Development, validation and reliability of a short food frequency questionnaire that measures sugar intake in Māori living in Gisborne, New Zealand

Hannah Esther Walter

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Abstract

Background: Worldwide, obesity, diabetes, cardiovascular and metabolic disease epidemics have increased in parallel with increasing levels of sugar intake, suggesting the idea that sugar may be partially responsible. In New Zealand (NZ) these chronic health conditions are more prevalent in the indigenous Māori population than the general population. To ascertain whether high sugar intake, and fructose in particular, is associated with chronic disease risk in this population, there is a need develop a valid and reliable dietary assessment instrument, that is easy to administer and comprehend, to measure sugary food and beverage intakes.

Objective: To develop, pretest and validate culturally appropriate self-administered, semi-quantitative food frequency questionnaire (FFQ), designed to measure and rank individuals usual sugars intakes over the previous month in Māori adults.

Design: An existing closed-end FFQ designed to identify people with high sugars intakes in a previous research study was adapted and pretested in both closed and open-ended formats in a sample of ten Māori adults living in Gisborne using cognitive interviewing techniques. Important sugar-containing food and beverage sources were identified from various sources including published FFQs, and the New Zealand Adult Nutrition Survey 2008/2009 as well as an environmental audit of local food outlets and supermarkets. Modifications made as a result of pretesting included adding additional foods and photographs, and rephrasing of questions. The final FFQ consisted of 33 items, with participants preferring the open-ended format. The FFQ was validated by comparing sugars estimates from the FFQ with estimates from three repeated 24hr diet recalls conducted over the preceding month in a convenience sample of 35 Māori adults, aged
20-65 years. Reliability of the FFQ was assessed by comparing sugars estimates from two administrations of the FFQ conducted 4 weeks apart.

**Results:** There was no significant difference between the mean intake from the FFQ and 24hr recalls for fructose, glucose and total sugar. Mean sucrose intake was significantly different (P=0.03) between the two instruments. Bland-Altman analyses for agreement between the FFQ and 2hr recalls ranged from 101 for fructose to 124 for sucrose. The limits of agreement (LoA) were wide; for fructose the LoA ranged from 32% - 318%. Classification into the same or adjacent quartile was 97% for fructose and 100% for all othersugars categories with weighted Kappa scores ranging from 0.47 for sucrose to 0.58 for glucose. Sugars estimates from both instruments were strongly correlated (Spearmans coefficients all ≥0.69). Intra-class correlations for sugars estimates obtained from the two FFQ administrations were all >0.8.

**Conclusion:** The Kai with Māori FFQ was found to be a reliable instrument that can adequately rank individuals according to their sugars intake as well as estimate group mean intakes. The FFQ provides a simple, efficient and cost effective method to measure sugar intake within the Māori population. Further successful evaluation with a larger sample size and biochemical markers would result in the ability for instrument could to be utilized in large-scale epidemiological studies to investigate the association between sugars intake and metabolic diseases in Māori adults.

**Keywords:** Dietary Assessment; Food frequency questionnaires; Sugar; Validity; Reliability; Māori adults
Preface

This MDiet project is a part of a larger study that aims to develop and validate a short food frequency questionnaire (FFQ) that can be used to measure sugar intakes in Māori adults.

The original closed-ended version of the FFQ was designed by an academic staff member with inspiration from several sources (Section 4.1) and underwent several modifications during January and February of 2013.

In February 2013 the FFQ was pretested in two formats (closed- and open-ended) among a sample of ten Māori adults. The open-ended version of the FFQ was favoured by participants and was subsequently modified to include additional sugar-containing foods and beverages commonly consumed by Māori adults living in Gisborne, NZ. Additional photos of food items and quantities were incorporated as well as format and wording changes to increase comprehension of the FFQ.

The final questionnaire is a 33-item, open-ended, self-administered, semi-quantitative FFQ. From March 2013 the evaluation study began which consisted of four interviews spaced approximately one week apart. The first interview consisted of obtainment of informed consent, administration of the FFQ and a 24 hour dietary recall. The second and third interviews consist of the 24-hour dietary recall only. For the final interview only the FFQ was administered. This allows for relative validity and reliability to be assessed.
Ongoing validation inclusive of 24 hour dietary recalls and biochemical markers will occur later in 2013 and beyond.

As part of this thesis, the candidate:

- Assisted with the development of the closed-ended FFQ via analysing the 2008/09 NZ Adult Nutrition Survey (ANS) data and conducting the environmental audit
- Crafted the open-ended version of the closed-ended FFQ
- Pretested two versions (open- and closed-ended) of the FFQ in a sample of ten Māori adults, living in Gisborne, NZ using cognitive interviewing. These interviews were audio recorded and transcribed.
- Finalised the FFQ into a 33 item, open-ended, self-administered, semi-quantitative FFQ
- Recruited participants, organised interviews and reminders, and generally administered the study locally
- Conducted all 24 hour dietary recall interviews and FFQ administration sessions
- Developed a spreadsheet in order to calculate participants sugars intake from the FFQ
- Entered and double checked all 24h recalls and FFQ data
- Interpreted the statistical findings
- Attended community events, cultural seminars and aided in health promotion tasks with Tairawhiti District Health
- Participated in regular Skype and phone meetings with the supervisors of the project
- Drafted and revised thesis chapters
There have been a number of people to whom I would like to express my gratitude to, for without them I would not have been able to complete this project:

I owe a tremendous amount to my primary supervisor, Dr Lisa Te Morenga, for letting me ring and whine, for answering each and every one of my many questions not only promptly but with patience and consideration, for always directing me with gentle kindness and tact, both when I wasn’t aware I needed it and when I was lost beyond belief. Her enthusiasm and encouragement has been a constant, and her assistance invaluable - A heartfelt thank you.

I am most grateful to my secondary supervisor, Dr Louise Mainvil, for providing much guidance and knowledge, particularly surrounding the design and evaluation of food frequency questionnaires – the heart of the project. Thank you.

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I am thankful to the people of Tairawhiti District Health who made me feel like I belonged. Special thanks to Nicki Mathieson who unfailingly gave me encouragement and support at every turn.

To each and every participant of the Kai with Māori study, I am most appreciative to, for so willingly giving up their time to assist in this project.

Petra Teufl is a star; she has provided priceless assistance and has been on my wavelength for the entirety of this journey. Her excellent food photography skills,
humour, pintrest and reality TV obsessions, along with many Skype dates have helped keep me sane.


Last and certainly not least, meine liebe Eltern, Monika und Manfred. Herzlichen dank, not only for your tolerance of my inability to fold away my clothes effectively aber für eure Humor, Unterstützung und Ermutigung, inclusive of cheerleading everything I do, even my mistakes like they were intentional. Jetzt gehen wir essen!

Kia tau ki a tātou katoa
Te atawhai o tō tātou Ariki, a Ihu Karaiti
Me te aroha o te Atua
Me te whiwhingatahitanga
Ki te wairua tapu
Ake, ake, ake
Amine
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<td>2008/09 New Zealand Adult Nutrition Survey</td>
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<td>CC</td>
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<td>Food Options of Dunedinites FFQ</td>
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<tr>
<td>g</td>
<td>grams</td>
</tr>
<tr>
<td>ICC</td>
<td>Intraclass correlation coefficient</td>
</tr>
<tr>
<td>LoA</td>
<td>Limits of Agreement</td>
</tr>
<tr>
<td>n</td>
<td>Number</td>
</tr>
<tr>
<td>NCD</td>
<td>Non communicable disease</td>
</tr>
<tr>
<td>NHS</td>
<td>Nurse’s Health Study</td>
</tr>
<tr>
<td>NNS</td>
<td>1997 National Nutrition Survey</td>
</tr>
<tr>
<td>NZ</td>
<td>New Zealand</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
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<tr>
<td>WDR</td>
<td>Weighed diet record</td>
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1. Introduction

In recent times, there have been epidemic of obesity, heart disease and diabetes worldwide. It is a widely known fact that poor diet is a major risk factor for most non-communicable diseases (NCDs), which for the very first time in history, are killing more people than infectious disease (World Health Organisation 2003). Over the last few decades, low fat diets have been recommended and promoted by international health agencies as the best dietary approach for preventing NCDs due to the evidence from a number of large trials linking high consumption of saturated fats and trans-fatty acids to disease (Willett, Stampfer et al. 1993, Hu, Stampfer et al. 1999, Hooper, Summerbell et al. 2012) but despite this effort the rate of chronic disease prevalence has continued to rise (World Health Organisation 2003, Lustig, Schmidt et al. 2012).

In developed nations, the reduction of fat in the food supply has typically been accompanied by an increase in sugars. In many processed foods fat reduction has been achieved by increasing the sugars content to maintain palatability. Thus the foods are still energy dense and likely to contribute to population weight gain and incidence of NCDs (Drewnowski and Popkin 1997). Recently, excessive intake of added sugars, in particular fructose, has been linked to diabetes, cardiovascular disease, obesity and gout (Johnson, Perez-Pozo et al. 2009).

In New Zealand (NZ), these chronic diseases have a greater health burden for Māori than for Pākehā New Zealanders. Māori are 2 times more likely to be obese, 1.3 times more likely to be taking blood pressure medication, 1.8 times more likely to have diagnosed ischaemic heart disease and 2.1 times more likely to be diagnosed with diabetes.
compared to their non-Māori counterparts (University of Otago and Ministry of Health 2011, Ministry of Health 2012). However, the role sugar has in the aetiology of these diseases for Māori it is yet to be clearly established.

Accurate assessment of usual dietary sugars intakes is necessary for establishing clear associations between sugars and health (Gibson 2005). Food frequency questionnaires (FFQ) are frequently used to assess dietary intakes in population studies as they have low respondent burden and are relatively cost efficient to administer (Gibson 2005). FFQs which have been developed and validated for NZ populations are typically long multi-nutrient questionnaires designed to assess whole diet patterns. These have been considered to be superior for assessing usual intakes of individual nutrients in such studies but can be cognitively challenging for some participants, as well as time consuming to administer and analyze (Willett 1998, Gibson 2005, Rockett, Berkey et al. 2007). Shorter questionnaires including fewer food and beverage items, in contrast, tend to underestimate nutrient estimates for nutrients associated with perceived socially undesirable behaviours like sugar consumption (Rockett, Berkey et al. 2007), but can reduce complexity for researchers and participants, especially in populations with low literacy and levels (Willett 1998). One option for increasing accuracy of sugars intake estimates while reducing complexity is use a short FFQ specifically designed to assess sugars at the expense of other nutrient intakes and energy (Thompson and Subar 2008).

There is currently no short validated method for assessing sugars intakes in the Māori population, which takes culture-specific dietary habits and literacy levels into account. Thus this research therefore aimed to develop, pretest and validate a short FFQ designed to assess sugars intake in this population.
2. Literature Review

In light of the prevalence of chronic disease in New Zealand this literature review aims to briefly discuss sugar consumption and health implications and review the various dietary assessment tools or instruments that would be most practical for utilization for the assessment of sugar intake in New Zealand Māori. The content of the literature review has been sourced from local and international tertiary institutions as well as databases such as “Science Direct” and “Ovid”. Key words used to elicit articles were “sugar”, “fructose”, “dietary assessment” and “food frequency questionnaire”.

