>
<td>□ No</td>
<td></td>
</tr>
<tr>
<td>Do you play a school sport?</td>
<td>□ Yes</td>
</tr>
<tr>
<td>□ No</td>
<td></td>
</tr>
<tr>
<td>Do you play a sport out of school?</td>
<td>□ Yes</td>
</tr>
<tr>
<td>□ No</td>
<td></td>
</tr>
<tr>
<td>What is the most common way that you get to and from school?</td>
<td>□ By car</td>
</tr>
<tr>
<td>□ By bus</td>
<td></td>
</tr>
<tr>
<td>□ Bike</td>
<td></td>
</tr>
<tr>
<td>□ Scooter/skateboard</td>
<td></td>
</tr>
<tr>
<td>□ Walk</td>
<td></td>
</tr>
<tr>
<td>□ Other (please specify)</td>
<td></td>
</tr>
</tbody>
</table>

If other, please specify: ___________________________________________________________________________________
Do you have any comments about the questions in the previous section?

Please add any comments you may have here:

What happens next?

We have one more online questionnaire for you to complete about your dietary habits. If you would like to take a break, please click the “Save & Return Later” button (be sure to take note of your code so you can return to this survey). Or, if you would like to continue, please click the “Submit” button.

You’re nearly there!
Dietary Habits Questionnaire

Fruit

On average how many servings of fruit - fresh, frozen, canned or stewed - do you eat per day or per week?

Do not include fruit juice or dried fruit.

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

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

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

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

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

On average how often do you eat bread?

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

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

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

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

If Other, please specify:

________________________________________
Milk

How often do you have milk (cow's milk or plant milk)?

- I do not have any milk
- Rarely
- Monthly
- 2-3 times a month
- Once a week
- 2-4 times a week
- 5-6 times a week
- Once a day
- More than once a day

What type of milk do you use the most of?

- None
- Cow's milk
- Plant-based milk (eg soy, rice, almond, coconut)
- Other (such as goat or sheep milk)

What kind of milk do you usually have?

- Whole or standard milk (Dark blue or silver)
- Reduced fat (light blue)
- Skim or trim (green or yellow)
- Other (please specify)

If Other, please specify:


What kind of milk do you usually have?

- Regular
- Lite
- Sweetened or flavoured
<table>
<thead>
<tr>
<th>Spreads and Oils</th>
</tr>
</thead>
<tbody>
<tr>
<td>What type of spread do you use the most of?</td>
</tr>
<tr>
<td>○ None</td>
</tr>
<tr>
<td>○ Butter (including semi soft)</td>
</tr>
<tr>
<td>○ Margarine (eg Canola, Sunflower, Olive oil based, or table spread)</td>
</tr>
<tr>
<td>○ Other (eg avocado, cream cheese), please specify</td>
</tr>
<tr>
<td>○ I don't know</td>
</tr>
</tbody>
</table>

If other, please specify: ________________________________

<table>
<thead>
<tr>
<th>What type of fat or oil is used most often in cooking in your household?</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ None</td>
</tr>
<tr>
<td>○ Butter</td>
</tr>
<tr>
<td>○ Coconut oil</td>
</tr>
<tr>
<td>○ Margarine</td>
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<tr>
<td>○ Oil (eg Olive, Canola, or one in a bottle)</td>
</tr>
<tr>
<td>○ Dripping or Lard</td>
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<tr>
<td>○ I don't know</td>
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<tr>
<td>Nuts</td>
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<td>---------------------</td>
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<tr>
<td>Almonds</td>
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<tr>
<td>Brazil</td>
</tr>
<tr>
<td>Cashew</td>
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<tr>
<td>Hazelnut</td>
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<tr>
<td>Macadamia</td>
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<tr>
<td>Peanut</td>
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<tr>
<td>Pecan</td>
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<tr>
<td>Pine nut</td>
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<td>Pistachio</td>
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<tr>
<td>Walnut</td>
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<tr>
<td>Other</td>
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<tr>
<td>Almond butter</td>
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<tr>
<td>Cashew butter</td>
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<tr>
<td>Hazelnut butter</td>
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<tr>
<td>Peanut butter</td>
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<tr>
<td>Walnut butter</td>
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<tr>
<td>Other</td>
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</tbody>
</table>
## Meat, Dairy and Eggs