The word sugar is very ubiquitous, making it difficult to compare literature. For the purpose of this review, the word ‘sugar’ has been defined as: monosaccharides (such as glucose) and disaccharides (such as sucrose) added to food by the manufacturer, cook and consumer, as well as sugars naturally present in honey, syrups, fruit juices and concentrates (Mann and Truswell 2007). Fructose has been found naturally in honey and fruit; it is a monosaccharide and is often used by manufactures as a sweetener, furthermore it makes up 50% of sucrose or ‘table sugar’ (Mann and Truswell 2007).

2.1 Sugar and Health Implications

Over the last three decades, there has been a worldwide rise in prevalence of the non-communicable diseases of obesity, cardiovascular disease, type two diabetes, metabolic syndrome and cancer (Ruxton, 2010 #65). In New Zealand the prevalence of obesity, a major risk factor for other chronic diseases, rose from 19% in 1997 to 28% in 2011 (Ministry of Health 2012).
The speed of this rise in disease prevalence suggests that environmental and behavioural factors have contributed to this problem, rather than genetic factors or evolutionary drivers (Johnson, Perez-Pozo et al. 2009). Supporting this idea, is the substantial change in the patterns of foods and beverages consumed that has occurred (World Health Organisation 2003).

Sugar consumption has increased globally over the past century, raising concerns that sugar may be partially responsible for the increasing prevalence of non-communicable diseases (Johnson, Perez-Pozo et al. 2009) (World Health Organisation 2003). Prospective cohort and experimental studies have provided inconsistent data on the impact of sugar on risk factors for metabolic diseases (Choi and Curhan 2008, Sonestedt, Overby et al. 2012, Wang, Sievenpiper et al. 2012). However, there is mounting evidence from international observational studies which support the notion that “excessive” sugar intakes resulting in high intake of the dietary sugar fructose, may be an important contributor to the development of these diseases (Johnson, Perez-Pozo et al. 2009, Richette and Bardin 2010, de Koning, Malik et al. 2012).

It is thought, that fructose could play a role in these disease states due to its propensity to increase uric acid levels (Nakagawa, Tuttle et al. 2005). For example, gout is found to be more prevalent in those with higher levels of serum urate (Richette and Bardin 2010). Māori men are thought to have one of the highest rates of gout in the world at >10% compared with <5% in non-Māori New Zealand men (Winnard, Wright et al. 2012).
Additionally, as previously stated obesity, diabetes and CVD are much more prevalent amongst Māori than non Māori New Zealanders (Ministry of Health 2012). Consequently, it is of great interest to examine whether the higher prevalence of these disease states in Māori might be partially explained by higher fructose or sugar intake.

2.2 Sugar Intake and Māori

Data on sugars intake and intakes of sugar-containing foods in New Zealand have been collected through a series of national nutrition surveys including the 1997 National Nutrition Survey (NNS97) and the 2008/09 Adult Nutrition Survey (ANS08/09) (Russell, Parnell et al. 1999, University of Otago and Ministry of Health, 2011 #15). For the two most recent surveys this data was collected using a multiple-pass 24-hour recall (Russell, Parnell et al. 1999, University of Otago and Ministry of Health 2011).

In ANS08/09 mean total sugar intake of NZ Māori was reported to be 131g/day for males and 110g/day for females (University of Otago and Ministry of Health 2011). These values for mean total sugar intake are similar to those in the for NZ Māori adults in the NNS97 of 135g for males and 117g for females (Russell, Parnell et al. 1999). This is greater than the ANS08/09 reported mean total sugar intake for all New Zealanders at 128g and 101g for males and females respectively (University of Otago and Ministry of Health 2011). Primary sources of sugar in the ANS08/09 for NZ Māori adults were identified, for men and woman respectively as, non-alcoholic beverages (17.6% and 15.9%), sugar and sweets (15.9% and 13.4%) and fruit (15.2% and 20.2%) (University of Otago and Ministry of Health 2011).
Sucrose intake of NZ Māori adults was estimated to be 67g/day for males and 56g/day for females (University of Otago and Ministry of Health 2011). These values are also similar to the mean sucrose intake reported in the NNS97 for NZ Māori adults of 71g/day for males and 61g/day for females (Russell, Parnell et al. 1999). Comparatively, the ANS08/09 reported mean sucrose intake for all New Zealanders was 61g for males and 48g for females (University of Otago and Ministry of Health 2011). Key contributors of sucrose for NZ Māori adults were identified as sugar and sweets (27.6% and 25.1%), non-alcoholic beverages (25.2% and 21.7%) and fruit (10% and 14.7%) for males and females respectively (University of Otago and Ministry of Health 2011).

Non-sucrose fructose intakes (i.e free, unbound fructose in foods and drinks) of NZ Māori adults was estimated to be 22g/day for males and 19g/day for females (University of Otago and Ministry of Health 2011). Again these values are similar to the mean non-sucrose fructose intake in the NNS97 for NZ Māori adults and for all New Zealanders in the ANS08/09 (both 23g for males and 20g for females) (Russell, Parnell et al. 1999) (University of Otago and Ministry of Health 2011). The primary sources of non-sucrose fructose in Māori for men and woman respectively were non-alcoholic beverages (24% and 19.5%), fruit (17% and 28.1%) and vegetables (11.4 and 9.9%) (University of Otago and Ministry of Health 2011).

Frequency of intake of a limited number of high-sugar food groups was also collected in the NNS97 using an unvalidated qualitative FFQ, and in the ANS08/09 via unvalidated
dietary habits questionnaire (University of Otago and Ministry of Health 2011). The NNS97 FFQ included only one question directly related to fruit intake and no questions specifically related to sugars. The ANS08/09 dietary habits questionnaire has two questions relating to fruit and vegetable intake (one each) and three regarding sugar specifically (one question for: fruit juice/drink, soft-drink/energy drink and confectionary intake). The results showed that consumption of soft-drinks and/or energy drinks of three or more times per week in Māori women was 1.5 times greater than in non-Māori women (University of Otago and Ministry of Health 2011). This indicates that for Māori women a larger proportion of sugars intake is derived from soft drinks and energy drinks. This consumption is likely to have contributed to the higher total sugar and sucrose, but not fructose intake values seen in the Māori women population.

Not only is sugar a difficult nutrient to measure, it is also typically under-reported, via all dietary assessment methods, in populations that are of low income and by those who are obese due to social desirability (Livingstone and Black 2003). Therefore it is likely that sugars intakes are underestimated in the ANS data. Moreover the Māori population has a greater prevalence of obesity and a higher proportion of adults living in areas of high socioeconomic deprivation than the non-Māori population (University of Otago and Ministry of Health 2011), thus the dietary assessment data may be subject to a greater degree of under-reporting bias. As the Māori population is at a greater risk for developing metabolic disease, it is of interest to examine the sugar intake within this population, to further investigate the relationship between risk factors for metabolic disease and sugar intake.
2.3 Dietary Assessment Methods

To understand the effect nutrients have on health, researchers and practitioners need valid and reliable ways to measure dietary intakes in groups and individuals. Over the last century there have been many methods and tools developed to determine intake. These are briefly described in relation to sugar intake below.

Diet records are considered the ‘gold standard’ as they provide a detailed description including type and amount of all foods and beverages consumed over a specified time period (Gibson 2005). Foods are often recorded as consumed reducing memory bias, however in order for this to occur the subject must well-trained and literate (Gibson 2005). The period of 3 dietary collection days is considered adequate for estimating habitual intake (Willett 1998). Duvigneaud, Wijndaele et al. (2007) used daily self-reported diet records to investigate the associations between various dietary factors and obesity and found obese women reported significantly higher sugar intake than their normal weight counterparts. Additionally underreporters, who were more likely to be overweight or obese, were found to report a significantly higher percentage of energy from protein, but lower percentage from fat than plausible reporters (Duvigneaud, Wijndaele et al. 2007). This is in line with evidence suggesting that fat and sugar containing foods such as sweets, pastries, biscuits and cakes are significantly under-reported in dietary records (Pryer, Vrijheid et al. 1997, Lafay, Mennen et al. 2000). With this in mind, diet records may not be wholly appropriate to use within the Māori population due to the relative prevalence of low literacy levels and the primary focus of investigating sugar intake (Satherley, Elliot et al. 2009).
The 24 hour dietary recall (24hr recall) method involves a structured interview where the participant is queried on the previous days intake (Gibson 2005). It has a relatively low respondent burden compared to other dietary assessment methods such as the diet record (Gibson 2005). It was utilized by Bell, Davis et al. (2006) to investigate the factors associated with consumption of sugar and fat reduced foods in a rural elderly population. It relies on the subject’s memory and ability to convey accurate portion sizes, but uses prompts and three-dimension tools which can provide aid for more accurate estimations (Gibson 2005, Thompson and Subar 2008). Due to the nature of a structured interview, this method requires a trained interviewer, which in large studies can increase costs and administration speeds (Willett 1998, Gibson 2005). However as high literacy levels are not required for the 24hr recall method, it would be a viable method for utilization within the Māori population.

Food frequency questionnaires (FFQ) are designed to assess habitual diet and are commonly utilized in epidemiological studies to assess the relationship between dietary habits and disease (Willett 1998, Gibson 2005). The literature review by Sonestedt, Overby et al. (2012) investigating whether high sugar consumption exacerbates the risk for cardiovascular disease and diabetes, highlighted that a FFQ was used in over 75% of the predominantly large prospective cohort trials investigating the link between dietary intake and health outcomes. This is because FFQs are cost effective to administer, as they do not require an interviewer. Additionally, they have a relatively low respondent burden, can rank individuals or groups by their intake and dependent on design, can
provide quantitative data (Willett 1998, Gibson 2005). However, they rely on the respondent’s memory, and recent dietary intake can create bias as subjects may find it hard to differentiate between usual intake over a specified time frame and intake from recent days (Gibson 2005). Furthermore, the FFQ must be specifically designed for the target population, as exclusion of foods that may play a particular contribution to food intake will result in inaccuracies (Willett 1998, Gibson 2005). This technique would be a viable way to measure intake in a Māori population as the respondent burden is relatively low.

Biochemical markers can be used as a measure of dietary intake with the underlying assumption that the biochemical marker responds to intake dose-dependently. Bingham, Luben et al. (2007) utilized spot urine tests as biomarkers for sugar consumption in a cross-sectional study of 875 individuals from the European Prospective Investigation of Cancer (EPIC) Norfolk study of nutrition and cancer. The results proved to be significantly correlated to self-reported dietary intakes (Bingham, Luben et al. 2007). However while they provide an estimate of dietary intake; they cannot provide or differentiate between sources of food from which the dietary intake originates. Therefore biomarkers are better used to assess the degree of under-reporting of sugars intakes from self-reported data and to adjust for measurement error as errors of the biomarker are not reliant on self reported data and are thus unlikely to be correlated with the measurement errors of the dietary assessment method (Bingham 2002). With this in mind, biomarkers could be used as a complementary method of dietary assessment for sugar intake in Māori.
The dietary assessment method used to determine sugar intake in Māori should be brief and easily comprehensible (Cade, Burley et al. 2004, Vucic, Glibetic et al. 2009), this is due to the prevalence of low socioeconomic status and low literacy levels found in the population (Satherley, Elliot et al. 2009). This will reduce respondent burden and subsequently will likely increase compliance and participation from the subjects (Vucic, Glibetic et al. 2009). Diet-disease associations often requires large sample sizes and thus the use of a FFQ to measure sugar intake in Māori best fits the criteria, as it is able to cost-effectively estimate a population’s usual sugar intake quickly, with a relatively low respondent burden.

2.4 Food Frequency Questionnaires that Measure Sugar Intake

Published and validated FFQs designed to solely measure sugar intake are scarce. However, there are a number of long, multi-nutrient FFQs that have been validated and/or tested for reliability for their ability to measure sugars intake (Table 2.1). This section is devoted to the discussion of validation and/or reliability studies of international FFQs measuring sugar intake (Table 2.2 and 2.3).

The Dutch Sweet Eating Questionnaire, designed to assess the influence of sweet eating on female weight loss after bariatric surgery is the only questionnaire found that solely assesses sugars intakes (van den Heuvel, Hörchner et al. 2011). It is a self-administered tool with 26 items pertaining to sugary foods and drinks (van den Heuvel, Hörchner et al. 2011). For validation, sugars estimated by the questionnaire were compared with sugars
Table 2.1: Description of validated and/or reliability tested international food frequency questionnaires (FFQs) which measure sugar intake in adults.

<table>
<thead>
<tr>
<th>FFQ</th>
<th>Purpose</th>
<th>Type</th>
<th>Administration</th>
<th>Period</th>
<th>Item</th>
<th>Frequency response (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian FFQ</td>
<td>To measure usual food and nutrient intakes</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>172</td>
<td>Open ended</td>
</tr>
<tr>
<td>Australian Cancer</td>
<td>To measure usual food and nutrient intakes for a series of cancer studies</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>135</td>
<td>9 (never - ≥4/d)</td>
</tr>
<tr>
<td>Block Alive</td>
<td>To generate point estimates for saturated fat, trans fat, total sugar and F/V</td>
<td>Qual</td>
<td>Self</td>
<td>1y</td>
<td>50</td>
<td>6 (&lt;1/w - everyday)</td>
</tr>
<tr>
<td>Blue Mountains Eye Study</td>
<td>To rank Australians according to their intake of total CHO, sugar, starch, fibre, GI and GL</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>145</td>
<td>9 (never - ≥4/d)</td>
</tr>
<tr>
<td>Cambridge</td>
<td>To assess usual food and nutrient intakes</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>130</td>
<td>9 (never - ≥6/d)</td>
</tr>
<tr>
<td>CHIS 05</td>
<td>To capture F/V and tsps of added sugar intake</td>
<td>Qual</td>
<td>Interviewer (telephone)</td>
<td>1m</td>
<td>11</td>
<td>Open-ended (/d, /w, /m)</td>
</tr>
<tr>
<td>CHIS 09</td>
<td>To capture F/V and tsps of added sugar intake</td>
<td>Qual</td>
<td>Interviewer (telephone)</td>
<td>1m</td>
<td>10</td>
<td>Open-ended (/d, /w, /m)</td>
</tr>
<tr>
<td>Dutch Sweet Eating Questionnaire</td>
<td>To assess the influence of sweet eating on female weight loss after bariatric surgery</td>
<td>Qual</td>
<td>Self</td>
<td>NS</td>
<td>26</td>
<td>10 (never - ≥3/d)</td>
</tr>
<tr>
<td>EPIC-Norfolk</td>
<td>To assess usual food and nutrient intake and to obtain food group data</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>130</td>
<td>9 (&lt;1/m - ≥6/d)</td>
</tr>
<tr>
<td>Eye Disease Case-Control Study</td>
<td>To estimate total energy intake and intakes of nutrients of interest in ocular research</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>60</td>
<td>9 (never - ≥6/d)</td>
</tr>
<tr>
<td>Finnish FFQ</td>
<td>To assess usual food and nutrient intakes, in particular CHO fractions, GI and GL</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>131</td>
<td>9 (never or seldom- ≥6/d)</td>
</tr>
<tr>
<td>FFQ</td>
<td>Purpose</td>
<td>Type</td>
<td>Administration</td>
<td>Period</td>
<td>Item</td>
<td>Frequency response (range)</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-------</td>
<td>-------------------------</td>
<td>--------</td>
<td>------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Five Factor 05 NHIS CCS</td>
<td>To assess approximate intakes of F/V, fibre, wholegrains, added sugar, calcium and dairy foods</td>
<td>Qual</td>
<td>Interviewer (in-person)</td>
<td>1y</td>
<td>18</td>
<td>10 (never - ≥5/d)</td>
</tr>
<tr>
<td>FODMAP FFQ</td>
<td>To assess usual food, nutrient and FODMAP intake</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>297</td>
<td>NS</td>
</tr>
<tr>
<td>Harvard booklet</td>
<td>To assess intake of various nutrients</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>116</td>
<td>9 (never - ≥6/d)</td>
</tr>
<tr>
<td>Harvard 80 Out</td>
<td>To categorise individuals by intake of certain nutrients hypothesised to be associated with cancer or heart disease</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>61</td>
<td>9 (never - ≥6/d)</td>
</tr>
<tr>
<td>Health of Older Iowa Women Study</td>
<td>To estimate usual food and nutrient intakes in older women</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>126</td>
<td>9 (never - ≥6/d)</td>
</tr>
<tr>
<td>Nambour FFQ</td>
<td>To assess usual food and nutrient intakes</td>
<td>Semi</td>
<td>Self</td>
<td>6m</td>
<td>129</td>
<td>9 (never - ≥4/d)</td>
</tr>
<tr>
<td>Oxford</td>
<td>To assess usual food and nutrient intakes</td>
<td>Semi</td>
<td>Self</td>
<td>1y</td>
<td>127</td>
<td>9 (never - ≥6/d)</td>
</tr>
<tr>
<td>Tehran Lipid and Glucose Study</td>
<td>To rank individuals according to levels of their food group intake and assess food group intake</td>
<td>Semi</td>
<td>Interviewer (in-person)</td>
<td>1y</td>
<td>168</td>
<td>Open-ended (/d, /w, /m, never)</td>
</tr>
<tr>
<td>The Dietary Fat and free Sugar-Short Questionnaire (DFS)</td>
<td>To measure intake of both saturated fat and free sugars</td>
<td>Qual</td>
<td>Self</td>
<td>1y</td>
<td>24</td>
<td>5 (&lt;1/m - ≥5/w)</td>
</tr>
</tbody>
</table>

FFQ=Food Frequency Questionnaire; Semi=semi-quantitative; Qual=qualitative; Self=self-administered; y=year; m=month; w=week; d=day; F=fruit; V=vegetable; CHO=carbohydrate; GI=glycemic index; GL=glycemic load; CHIS=California Health Interview Survey; tsps=teaspoons; NS=not specified; EPIC=European Prospective Investigation into Cancer and Nutrition; NHIS=National Health Interview Survey; FODMAP= Fermentable, Oligo-, Di-, Mono-saccharides and Polyols; CCS=Cancer Control Supplement
Table 2.2: Description of food frequency questionnaire (FFQ) validation studies, including statistical tests utilized and results presented for sugar intake in adults between the food frequency questionnaire and reference method.