**How often do you eat each of the following foods:**

<table>
<thead>
<tr>
<th></th>
<th>More than once a day</th>
<th>Once a day</th>
<th>5-6 times a week</th>
<th>2-4 times a week</th>
<th>Once a week</th>
<th>2-3 times a month</th>
<th>Monthly</th>
<th>Rarely</th>
<th>I do not eat this</th>
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</thead>
<tbody>
<tr>
<td>Egg</td>
<td></td>
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<td></td>
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<tr>
<td>Cow's milk</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Dairy products excluding milk (eg cheese, yoghurt - don’t include plant based)</td>
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<td>Processed meat (eg ham, bacon, sausages, luncheon, canned corned beef, pastrami, salami)</td>
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<tr>
<td>Other red meat (including beef, lamb, venison etc don’t include processed meat)</td>
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<tr>
<td>Pork</td>
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<td>Poultry (including chicken, turkey etc)</td>
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<td></td>
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<tr>
<td>Fish</td>
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<tr>
<td>Other seafood/shellfish (eg prawns, squid, crab)</td>
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<tr>
<td>Legumes</td>
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<tr>
<td>How often do you eat lentils, chickpeas, kidney beans or baked beans? (Don't include peas or peanuts)</td>
<td>○ I do not eat legumes ○ Rarely ○ Monthly ○ 2-3 times a month ○ Once a week ○ 2-4 times a week ○ 5-6 times a week ○ Once a day ○ More than once a day</td>
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</tbody>
</table>
### Other Foods

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>How often do you eat tofu, tempeh and tofu products?</td>
<td>I do not eat these&lt;br&gt;Rarely&lt;br&gt;Monthly&lt;br&gt;2-3 times a month&lt;br&gt;Once a week&lt;br&gt;2-4 times a week&lt;br&gt;5-6 times a week&lt;br&gt;Once a day&lt;br&gt;More than once a day</td>
</tr>
<tr>
<td>How often do you eat vegetarian ingredients (like quorn, nut meat, vegetarian mince) that are used in other dishes?</td>
<td>I do not eat these&lt;br&gt;Rarely&lt;br&gt;Monthly&lt;br&gt;2-3 times a month&lt;br&gt;Once a week&lt;br&gt;2-4 times a week&lt;br&gt;5-6 times a week&lt;br&gt;Once a day&lt;br&gt;More than once a day</td>
</tr>
<tr>
<td>How often do you eat vegetarian sausages, nuggets, patties etc?</td>
<td>I do not eat vegetarian meat alternatives&lt;br&gt;Rarely&lt;br&gt;Monthly&lt;br&gt;2-3 times a month&lt;br&gt;Once a week&lt;br&gt;2-4 times a week&lt;br&gt;5-6 times a week&lt;br&gt;Once a day&lt;br&gt;More than once a day</td>
</tr>
<tr>
<td>How often do you eat vegetarian &quot;meat alternatives&quot; (like chicken-free chicken, vegetarian chicken schnitzel, meat-free bacon rashers etc)?</td>
<td>I do not eat these&lt;br&gt;Rarely&lt;br&gt;Monthly&lt;br&gt;2-3 times a month&lt;br&gt;Once a week&lt;br&gt;2-4 times a week&lt;br&gt;5-6 times a week&lt;br&gt;Once a day&lt;br&gt;More than once a day</td>
</tr>
</tbody>
</table>
### Sweet Drinks

**How often do you drink diet or drinks labelled “sugar-free”?**
- [ ] I do not drink diet or sugar-free drinks
- [ ] Rarely
- [ ] Monthly
- [ ] 2-3 times a month
- [ ] Once a week
- [ ] 2-4 times a week
- [ ] 5-6 times a week
- [ ] Once a day
- [ ] More than once a day

**How often do you drink fizzy drinks? Don’t include diet varieties. (e.g. Coca-cola, Pepsi, lemonade)**
- [ ] I do not drink fizzy drinks
- [ ] Rarely
- [ ] Monthly
- [ ] 2-3 times a month
- [ ] Once a week
- [ ] 2-4 times a week
- [ ] 5-6 times a week
- [ ] Once a day
- [ ] More than once a day

**How often do you drink fruit juices, drinks or cordials? (e.g. Just Juice, Fresh-up, Keri, Golden Circle, Ribena, Charlie’s, Raro). Don’t include diabetic, diet or sugar-free varieties.**
- [ ] I do not drink juice or cordial
- [ ] Rarely
- [ ] Monthly
- [ ] 2-3 times a month
- [ ] Once a week
- [ ] 2-4 times a week
- [ ] 5-6 times a week
- [ ] Once a day
- [ ] More than once a day

**How often do you drink energy drinks? (e.g. V, Lift plus, Red Bull, Powerade)**
- [ ] I do not drink energy drinks
- [ ] Rarely
- [ ] Monthly
- [ ] 2-3 times a month
- [ ] Once a week
- [ ] 2-4 times a week
- [ ] 5-6 times a week
- [ ] Once a day
- [ ] More than once a day
## Snacks

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

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

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

Include nut and other sweet snack bars.