<table>
<thead>
<tr>
<th>FFQ</th>
<th>Validation study</th>
<th>Reference method</th>
<th>Participants</th>
<th>Statistical test</th>
<th>Sugar (g)</th>
<th>Suc. (g)</th>
<th>Fruc. (g)</th>
<th>Gluc. (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvard 80 Out</td>
<td>Willett, 1985</td>
<td>4 x 7d EDR</td>
<td>173 F USA residents, 34-59y</td>
<td>Crude PC; E-adjusted PC</td>
<td>0.60; 0.54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvard Booklet</td>
<td>Willett, 1988</td>
<td>4 x 7d EDR</td>
<td>150 F USA residents, 34-59y</td>
<td>Crude PC; E-adjusted PC</td>
<td>0.50; 0.45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health of older Iowa women FFQ</td>
<td>Munger, 1992</td>
<td>5 x 24h recall</td>
<td>44 F USA residents, 55-69y</td>
<td>Crude PC; E-adjusted PC</td>
<td>-0.04; -0.07</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cambridge</td>
<td>Bingham, 1994</td>
<td>4 x 4d WDR</td>
<td>160 F UK residents, 50-65y</td>
<td>SC</td>
<td>0.44</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHIS 05</td>
<td>OPEN Study&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4 x 24h recall (1/season)</td>
<td>484 M&amp;F USA residents, 40-69y</td>
<td>PC</td>
<td>M=0.69&lt;sup&gt;b&lt;/sup&gt;, F=0.66&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>EATS Study&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>4 x 24h recall (1/season)</td>
<td>1640 M&amp;F USA resident, 20-70y</td>
<td>PC</td>
<td>M=0.59&lt;sup&gt;b&lt;/sup&gt;, F=0.66&lt;sup&gt;b&lt;/sup&gt;</td>
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</tr>
<tr>
<td>CHIS 09</td>
<td>OPEN Study&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4 x 24h recall (1/season)</td>
<td>484 M&amp;F USA residents, 40-69y</td>
<td>PC</td>
<td>M=0.71&lt;sup&gt;b&lt;/sup&gt;, F=0.61&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>EATS Study&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>4 x 24h recall (1/season)</td>
<td>1640 M&amp;F USA residents, 20-70y</td>
<td>PC</td>
<td>M=0.59&lt;sup&gt;b&lt;/sup&gt;, F=0.70&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>FFQ</td>
<td>Validation study</td>
<td>Reference method</td>
<td>Participants</td>
<td>Statistical test</td>
<td>Sugar (g)</td>
<td>Suc. (g)</td>
<td>Fruc. (g)</td>
<td>Gluc. (g)</td>
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</tr>
<tr>
<td>Five Factor 05 NHIS CCS</td>
<td>OPEN Study(^a)</td>
<td>4 x 24h recall (1/season)</td>
<td>484 M&amp;F USA residents, 40-69</td>
<td>Deattenuated PC</td>
<td>M=0.68(^b), F=0.66(^b)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EATS Study(^a)</td>
<td>4 x 24h recall (1/season)</td>
<td>1640 M&amp;F USA residents, 20-70y</td>
<td>Deattenuated PC</td>
<td>M=0.59(^b), F=0.66(^b)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPIC-Norfolk</td>
<td>McKoewn, 2001</td>
<td>2 x 7d EDR</td>
<td>146 M&amp;F UK residents, 45-74y</td>
<td>Crude PC; E-adjusted-deattenuated PC</td>
<td>M=0.48; 0.72 F=0.54; 0.70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxford</td>
<td>Brunner, 2001</td>
<td>7d EDR</td>
<td>457M &amp; 403F UK servants</td>
<td>Crude SC; E-adjusted SC</td>
<td>M=0.48;0.48 F=0.43;0.48</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Australian FFQ</td>
<td>Ambrosini, 2002</td>
<td>4 x 7d EDR</td>
<td>72 Australian residents, mean age:55M, 49F</td>
<td>PC</td>
<td>M=0.62, F=0.76</td>
<td>M=127(115-139) F=131(113-151)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nambour FFQ</td>
<td>Marks, 2006</td>
<td>6 x 2d WDR</td>
<td>115 M&amp;F Australian residents, 25-75y</td>
<td>Crude SC; E-adjusted SC</td>
<td>0.53:0.46</td>
<td>131 (83-205)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block Alive</td>
<td>Lalonde, 2008</td>
<td>2 x 24hr recall</td>
<td>41 M&amp;F Canadian cardiac rehabilitation outpatients</td>
<td>Crude PC; Deattenuated PC</td>
<td>0.71; 0.92</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FODMAP FFQ</td>
<td>Barrett, 2010</td>
<td>4x 7d EDR</td>
<td>72 M&amp;F Australian residents, 23-72y</td>
<td>SC; weighted kappa; Crude % agreement (LoA)</td>
<td>0.55:0.39 0.49;0.48 0.66;0.65; 0.48</td>
<td>137 (88-214) 125 (70-220) 163 (97-271)</td>
<td>156 (90-271) 163 (97-277)</td>
<td></td>
</tr>
<tr>
<td>FFQ</td>
<td>Validation study</td>
<td>Reference method</td>
<td>Participants</td>
<td>Statistical test</td>
<td>Sugar (g)</td>
<td>Suc. (g)</td>
<td>Fruc. (g)</td>
<td>Gluc. (g)</td>
</tr>
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<td>------------------------------------------</td>
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</tr>
<tr>
<td>Tehran Lipid and Glucose Study</td>
<td>Esfahani, 2010</td>
<td>12 x 24hr recall</td>
<td>132 M&amp;F Tehran residents, 20-70y</td>
<td>Crude SC; E-adjusted-detennuated SC</td>
<td>M=0.77;0.77&lt;sup&gt;c&lt;/sup&gt;;0.79&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Dietary Fat and free Sugar-Short Questionnaire (DFS)</td>
<td>Francis, 2012</td>
<td>4d EDR</td>
<td>40 M&amp;F Australian university students, mean age: 21.3y</td>
<td>SC</td>
<td>0.37&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.36&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.25&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.22&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>172 item validated FFQ</td>
<td></td>
<td></td>
<td>0.38&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.45&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.19&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Finnish FFQ</td>
<td>Kaartinen, 2012</td>
<td>2 x 3d EDR</td>
<td>510 M&amp;F Finnish residents, 25-74y</td>
<td>Crude SC; E-adjusted SC</td>
<td>0.28;0.37</td>
<td>0.36;0.46</td>
<td>0.28;0.39</td>
<td></td>
</tr>
</tbody>
</table>

FFQ=food frequency questionnaire; g=grams; Suc.=sucrose; Fruc.=fructose; Gluc.=glucose; d=day; y=years; EDR= estimated diet record; WDR= weighed diet record; 24h=24 hour; F=female; M=male; USA=United States of America; UK=United Kingdom; PC=Pearson Correlation; SC=Spearman Correlation; LoA=Limits of Agreement; E=Energy; CHIS=California; Health Interview Survey; OPEN= Observing Protein and Energy; EATS=Eating at America’s Table; tsp=teaspoon; NHIS=National Health Interview Survey; CCS=Cancer Control Supplement; EPIC=European Prospective Investigation into Cancer and Nutrition; FODMAP= Fermentable, Oligo-, Di-, Mono-saccharides and Polyols

<sup>a</sup> Unpublished data
<sup>b</sup> Added sugar (tsp)
<sup>c</sup> Simple sugars (g)
<sup>d</sup> Nutrient values expressed as a percentage of total energy intake
Table 2.3: Description of reliability studies of food frequency questionnaires (FFQ) measuring sugar intakes in adults inclusive of, statistical test and results for test-retest reliability.

<table>
<thead>
<tr>
<th>FFQ</th>
<th>Reliability study</th>
<th>Int.</th>
<th>Participants</th>
<th>Statistical Test</th>
<th>Sugar (g)</th>
<th>Suc. (g)</th>
<th>Fruc. (g)</th>
<th>Gluc. (g)</th>
<th>Additional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvard 80 Out</td>
<td>Willet, 1985</td>
<td>1y</td>
<td>173 F USA residents, 34-59y</td>
<td>PC;ICC</td>
<td>0.71;0.71</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health of older Iowa women FFQ</td>
<td>Munger, 1992</td>
<td>2y, 6m</td>
<td>44 F USA residents, 55-69y</td>
<td>Crude PC:</td>
<td>0.49;0.40;0.5</td>
<td></td>
<td></td>
<td></td>
<td>3 admin. of the same FFQ</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FFQ1vsFFQ2; FFQ1vsFFQ3; FFQ2vs:FFQ3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye Disease Case-Control Study FFQ</td>
<td>Ajani, 1994</td>
<td>12-18m</td>
<td>281 M&amp;F USA residents, mean age:64.4y</td>
<td>E-adjusted Partial Corr.</td>
<td>0.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPIC-Norfolk</td>
<td>McKoewn, 2001</td>
<td>NS</td>
<td>146 M&amp;F UK residents, 45-74y</td>
<td>Crude PC; E-adjusted PC</td>
<td>M=0.64;</td>
<td>0.62</td>
<td>0.78</td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td>Block Alive</td>
<td>Lalonde, 2008</td>
<td>2w</td>
<td>90 M&amp;F Canadian cardiac rehabilitation outpatients</td>
<td>PC</td>
<td>0.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australian Cancer FFQ</td>
<td>Ibiebele, 2009</td>
<td>1y</td>
<td>100 Australian residents, 22-79y</td>
<td>ICC; weighted kappa</td>
<td>0.58;0.48</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFQ</td>
<td>Reliability study</td>
<td>Int.</td>
<td>Participants</td>
<td>Statistical Test</td>
<td>Sugar (g)</td>
<td>Suc. (g)</td>
<td>Fruc. (g)</td>
<td>Gluc. (g)</td>
<td>Additional</td>
</tr>
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</tr>
<tr>
<td>FODMAP FFQ</td>
<td>Barret, 2010</td>
<td>1y</td>
<td>72 M&amp;F Australian residents, 23-72y</td>
<td>ICC</td>
<td>0.77</td>
<td>0.85</td>
<td>0.73</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>Tehran Lipid and Glucose</td>
<td>Esfahani, 2010</td>
<td>14m</td>
<td>132 M&amp;F Tehran residents, 20-70y</td>
<td>Crude ICC; E-adj. ICC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Simple sugars M=0.86;0.7 7. F=0.83;0.74</td>
</tr>
<tr>
<td>Dutch Sweet Eating Questionnaire</td>
<td>van den Heuvel, 2010</td>
<td>2w</td>
<td>138 F Dutch residents undergone bariatric surgery, 22-62y 29</td>
<td>PC</td>
<td>0.32-0.99</td>
<td></td>
<td></td>
<td></td>
<td>Corr. were calculated for each item</td>
</tr>
<tr>
<td>The Dietary Fat and free</td>
<td>Francis, 2012</td>
<td>145-168 d</td>
<td>Australian university students, mean age:21.8y</td>
<td>ICC</td>
<td>0.83</td>
<td></td>
<td></td>
<td></td>
<td>Corr. Between overall scores</td>
</tr>
<tr>
<td>Sugar-Short Questionnaire</td>
<td></td>
<td></td>
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</tbody>
</table>

FFQ=food frequency questionnaire; Int=Interval; g=grams; Suc.=sucrose; Fruc.=fructose; Gluc.=glucose; y=year; m=month; w=week; d=day; F=female; M=male; USA=United States of America; UK=United Kingdom; PC=Pearson correlation coefficient; ICC=Intraclass correlation coefficient; admin.=administration; E=energy; Corr.=correlation; NS=not specified; EPIC=European Prospective Investigation into Cancer and Nutrition; FODMAP=Fermentable, Oligo-, Di-, Mono-saccharides and Polyols
estimates obtained from one or two ‘dietary interviews’ (diet histories) conducted by various hospital dietitians in 136 women who had undergone bariatric surgery in the Netherlands (van den Heuvel, Hörchner et al. 2011). This technique is not recognized as a reference method for dietary assessment and subsequently it is difficult to derive definitive conclusions surrounding the validity and reliability of the questionnaire (Cade, Thompson et al. 2002). The authors state the tool appeared to be both valid and reliable; however its design and validation limit the tools applicability to males and a non-Western population (van den Heuvel, Hörchner et al. 2011). As there is yet to be published literature utilizing the questionnaire to measure sugar intake it difficult to further assess or identify any strengths and weaknesses of the questionnaire.

The Dietary Fat and free Sugar-Short Questionnaire (DFS) was recently designed to measure intake of both saturated fat and free sugars in Australian adults. It is a qualitative, administered tool with 24 items intended to measure intake over the past year (Francis and Stevenson 2013). The preliminary investigation into validity by Francis and Stevenson (2013) used 4 day estimated diet records (EDR) and a 172-item previously validated FFQ in 40 male and female Australian university students with a mean age of 21 years. Reliability was established with repeated administration of the FFQ in 29 of the individuals 145 – 169 days after the initial administration (Francis and Stevenson 2013). The interclass correlation coefficient for sugar was 0.83 and validity was calculated with spearman rank correlations against the diet records (0.37) and a previously validated FFQ (0.38) (Francis and Stevenson 2013). These results show promise of good reliability and moderate validity of the DFS. As there is yet to be published literature using the tool it is
difficult to reach definitive conclusions regarding the tool’s ability to measure sugar intake. In order for association between sugar intake and health outcomes to be established by the DFS further and more extensive validation is required.

The Harvard FFQ is one of the most widely used dietary assessment instruments, it is a self administer, semi-quantitative, closed-ended, 116 item FFQ designed to measure intake of various nutrients over the previous year (Willett, Sampson et al. 1985). It was initially validated in 1985 against four 7 day EDR in 150 adult females(Willett, Sampson et al. 1985). The seasonal validation utilizing 7 day EDR is strength to the validation study as it accounts for discrepancies in intake that occur over the year (Willett 1998). The validation study shows crude correlations range from 0.54 – 0.6 and reliability correlations to be 0.71 for sugars (Willett, Sampson et al. 1985) (Table 2.2 and 2.3). A crude correlation coefficient of around 0.5 between the two methods has been suggested to indicate the FFQ has the capability to rank individuals according to nutrient intake (Brunner, Stallone et al. 2001). These values show the FFQ has good capabilities to measure sugar intake. The authors believe the tool is able to reasonably categorize individuals by nutrient intake (Willett, Sampson et al. 1985). A version of this FFQ has been utilized in the Nurse’s Health Study (NHS). It was observed in the NHS that those who consumed one or more servings per day of a sugar-sweetened soft drink or fruit punch were twice as likely to developed type two diabetes during the study than those who rarely had these beverages (Schulze, Manson et al. 2004). The validation study of the FFQ reflects the demographics of the NHS participants, adding strength that the FFQ is comprehensible by and appropriate for the participants and decreasing the chances that
the observed association between sugar-sweetened soft drink/fruit punch and diabetes is due to measurement error (Willett 1998, Cade, Burley et al. 2004).

The EPIC Norfolk FFQ is a semi-quantitative, self administered, 130-item tool that has been designed to assess usual food and nutrient intakes and to obtain food group data over the past year for English adults (McKeown, Day et al. 2001)(Table 2.1). Similar to the Harvard FFQ, the EPIC Norfolk FFQ utilized two 7 day EDR as the reference tool during the validation study on 146 male and female United Kingdom (UK) residents aged 45 – 74 (McKeown, Day et al. 2001). The instrument was validated for its ability to measure various nutrients including sugars intakes. The crude correlation coefficients for validity and reliability of sugar intakes were moderate (0.48 – 0.52 and 0.62 – 0.72 respectively) (McKeown, Day et al. 2001) (Table 2.2 and 2.3). Using this instrument, sugars intakes of obese and non obese participants were compared. Based on the FFQ results there were no apparent differences in sugars intakes between these two groups (Bingham, Luben et al. 2007). However, when using urine and plasma biomarkers of sugars intakes, sucrose intake was significantly associated with biomarkers in non-obese individuals, but there were no significant associations between biomarkers and sucrose intakes in the obese, suggesting significant under-reporting on sugars intakes in the obese participants (Bingham, Luben et al. 2007). This proposes that while the FFQ appears to adequately measure sugars intakes overall, estimates from obese individuals may be less reliable than those from lean individuals (Bingham, Luben et al. 2007).
Table 2.2 describes a number of food frequency questionnaires that have been validated for their ability to assess sugars intakes. None of the instruments presented have been designed for NZ populations, with most designed for United States (US) or European populations, where dietary patterns differ due to differences in food availability and culture. Thus although many of these instruments have been shown to produce valid estimates of sugars intakes they should not be used to measure sugar intake in a NZ population prior to validity being established within NZ (Cade, Burley et al. 2004).

2.5 New Zealand Validated FFQs

No sugar specific or short tools measuring sugar intake have been developed and validated for use in New Zealand. Five long, multi-nutrient FFQ that have been validated for sugar intake in NZ adults are described in table 2.4 (Sharpe, Page et al. 1993, Bolch 1994, Marshall 1994, Bell, Swinburn et al. 1999, Sam 2012). For these FFQ the validity crude correlation coefficients between the reference method and FFQ range from 0.32 – 0.58 for sugars intakes (Table 2.4). All questionnaires are self-administered and assess intake over the past year, and all except the questionnaire developed by Bell, Swinburn et al. (1999) are semi-quantitative (Sharpe, Page et al. 1993, Bolch 1994, Marshall 1994, Bell, Swinburn et al. 1999, Sam 2012).

The Bell, Swinburn et al. (1999) questionnaire included 89 items and utilized a quantitative format designed to assess the usual nutrient intake of NZ Samoan’s. It was validated by comparison against a 7 day EDR in 55 Samoan individuals. The weak crude correlation of 0.32 for sugar is attributed by the authors, to the burden the reference
<table>
<thead>
<tr>
<th>Author, year</th>
<th>Origin</th>
<th>Type Admin. Item</th>
<th>Freq. response Time period</th>
<th>Purpose</th>
<th>Reference method</th>
<th>Participants (age) location</th>
<th>Ethnicity</th>
<th>Statistical test</th>
<th>Sugar (g) Fruc. (g) Suc. (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharpe, 1993</td>
<td>Willet</td>
<td>Semi Self</td>
<td>75 (never-daily) 1y</td>
<td>Cardiovascular risk assessment</td>
<td>7d EDR</td>
<td>50M, 52F (25-75y) North Island</td>
<td>80% NZE 4% Maori 12% PI</td>
<td></td>
<td>a)0.58&lt;sup&gt;a&lt;/sup&gt; b)0.53&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Marshall, 1994</td>
<td>Semi Self</td>
<td>132 (never-daily) NS</td>
<td>To assess the usual nutrient intake of NZ Adults</td>
<td>7d EDR</td>
<td>101F (mean age=21) Dunedin</td>
<td></td>
<td></td>
<td>0.46-0.52&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Bolch, 1994</td>
<td>Marshall Semi Self, 1994</td>
<td>132 (never-daily) 1y</td>
<td>To assess the usual nutrient intake of NZ Adults</td>
<td>7d EDR</td>
<td>40M, 35F (25-49y) Dunedin</td>
<td></td>
<td></td>
<td>0.58&lt;sup&gt;c&lt;/sup&gt; 0.58&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Bell, 1999</td>
<td>Willet</td>
<td>QuanSelf</td>
<td>89 (never-daily) 1y</td>
<td>To assess the usual nutrient intake of NZ Samoans</td>
<td>7d EDR</td>
<td>24M, 31F (&gt;20y) Auckland</td>
<td>100% Samoan</td>
<td>0.32&lt;sup&gt;a&lt;/sup&gt; 0.28&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Sam, 2012</td>
<td>UK EPIC</td>
<td>Semi Self</td>
<td>154 (never-≥2/day) 1y</td>
<td>To assess the usual nutrient intake of NZ Adults</td>
<td>8d WDR</td>
<td>66M, 69F (30-59y) Dunedin</td>
<td>96% NZEO 3% Maori 1% PI</td>
<td>140 (56-347) 126 (50-317)</td>
<td>0.38&lt;sup&gt;a&lt;/sup&gt; 0.47&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

FFQ=food frequency questionnaire; Admin=administration; Freq.=frequency; g=gram; Fruc.=fructose; Suc.=sucrose; Semi=semi-quantitative; Quan=quantitative; Self=self-administered; y=year(s); m=month; w=week; d=day; NZ=New Zealand; NS=not specified; NA=not assessed; EDR=estimated diet record; WDR=weighed diet record; M=males; F=females; NZE=New Zealand Europeans; PI=Pacific Islanders; NZEO=New Zealand European and others; (LoA); LoA=Limits of Agreement

<sup>a</sup>=Crude Spearman CC (correlation coefficient)<br><sup>b</sup>=Energy-adjusted Spearman CC<br><sup>c</sup>=Crude Pearson CC<br><sup>d</sup>=Energy-adjusted Pearson CC<sup>e</sup>=mean % agreement
method placed upon the participants rather than the flaws within the FFQ, as many records were returned with inaccurate measurements or incomplete (Bell, Swinburn et al. 1999). It was concluded that the FFQ was likely to give a better representation of usual intake in this population than the EDR (Bell, Swinburn et al. 1999).

Sharpe, Page et al. (1993) validated a 75 item designed for cardiovascular risk assessment against a 7 day diet record in 102 individuals. Crude correlation coefficients for sugar intake ranged from 0.53 when standard servings were present and 0.58 when 4 serving size options were presented (Sharpe, Page et al. 1993)(Table 2.4). The FFQ included illustrations of foods and portion size, this is encouraged by experts as it aids portion size quantification and memory (Cade, Thompson et al. 2002).

Bolch (1994) is a further validation of the 132 item FFQ produced by Marshall (1994). (Marshall 1994) first validated the FFQ in 101 female human nutrition students and Bolch (1994) extended the validation in 75 Dunedin adults aged 29 – 45 years. The crude correlation coefficients for sugars were acceptable (0.58) (Bolch 1994). One limitation regarding the validation of this questionnaire was that whilst the FFQ assessed yearly intake the reference method was a single 7 day EDR completed over one month timeframe. Thus the reference method would not reflect seasonal variations in intake patterns. However, sugar intake has been found to remain relatively consistent over seasons and as such the consecutive validation of the FFQ not a large point of concern.
In addition these aforementioned FFQs were all developed and validated in the 90’s (Sharpe, Page et al. 1993, Bolch 1994, Marshall 1994, Bell, Swinburn et al. 1999). As consumption patterns and the type and variety of food products available have undergone rapid expansion within the last two decades it is unlikely that these FFQ incorporate all common sugar-containing foods and beverages consumed today. For example energy drink’s which have proliferated in abundance in the western world and New Zealand over the last decade (Reissig, Strain et al. 2009). Moreover as none of the FFQs were developed or validated with Māori specifically in mind, it is quite likely that the FFQs may not be culturally appropriate for Māori, and they may not include some important sugar-containing food and beverage sources.

The Food Options of Dunedinites FFQ (FOOD-FFQ) was validated in 2012 by Sam (2012). It is a multi-nutrient 154-item FFQ designed to assess the usual nutrient intake of NZ Adults (Table 2.4). Foods were identified from the NNS97 and inspection tours of supermarkets as well as focus group feedback. Interviews were used to adapt the food list from the UK EPIC questionnaire (Sam 2012). The validation study was undertaken with 135 individuals (3% Māori) living in Dunedin. Participants completed 8 days of weighed diet-records in total over a one year period, which included 2-day diet records collected in each season (Sam 2012). In addition blood samples were collected for the measurement of nutritional intake biomarkers. The crude correlation coefficients were 0.38 for fructose and 0.47 for sucrose (Sam 2012). While this indicates that the FFQ may perform adequately, it is not a strong correlation, in particular for fructose (Brunner, Stallone et al. 2001, Cade, Thompson et al. 2002). Thus the usefulness of this FFQ to
explore associations between sugars and health would be limited to very large population studies.

A strength of these NZ FFQs are that they include a comprehensive list of food items and are able to assess intakes of multiple nutrients. Long multi-nutrient FFQ have been seen as superior for assessing individual nutrient intakes against short questionnaires (Rockett, Berkey et al. 2007). This is due to shorter questionnaires tending to underestimate nutrient estimates, particularly those associated with socially undesirable behaviors like sugar consumption (Rockett, Berkey et al. 2007). However multi-nutrient FFQ often have a limited number of questions (generally 6 – 10) that pertain to sugary foods and beverages. Therefore, they may not be able to provide sufficiently precise data on sugar intakes (Willett 1998). This coupled with the unnecessary time and respondent burden of a administering a multi-nutrient FFQ when sugar is the primary interest limits the use of the current tools.