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

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

- [ ] I do not eat these
- [ ] Rarely
- [ ] Monthly
- [ ] 2-3 times a month
- [ ] Once a week
- [ ] 2-4 times a week
- [ ] 5-6 times a week
- [ ] Once a day
- [ ] More than once a day
**Fast Food**

How often do you eat fast food or takeaways from places like McDonalds, KFC, Burger King, Pizza shops or fish and chip shops?

- [ ] I do not eat fast food
- [ ] Rarely
- [ ] Monthly
- [ ] 2-3 times a month
- [ ] Once a week
- [ ] 2-4 times a week
- [ ] 5-6 times a week
- [ ] Once a day
- [ ] More than once a day

How often do you eat pies and other hot food that you buy ready-to-eat?

- [ ] I do not eat these
- [ ] Rarely
- [ ] Monthly
- [ ] 2-3 times a month
- [ ] Once a week
- [ ] 2-4 times a week
- [ ] 5-6 times a week
- [ ] Once a day
- [ ] More than once a day
### Breakfast Consumption

How many days in an average week do you have something to eat for breakfast?

- [ ] I don’t usually have breakfast
- [ ] 1 day a week
- [ ] 2 days a week
- [ ] 3 days a week
- [ ] 4 days a week
- [ ] 5 days a week
- [ ] 6 days a week
- [ ] 7 days a week
### Supplement Use

Did you take any supplements during the last year?  
- [ ] Yes  
- [x] No

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

- [ ] Multivitamin and/or multimineral
- [ ] Single vitamin or mineral
- [ ] Oil
- [ ] Bran
- [ ] Lecithin
- [ ] LSA
- [ ] Kelp
- [ ] Spirulina
- [ ] Glucosamine and/or chondroitin
- [ ] Echinacea
- [ ] Ginkgo
- [ ] Hypericum (St. John's Wort)
- [ ] Sports supplement
- [ ] Other (please specify)

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

Multivitamin and/or multimineral:

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

Multivitamin and/or multimineral:

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

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

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

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

Single vitamin or mineral:

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

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

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

Please specify the type of oil:

Oil: How long did you take the supplement in the last 12 months?

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

Oil:

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

Oil:

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

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

Bran: How long did you take the supplement in the last 12 months?

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

Bran:

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

Bran:

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

When taking a photo (or two), please make visible the brand and the list of contents.
Lecithin: How long did you take the supplement in the last 12 months?  
- Daily  
- More than once a week  
- Once per week  
- Monthly  
- Regularly but for a limited time  
- Not very often

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

Lecithin:  
If you are able to take a photo of your supplement packaging, please do so and upload here (you can complete the questionnaire and come back to upload a photo at a later time).  
When taking a photo (or two), please make visible the brand and the list of contents.

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

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

LSA:  
If you are able to take a photo of your supplement packaging, please do so and upload here (you can complete the questionnaire and come back to upload a photo at a later time).  
When taking a photo (or two), please make visible the brand and the list of contents.

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

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

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

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

Spirulina: How long did you take the supplement in the last 12 months?

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

Spirulina:

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

Spirulina:

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

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

Glucosamine and/or chondroitin: How long did you take the supplement in the last 12 months?

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

Glucosamine and/or chondroitin:

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

Glucosamine and/or chondroitin:

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

When taking a photo (or two), please make visible the brand and the list of contents.
| **Echinacea:** How long did you take the supplement in the last 12 months? | 0 Daily  
0 More than once a week  
0 Once per week  
0 Monthly  
0 Regularly but for a limited time  
0 Not very often |
| --- | --- |
| **Echinacea:**  
If you know the brand name and/or the product name please write them here. Please provide as much information about the product as possible. |  |
| **Echinacea:**  
If you are able to take a photo of your supplement packaging, please do so and upload here (you can complete the questionnaire and come back to upload a photo at a later time).  
When taking a photo (or two), please make visible the brand and the list of contents. |  |
| **Ginkgo:** How long did you take the supplement in the last 12 months? | 0 Daily  
0 More than once a week  
0 Once per week  
0 Monthly  
0 Regularly but for a limited time  
0 Not very often |
| **Ginkgo:**  
If you know the brand name and/or the product name please write them here. Please provide as much information about the product as possible. |  |
| **Ginkgo:**  
If you are able to take a photo of your supplement packaging, please do so and upload here (you can complete the questionnaire and come back to upload a photo at a later time).  
When taking a photo (or two), please make visible the brand and the list of contents. |  |
| **Hypericum (St John’s Wort):** How long did you take the supplement in the last 12 months? | 0 Daily  
0 More than once a week  
0 Once per week  
0 Monthly  
0 Regularly but for a limited time  
0 Not very often |
| **Hypericum (St John’s Wort):**  
If you know the brand name and/or the product name please write them here. Please provide as much information about the product as possible. |  |
Hypericum (St John’s Wort):

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

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

Sports supplement: How long did you take the supplement in the last 12 months?