2.6 Conclusion

There is currently no simplified suitable tool that can adequately assess sugars intake in Māori. To assess sugars intake Māori, use of total dietary assessment methods such as the 24hr recall is possible. The 24hr recall does not require high literacy levels from the participant and has a relatively low respondent burden. However, for an epidemiological study to determine the association between sugar intake and health outcomes in Māori 24hr recalls would be time consuming, expensive and require trained nutritionist to complete and code the information. Thus rendering 24hr recalls an infeasible option.
A short FFQ would provide a reliable and feasible method for measuring sugar intakes in a low literacy and low socioeconomic status Māori population. Furthermore it would be cost effective and efficient as there is a low respondent burden. Additionally with the ability to estimate group means and rank individuals, conclusions could be drawn on the association between sugars and health outcomes. As no short FFQ designed to measure sugar currently exists there is a need develop and validate a short FFQ specific to Māori and sugar intake.
3. Objective Statement

In New Zealand obesity, gout, diabetes, cardiovascular and metabolic diseases are more prevalent in the indigenous Māori population than the general population (Ministry of Health 2012, Winnard, Wright et al. 2012). High sugar intakes, and specifically fructose, have been linked to the increase in the prevalence of these diseases that has been seen throughout the world (Johnson, Perez-Pozo et al. 2009, Richette and Bardin 2010).

Definitive evidence linking sugars, and fructose to chronic disease risk has been limited by a lack of reliable methods for measuring sugars intakes at a population level. We see a need to develop a valid and reliable tool to measure sugar intakes in NZ Māori populations to examine whether excess sugar intakes are contributing to their increased risk of chronic diseases, as none currently exists.

The aim of this study is to develop, pre-test and validate a culturally appropriate short dietary assessment tool that measures sugar intake in a Māori population. This tool will be used to examine the relationship between sugar intake and chronic disease in order to justify public health recommendations to limit sugars intake.

Objectives:

1. To create a short dietary assessment questionnaire designed to assess and rank individuals sugars intakes based on foods and beverages that make an important contribution to added sugars and fructose intakes of Māori identified using the 08/09 Adult Nutrition Survey 24hr dietary recall data.
2. To pre-test two formats of the short dietary assessment tool, via cognitive interviews, to ensure the tool is comprehensible to the target audience, culturally appropriate, at a suitable literacy level and includes all important food sources of dietary sugars.

3. To assess the relative validity of the short dietary assessment tool for assessing added sugars and fructose intakes over the previous month, by comparison with a reference dietary assessment method (repeated 24 hour dietary recalls) reflecting intakes over the same time period.

4. To determine test-retest reliability of the short dietary assessment tool by comparing sugars estimates from repeated administrations of the tool four weeks apart.
4. Subjects and Methods

Ethics
This study was approved and conducted in accordance with the guidelines of the Otago University Human Ethics Committee. Informed consent was obtained from all subjects (Appendix 1).

Design
This study was an observational study involving the development and pre-testing of a short FFQ designed to assess sugars intakes, and validation of the finalized FFQ against a reference dietary assessment method (repeated 24hr recalls) in a convenience samples of Māori adults living in Gisborne, New Zealand who provided dietary intake data assessed using both dietary assessment methods between March and May 2013.

Subjects
For pre-testing a convenience sample of 10 New Zealand Māori adults was recruited via face-to-face recruitment. For the validation study a convenience sample of 35 New Zealand Māori adults was recruited via, face-to-face recruitment, word of mouth, the virtue of the health provider Ngati Porou Hauora and flyers placed around the Gisborne district from February to May 2013. Participation was voluntary for both pre-testing and validation, upon completion of each interview participants were given a koha of a $10.00 supermarket voucher as compensation for their time and travel expenses.
Eligibility was based upon the following criteria:

- New Zealand Māori ethnicity living in the Gisborne region
- Aged between 18 – 65 years
- Those who do not have any impairment which may prevent them from correctly remembering their previous intake
- Those physically and mentally capable to provide informed written consent to partake
- Those that had not had prior nutritional or medical training

4.1 Development and Pretesting

A 33-item, self-administered, semi-quantitative FFQ aiming to measure usual sugar consumption over the previous month was developed for Māori adults, living in Gisborne New Zealand. The timeframe for the FFQ of one month was selected as further research projects intend to validate the FFQ against, and correlate it to biochemical markers such as serum uric acid and disease-risk biomarkers such as lipids and blood pressure. These biomarkers have been found to significantly change in response to diet (3-4 weeks). Subsequently a one month FFQ is appropriate for correlation of sugars with disease risk biochemical markers. Additionally, as individuals have been found to answer the FFQs for the last month of intake even when asked about their intake over the whole year (Subar, Thompson et al. 1995), the timeframe of one month FFQ would be as suitable as a 1 year FFQ for examining correlations with disease states such as diabetes.
Two versions of the paper-based FFQ were created, open and closed ended. The open-ended version of the FFQ contained the same food items as the closed ended, but the frequency and most quantity questions were open-ended allowing participants to record exactly what they consumed. The closed-ended version of the FFQ had nine frequency response categories, ranging from “never or less than once a month” to “6 or more times a day” and five to seven quantity categories depending on the food item.

Sugar containing food and beverage items were compiled from various sources:

- Crutchley (2012), which had been based on the format of the FOOD-FFQ (Food Options of Dunedinites) (Sam 2012) and tested for suitability in a Māori population during a summer studentship in 2012/2013 (McNeil 2013);
- a fruit FFQ previously validated with NZ adults (Mainvil 2011)
- a sugar-sweetened beverages FFQ validated with USA adults (Hedrick, Comber et al. 2010)
- New Zealand adult nutrition surveys (University of Otago and Ministry of Health 2011)
- An environmental audit of local food outlets and two supermarkets, including observations of the target audience were carried out to ensure food items represented major sources of sugars intakes in the NZ Māori Gisborne population

The design of the closed-ended frequency categories and options for quantifying usual intakes of each food item, including photos, was inspired from various sources (Gibson 2005, Hedrick, Comber et al. 2010). Photos were sourced from the Department of Human Nutrition’s Dietary Assessment Photos and additional photos were taken of foods and
drinks that were commonly found for sale in Gisborne during the environmental audit (Nutrition 2013).

Partially inspired by the work of (Kristjansdottir 2005), an open ended version of the closed ended FFQ was developed. This was based upon previous qualitative research by Mainvil (2011) which examined low income NZ adults thought processes while completing FFQ. This research suggested that an open ended format may be more suitable for this group.

**Pretesting**

In order to ensure comprehension the FFQ should be rigorously pre-tested in the target community to observe that not only are the instructions clear but that the method for recording the response is unambiguous (Cade, Burley et al. 2004). Therefore both formats of the FFQ were pretested with ten representatives of the target population (2 males, 8 females) using cognitive, think-aloud interviews in order to explore the comprehension of the participants as well as their ability to accurately record their usual intake using the tool (Subar, Thompson et al. 1995). The interviews were audio recorded and transcribed (if agreed to by the participant) and detailed notes were taken during the interviews to refine the FFQ.

The FFQs were presented in an alternating sequence between open and closed format, with a minimum wait time of 15 minutes between FFQ formats to prevent participants
from mental fatigue and to minimize the risk of bias caused by ready recall of previous responses (Subar, Thompson et al. 1995, Mainvil 2011).

Nine participants stated that they preferred the open-ended questionnaire, with only one participant preferring the closed-ended questionnaire. The participant preferring the closed-ended questionnaire had no difficulties using the open-ended questionnaire. In contrast, many of the participants who preferred the open-ended questionnaire experienced difficulties comprehending the format and tick box structure. Therefore the open-ended format was selected and refined for use in the validation and reliability study. Some examples of modifications include:

- A “never” tick box was included as participants were perplexed on how to navigate the question had they not consumed the food item.
- Additional pictures of food items were added to visually aid the participants.
- Further portion sizes and volume options in particular for the alcohol questions as participants experienced cognitive difficulties when calculating the amounts they usually consumed.

4.2 The Finalized FFQ

The final version of the FFQ is in a self-administered, open-ended semi-quantitative format, with 34 questions pertaining to quantities and frequency of consumption of sweet or sweetened foods and beverages eaten over the past month (Appendix 2). Since there is a wide variety of breakfast cereals with a substantial variation in sugar contents available in the NZ market a supplementary question, was included to elicit information about the
specific brand of breakfast cereal consumed. Two additional questions requesting information on any changes in diet and weight are included at the end of the questionnaire. These questions were included to add richness to the interpretation of the future research conducted using this FFQ.

4.3 Validation and Reliability Study

Weighed diet records are currently considered the gold standard reference method against which to validate another dietary instrument even though they are subject to substantial measurement error, usually as a result of under-reporting of dietary intakes. Three day diet records have been used most frequently (Stram, Longnecker et al. 1995). Dietary record keeping requires that respondents be both motivated and literate (Cade, Thompson et al. 2002), however in our population literacy levels are relatively low (Satherley, Elliot et al. 2009). Thus, we chose to validate the FFQ against a repeated 24hr dietary recall (24hr recall) reference method which are simpler for participants with low literacy and have lower respondent burden to increase motivation levels (Cade, Thompson et al. 2002, Cade, Burley et al. 2004).

We used the United States Department of Agriculture five-step 24hr recall method in which the participants are probed for frequently forgotten foods using a predetermined list of snacks and beverages that contain sugar (Blanton, Moshfegh et al. 2006)(Table 4.1). This method has been shown to have improved precision in comparison with the standard four stage method 24hr recall method (as used in the ANS08/09) (Raper, Perloff et al. 2004, University of Otago and Ministry of Health 2011). For each participant 24hr
recalls were collected on three days during a 3 week period including, where possible, two random week days and one weekend day. Three dimensional food models and food photographs were used to assist participants to accurately estimate portion sizes.

4.3.1 Data Collection

This data collection process comprised of four interviews spaced approximately one week apart over a one month period (Figure 4.2). Interviews were conducted in the participant’s own home or at a pre-arranged suitable location such as a health clinic. All interviews were conducted by the student dietitian according to a standard operating protocol.
Table 4.1: The forgotten food list used in the 5-step multiple-pass 24h recall during data collection for the ‘Kai with Maori’ food frequency questionnaire validation study

<table>
<thead>
<tr>
<th>Food Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fizzy/Soft drink</td>
<td>Fruit juice (100% fruit juice) (no added sugar) e.g. Just Juice</td>
</tr>
<tr>
<td></td>
<td>Cordials or fruit drinks eg. raro</td>
</tr>
<tr>
<td></td>
<td>Alcoholic drinks eg. RTD</td>
</tr>
<tr>
<td></td>
<td>Lollies or chocolate</td>
</tr>
<tr>
<td></td>
<td>Desserts/puddings</td>
</tr>
<tr>
<td></td>
<td>Fruit</td>
</tr>
<tr>
<td></td>
<td>Vegetables</td>
</tr>
<tr>
<td></td>
<td>Biscuits, cake or muffins</td>
</tr>
<tr>
<td></td>
<td>Fried bread</td>
</tr>
<tr>
<td></td>
<td>Golden syrup</td>
</tr>
<tr>
<td></td>
<td>Tomato or BBQ sauce</td>
</tr>
</tbody>
</table>

RTD=ready to drink

Figure 4.2: Overview of the data collection procedure from the Kai with Māori study
At the first interview, participants were provided with an information sheet explaining the study aims and procedures. After participants had read the information sheet, a verbal description of the study purpose, design and procedure, information on confidentiality and freedom to withdraw was given. Participants were required to complete a consent form (Appendix 3), a brief questionnaire on personal information inclusive of contact details and date of birth (Appendix 4), and a demographic questionnaire (Appendix 5). The first administration of the FFQ (FFQ1) took place followed by a 24hr recall of the previous day’s intake. At each of the second and third interviews a 24hr dietary recall was collected. At the final interview (in week four) only the FFQ was re-administered (FFQ2).

When completing the FFQ, participants were verbally reminded to think about their diet over the last month and to answer the questions based on this. After participants had completed each FFQ, it was checked to ensure that no question items had been missed. After each 24hr recall, participants were asked if this was representative of a usual intake. If intakes were not representative of usual intake reasons for the discrepancy were recorded.

4.4 Statistical Analysis

Sample size

The size of the sample was calculated based on what was feasible given the length of time for the study. In a validation study it is recommended that a sample size of at least 50 is desirable for precision during analysis (Cade, Thompson et al. 2002). However, this
is a part of a wider study, where ongoing validation will occur with further participant recruitment, therefore strengthening the overall results.

**Food frequency questionnaire**

For each individual FFQ data was entered into a Microsoft Office Excel spreadsheet to calculate estimates of usual intakes of fructose, glucose, sucrose and total available sugars (Microsoft Corporation 2010)(Appendix 6). The spreadsheet multiplied the reported frequency of consumption for each food item by an estimate of the average weight in grams for each of total sugars, fructose, glucose and sucrose for that item. These values were summed for all food items consumed and converted to an estimate of the individual’s daily estimated sugars intakes for that month.

The sugar profile of the grouped or collapsed food items from the FFQ was determined by weighting all items included in the food group by the reported frequency of consumption by/of Māori subjects in the ANS08/09 (University of Otago and Ministry of Health 2011). For example the FFQ item “beer, lager or cider” was composed of 32% “ale” and 68% “lager/draught/bitter” based on the frequency of consumption of these items by Māori included in the ANS. Similarly, the sugar profile of the sub item “ice block” was composed of 80% “cordial based ice block” and 20% “milk based ice block”. The composition of fructose, glucose, sucrose and total sugar in each food comprising a grouped (or collapsed) item was obtained from the 2010 version of the NZ food composition tables (NZ FOODfiles2010v2).
24hr dietary recall

The 24hr recall data was analysed using © Kai-culator [0.85] dietary assessment software including FOODfiles 2010v2 (Department of Human Nutrition 2011). If food items or recipes present in the 24hr recalls were not in the Kaiculator database, they were substituted with generic items or recipes which were considered to have the most similar food composition. For example; both “Sprite” and “7UP” were substituted with the generic “Soft drink – lemonade”. The three 24hr recalls were averaged to obtain the usual daily intake of fructose, glucose, sucrose and total sugars of each participant.

Mean sugars intake

As sugars intakes were not normally distributed they were log transformed. The geometric mean usual sugars intake and 95% confidence intervals (CI) are reported and were calculated from the two FFQ and the mean intake of the three 24hr recalls. A two-sided paired t-test was used to examine the geometric mean differences between the intake of the second administration of the FFQ (FFQ2) and the mean 24hr recall as well as between the first and second FFQ administrations (Gibson 2005). Differences were back transformed to give a ratio (FFQ2:24hr recall) and expressed as percentages. The geometric means of usual sugar intake were also compared to the median sugars intakes for Māori aged >15 years reported in the ANS08/09 (University of Otago and Ministry of Health 2011).
**Strength of agreement**

Bland-Altman limits of agreement (LOA) define the limits within which 95% of these differences are expected to fall and provide a measure of how two methods compare. A LOA of 100% represents perfect agreement between two methods (Bland and Altman 1999). Bland Altman LOAs were calculated for FFQ2 versus the 24hr recall sugars estimates, and for FFQ1 versus FFQ2 estimates.

**Classification into categories of consumption**

Cross classification of the sugar intakes from FFQ2 and 24hr recalls and the percentage of participants classified into the same, adjacent and extreme quartiles was calculated. Additionally, Cohen’s weighted kappa was calculated for each sugar from the observed and expected proportions. Kappa values assess agreement, and are broken into quintiles between zero (indicative of complete disagreement) and one (indicative of complete agreement) (Masson, McNeill et al. 2003).

**Strength of association**

Spearman correlations were calculated to assess the strength of association between sugars intakes estimated by the FFQ2 and 24hr recall,methods (Bland and Altman 1986, Cade, Thompson et al. 2002). Since total diet was not assessed by the FFQ, analyses could not be adjusted for total energy intake.
Intraclass correlation coefficients

Test-retest reliability, to measure the consistency of the FFQ, was assessed by examining the differences in geometric mean sugar intakes using a paired t-test and intraclass correlations (ICCs) for the two administrations of the FFQ administered approximately four weeks apart. ICCs take into account within- and between-subject variation, and as such this method is considered the gold standard for assessing reliability (Kottner, Audige et al. 2011). An ICC value of 0.5 or above is considered to indicate acceptable reliability (Cade, Burley et al. 2004).
5. Results

5.1 Participants

A total of 35 Māori male (15) and female (20) Gisborne residents completed both FFQ administrations and three 24hr recalls and their data was included in the analysis of relative validity and reliability of the FFQ. There were no drop-outs from the study.

Participant characteristics

Participant characteristics can be seen in table 5.1. There was a higher proportion of females participated than males. A wide range of ages was represented with a greater weighting of younger adults. Of the participants 86% had a minimum of the 6th form school certificate or equivalent. Additionally 45% of participants had at least one co-morbidity such high blood pressure and/or high cholesterol.

5.2 Mean Sugar Intake

Geometric mean estimates of usual intakes of fructose, glucose, sucrose and total sugars were derived from the repeat 24h recalls are shown in Table 5.2. Sugars estimates derived from both the FFQ and the repeated 24hr recalls were greater than those estimated by the by ANS.

5.3 Relative Validity

Mean sugars intake

The mean estimates of sugars intakes from FFQ2 tended to be higher than the estimates from the mean 24hr recall estimates (Table 5.2), but the difference was only statistically significant for sucrose estimates from FFQ2 1.24 times higher than the mean 24hr recall intake (p=0.03) (Table 5.2).
Table 5.1 Characteristics of the Kai with Māori validation study participants.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>15</td>
<td>43</td>
</tr>
<tr>
<td>Females</td>
<td>20</td>
<td>57</td>
</tr>
<tr>
<td><strong>Age, years</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>30-39</td>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>40-49</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>50-59</td>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>60 – 65</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NZ Māori</td>
<td>35</td>
<td>100</td>
</tr>
<tr>
<td><strong>Highest educational qualification</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No secondary school qualification</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Secondary school</td>
<td>16</td>
<td>46</td>
</tr>
<tr>
<td>Tertiary education(^a)</td>
<td>14</td>
<td>40</td>
</tr>
<tr>
<td><strong>Employment status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>22</td>
<td>63</td>
</tr>
<tr>
<td>Part-time</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>Unemployed</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Other(^b)</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td><strong>Co-morbidities(^c)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High blood pressure</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>High cholesterol</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Heart disease or angina</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Diabetes Type Two</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Gout</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Asthma</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>Sleep Apnoea</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

\(n=\) number
\(^a\) trade/technical school, polytechnic or university attendance for a minimum of 3 months
\(^b\) Includes, students, retirees and homemakers
\(^c\) In some cases participants are afflicted with more than one co-morbidity
Table 5.2: Geometric means of daily sugar intake from FFQ2 and mean 24hr recall of participants in the Kai with Māori study (n=35) and medians of Māori participants (n=1040) in the New Zealand Adult Nutrition Survey (ANS)

<table>
<thead>
<tr>
<th>Sugar</th>
<th>Geometric mean FFQ2 (CI)</th>
<th>Geometric mean of the mean 24hr recall (CI)</th>
<th>Geometric mean difference ratio (^a) (CI)</th>
<th>ANS medians Male: Female (^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>28.8 (22.48 – 36.95)</td>
<td>28.6 (21.53 – 38.06)</td>
<td>1.01 (0.83 – 1.23)</td>
<td>20.0 : 17.0</td>
</tr>
<tr>
<td>Glucose</td>
<td>27.2 (21.37 – 34.72)</td>
<td>25.6 (19.37 – 33.80)</td>
<td>1.87 (0.28 – 1.29)</td>
<td></td>
</tr>
<tr>
<td>Sucrose</td>
<td>94.9 (72.88 – 123.68)</td>
<td>76.4 (57.93 – 100.68)</td>
<td>1.24* (1.23 – 1.51)</td>
<td>60.0 : 49.0</td>
</tr>
<tr>
<td>Total Sugar</td>
<td>169.8 (135.55 – 212.59)</td>
<td>158.0 (126.83 – 196.94)</td>
<td>1.07 (0.45 – 1.25)</td>
<td>124.0 : 113.0</td>
</tr>
</tbody>
</table>

24hr=24 hour; CI=Confidence Interval at 95%; FFQ2=second administration of the Kai with Māori food frequency questionnaire; ANS= New Zealand Adult Nutrition Survey 2008/09

\(^a\) Geometric mean difference between FFQ2 and mean 24hr recall via a two-sided paired t-test

\(^b\) Median intake of 1040 NZ Māori aged 15+ as reported in the New Zealand Adult Nutrition Survey 2008/09 report using one 24h recall (ANS)

*P<0.05
Bland-Altman

Strength of agreement between FFQ2 and the mean of the three 24hr recalls is presented in table 5.3. Good agreement (values close to 100 and including 100 in the 95% Confidence interval (CI) was shown for fructose [101 (95% CI 83 – 123)] glucose [107 (95% CI: 88-129)] and total sugars [107 (95% CI: 92 – 125)]. Agreement for sucrose intake was poor with the FFQ2 over-estimating mean 24h recall intakes by 24%. Our FFQ shows better agreement than fructose, glucose and total sugar than that reported in other comparable studies (Table 5.3).

The lower limits of agreement (LOA) ranged from 32% for fructose to 44% for total sugar and the upper from 260% for total sugar to 321% for glucose (Table 5.3) indicating insufficient sensitivity for estimating sugars intakes at the individual level. The LOA are wider than those reported in previous studies (Ambrosini, Mackerras et al. 2003, Marks, Hughes et al. 2006, Barrett and Gibson 2010, Sam 2012), however none of the previous studies show the FFQ has the ability to estimate sugars in an individual.