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

Sports supplement:

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

Sports supplement:

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

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

If Other, please specify:

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

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

Other:

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

Other:

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

When taking a photo (or two), please make visible the brand and the list of contents.
Do you have any comments about this survey?

Please add any comments you may have about this questionnaire here:

___________________________________________
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/bras on the top of the head.
2. If the participant is taller than the investigator, use a step tool to take the measurements. Errors can be minimised by the investigator being parallel to the participant and the headpiece.
3. Tell the participant to stand with their heels together and toes apart pointing outward at approximately a 60-degree angle.
4. Make sure the back of the head, shoulder blades, buttocks, and heels of the participant are touching the backboard/stadiometer.
5. Make sure the participant's head is aligned in the Frankfort horizontal plane, where a horizontal line connects from the ear canal to the lower border of the orbit of the eye.
6. Lower the headpiece to rest firmly on the top of the participant's head and ask the participant to stand as tall as possible and take a deep breath.
7. Record the result to the nearest 0.1 cm in the HEIGHT 1 box on the recording sheet without informing the participants.
**WEIGHT**

1. Ask the participant to remove any heavy clothing (such as jackets, heavy tops, boots etc). As the participant would have just had their height measurement done, they should not be wearing shoes.

2. Turn on the scales, ensure they are switched on to metric (kg).

3. Ask the participant to step on to the scales so that they are facing away from the display (prevent seeing the weight) cautioning them that they need to step up onto the scales.

4. Wait for the scales to read or come to a stable number.

5. Record the participant’s weight to the nearest 0.1 kg in the WEIGHT 1 box on the recording sheet without informing the participant

**ULNA LENGTH:**

Ulna length is measured between the point of the elbow and the midpoint of the prominent bone of the wrist using an anthropometric 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 more than 0.5 units apart? If so take a third measurement where required.
Appendix H: 24-Hour Diet Recall Protocol

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”

“Lets 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)
Tips Sheet

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

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

Where possible for packaged foods collect the brand name

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

Do not
- Collect information about herbs and spices that are used in very small quantities
- Ask leading questions
- Ask for recipes for traditional home baking, but do note if it is gluten free.
- Make assumptions

Do
- Keep your prompts neutral
- Ask about cooking method and the type of fat used in cooking e.g. if they say baked, ask what with?
- Collect brand names for margarine, butter, juices/fruit drinks, breakfast cereals, energy drinks, breads, dairy alternatives (e.g. almond milk) as the micronutrient content of these products can vary considerably from brand to brand.
- Ask for the recipe for less traditional home baking (e.g. brownies made with black beans, raw caramel slice etc)
Useful 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. ¼ a medium capsicum)
- Use photos to help estimate portion size for similar vegetables not shown in pictures (e.g. broccoli can be used to estimate cauliflower, peas can be used for corn or bean etc).
- Use thickness guides and rulers to help estimate sliced vegetables (e.g. cucumber).

DAIRY
- Milk – brand name and fat content (show picture of bottle tops)
- Yoghurt – brand and with fruit or plain/natural or vanilla, reduced fat, low fat
- Ice cream – brand, any additions? If in a bowl use pictures to help estimate amounts.
- Cheese – type (e.g. Edam, Colby, Feta), brand, grated (in cups or use pictures) or sliced (thickness guides)

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

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

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

- Juices/Fruit Drinks
  - Terms used interchangeably so always collect brand information if possible
  - 100% juice or fruit drink
  - No sugar added or sweetened?
  - Added vitamins
  - Commercial or freshly squeezed
  - Did they dilute with water, is so how much
  - Use cups or pictures of cans and bottles to help estimate portion size

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

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

PACKAGED FOODS

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

MIXED DISHES

- Try and record recipe if possible
- If recipe unavailable try and get as much detail as possible
- Check any protein ingredients, starchy ingredients, vegetables, sauces
- Use photos, cups, plates and bowls to estimate portion size
### Appendix I Data Collection Day Spread

#### First Diet Recall Day of the Week.

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<th>Day</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative</th>
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<tr>
<td>Tue</td>
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#### Second Diet Recall Day of the Week.

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<tr>
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