Cross classification

Table 5.4 shows the agreement in cross-classification between the FFQ2 and 24hr recalls for ranking participants into correct quartiles for sugars intakes. Glucose, sucrose and total sugar intake were 100% classified into the same or adjacent quartile. Weighted kappas ranged from 0.47 for sucrose to 0.58 for glucose indicating moderate agreement (Masson, McNeill et al. 2003). The only nutrient with any degree of gross misclassification (ranking an individual into extreme quartiles) was fructose (3%).
Table 5.3: Bland-Altman strength of agreement between sugar intakes derived from FFQ2 and mean 24h recall shown as a percentage\textsuperscript{a}.

<table>
<thead>
<tr>
<th>Sugar</th>
<th>Mean % agreement (CI)</th>
<th>Limits of Agreement (%)\textsuperscript{c}</th>
<th>Mean % agreement\textsuperscript{b} (CI) from previous studies\textsuperscript{c}</th>
<th>Limits of Agreements (%)\textsuperscript{d} from previous studies\textsuperscript{c}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>101 (83 – 123)</td>
<td>32 - 318</td>
<td>140 (129-151)</td>
<td>56-347</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>156</td>
<td>90-271</td>
</tr>
<tr>
<td>Glucose</td>
<td>107 (88 – 129)</td>
<td>35 – 321</td>
<td>163</td>
<td>97-277</td>
</tr>
<tr>
<td>Sucrose</td>
<td>124 (102 – 151)</td>
<td>40 – 319</td>
<td>126 (117-137)</td>
<td>50-317</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>125</td>
<td>70-220</td>
</tr>
<tr>
<td>Total sugars</td>
<td>107 (92 – 125)</td>
<td>44 – 260</td>
<td>117</td>
<td>66-206</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>127</td>
<td>115-139</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>131</td>
<td>113-151</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>137</td>
<td>88-214</td>
</tr>
</tbody>
</table>

CI=Confidence Interval

\textsuperscript{a} Data from the FFQ and 24h recalls were collected from 35 participants, natural log-transformed for the Bland-Altman analysis, back-transformed, and multiplied by 100% for ease of interpretation.

\textsuperscript{b} Mean % agreement=(sugar intake of FFQ/sugar intake of mean 24h recall or reference method) x 100%

\textsuperscript{c} The Bland-Altman method was carried out on three international studies measuring sugars (table 2.2) (Ambrosini, Mackerras et al. 2003, Marks, Hughes et al. 2006, Barrett and Gibson 2010) and one NZ study (Sam 2012).

\textsuperscript{d} The width of the limits of agreement represents the range in which 95% of the differences between the FFQ and mean 24h recall or reference method are expected to fall.
Table 5.4: Cross-classification of Kai with Māori study participants (n=35) by quartiles of sugar intake between FFQ2 and mean 24h recall and weighted Kappa values

<table>
<thead>
<tr>
<th>Sugar</th>
<th>Same quartile (%)(^a)</th>
<th>Adjacent quartile (%)(^b)</th>
<th>Extreme quartile (%)(^c)</th>
<th>Weighted Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>57</td>
<td>40</td>
<td>3</td>
<td>0.54</td>
</tr>
<tr>
<td>Glucose</td>
<td>69</td>
<td>31</td>
<td>0</td>
<td>0.58</td>
</tr>
<tr>
<td>Sucrose</td>
<td>60</td>
<td>40</td>
<td>0</td>
<td>0.47</td>
</tr>
<tr>
<td>Total sugars</td>
<td>66</td>
<td>34</td>
<td>0</td>
<td>0.54</td>
</tr>
</tbody>
</table>

\(^a\)Percentage of participants classified into the same quartile of sugar intake
\(^b\)Percentage of participants classified into the adjacent quartile of sugar intake
\(^c\)Percentage of participants grossly classified into the extreme quartile of sugar intake
Correlation coefficients

Spearman correlation coefficients for estimates of fructose, glucose, sucrose and total sugars intake derived from FFQ2 and the 24h recalls are shown in table 5.5. All correlation coefficients were ≥ 0.69 (Table 5.5). Correlation coefficients for glucose, sucrose and fructose were greater than the crude (unadjusted for energy intake) estimates reported from previous studies (Table 5.5).

5.4 Test-retest Reliability

Mean sugars intake

Sugars estimates were not significantly different between the two administrations of the FFQ, although sugars estimates were consistently higher from FFQ1 (Table 5.6).

Bland Altman

Cade, Thompson et al. (2002) recommends Bland-Altman analyses as a preferred analysis of use when investigating reliability, although fewer than 10% of published validation studies report this measure (Cade, Thompson et al. 2002). Bland-Altman analyses showed acceptable agreement between FFQ1 and FFQ2 for all sugars (95% confidence intervals all included 100) (Table 5.7). The limits of agreement (LoA) were wide, the lower ranged from 33% for sucrose to 39% for total sugar and the upper from 307% for total sugar to 346% for glucose (Table 5.7) This indicates discrepancies in sugars intake between the two administrations for some individuals.
### Table 5.5: Correlation coefficients (CC) between FFQ2 and mean 24h recall daily intakes of sugars amongst Kai with Māori study participants (n=35) and results from previous validation studies for sugars

<table>
<thead>
<tr>
<th>Sugar</th>
<th>$R^a$</th>
<th>$R$ from previous studies$^{b,c}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>0.69*</td>
<td>0.25-0.38$^d$</td>
</tr>
<tr>
<td>Glucose</td>
<td>0.74*</td>
<td>0.22$^d$</td>
</tr>
<tr>
<td>Sucrose</td>
<td>0.74*</td>
<td>-0.04-0.60$^e$</td>
</tr>
<tr>
<td>Total sugars</td>
<td>0.76*</td>
<td>0.28-0.77$^f,g$</td>
</tr>
</tbody>
</table>

*R=Correlation coefficient

$^a$Spearman correlation coefficients

$^b$Crude correlation coefficients derived from FFQs validated for sugars. Refer to table 2.1 and 2.2 for detailed information on the studies.

*P<0.05

$^c$Fourteen studies used Pearson correlations; eleven studies used Spearman correlations

$^d$Data available for ≤3 studies

$^e$Data available for 5 studies

$^f$Four studies examined “added sugars” and one study “simple sugars”

$^g$Data available for 18 studies

*P<0.05
**Table 5.6:** Geometric means of daily sugar intake from the Kai with Māori study (n=35) food frequency questionnaires (FFQ)

<table>
<thead>
<tr>
<th>Sugar</th>
<th>Geometric mean FFQ1 (CI)</th>
<th>Geometric mean FFQ2 (CI)</th>
<th>Geometric mean difference a ratio (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>33.1 (24.97 – 41.95)</td>
<td>28.8 (22.48 – 36.95)</td>
<td>1.15 (0.95 – 1.39)</td>
</tr>
<tr>
<td>Glucose</td>
<td>31.2 (24.65 – 39.43)</td>
<td>27.2 (21.37 – 34.72)</td>
<td>1.14 (0.95 – 1.39)</td>
</tr>
<tr>
<td>Sucrose</td>
<td>98.9 (74.80 – 130.90)</td>
<td>94.9 (72.88 – 123.68)</td>
<td>1.10 (0.86 – 1.27)</td>
</tr>
<tr>
<td>Total Sugar</td>
<td>186.6 (147.76 – 235.67)</td>
<td>169.8 (135.55 – 212.59)</td>
<td>1.10 (0.92 – 1.31)</td>
</tr>
</tbody>
</table>

CI=Confidence interval FFQ1= first administration of the Kai with Māori food frequency questionnaire; FFQ2 = second administration of the Kai with Māori food frequency questionnaire

aGeometric mean difference between FFQ1 and FFQ2 using a two-sided paired t-test
Table 5.7: Bland-Altman strength of agreement between sugar intakes derived from FFQ1 and FFQ2 recall shown as a percentage$^a$.

<table>
<thead>
<tr>
<th>Sugar</th>
<th>Mean % agreement (CI)</th>
<th>Limits of Agreement (%)$^c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>115 (95 – 139)</td>
<td>37 – 354</td>
</tr>
<tr>
<td>Glucose</td>
<td>114 (95 – 138)</td>
<td>38 – 346</td>
</tr>
<tr>
<td>Sucrose</td>
<td>104 (86 – 127)</td>
<td>33 – 327</td>
</tr>
<tr>
<td>Total sugars</td>
<td>110 (92 – 131)</td>
<td>39 – 307</td>
</tr>
</tbody>
</table>

CI=Confidence Interval

$^a$Data from the FFQ1 and FFQ2 were collected from 35 participants, natural log-transformed for the Bland-Altman analysis, back-transformed, and multiplied by 100% for ease of interpretation.

$^b$Mean % agreement = (sugar intake of FFQ/sugar intake of mean 24h recall or reference method) x 100%

$^c$The width of the limits of agreement represents the range in which 95% of the differences between the FFQ1 and FFQ2 are expected to fall.
Intraclass correlation coefficients

Intraclass correlations (ICCs) showing the reliability of sugars estimates from repeated administrations of the FFQ are given in Table 5.8. ICCs varied from 0.81 (fructose and glucose) to 0.85 (sucrose). This shows near perfect agreement. In comparison to previous studies, we found better repeatability for assessment of fructose and glucose intakes, and comparable repeatability for sucrose and total sugars intakes.
<table>
<thead>
<tr>
<th>Sugar</th>
<th>ICC</th>
<th>CC from previous studies&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>0.81</td>
<td>0.65&lt;sup&gt;b&lt;/sup&gt;-0.73</td>
</tr>
<tr>
<td>Glucose</td>
<td>0.81</td>
<td>0.75</td>
</tr>
<tr>
<td>Sucrose</td>
<td>0.85</td>
<td>0.40-0.85</td>
</tr>
<tr>
<td>Total sugars</td>
<td>0.83</td>
<td>0.58-0.86</td>
</tr>
</tbody>
</table>

ICC=Intraclass correlation coefficient; CC=Correlation Coefficient

<sup>a</sup> Range of CC (including crude and energy-adjusted) derived from reliability studies of FFQs measuring sugars. Refer to table 2.3 for more detailed information regarding the studies.

<sup>b</sup> Reliability CC from Sam (2012) not shown in tables.
6. Discussion

For this study we developed, pre-tested, refined and validated the “Kai with Māori FFQ” – a food frequency questionnaire designed to assess sugars intakes in a Māori population. Preliminary findings from a validation study conducted in 35 adult Māori volunteers show that the FFQ provided repeatable estimates of sugars intakes and was able to rank individuals by their usual intake of fructose, glucose, sucrose and total sugar with good relative validity, and could consequently differentiate individuals with high sugar intake from those with low sugar intake. Bland-Altman analyses (for absolute agreement) however showed that the FFQ tended to over-estimate sugars intakes with wide limits of agreement indicating the FFQ should not be used to assess intakes at an individual level (Bland and Altman 1999).

6.1 Relative Validity

Relative validity of the FFQ to rank individual intake was shown to be strong. The Spearman's correlation coefficients (SC) for intakes measured by the FFQ and the 24hr recalls were all above 0.69 which is considered “good” performance (Cade, Thompson et al. 2002). The observed correlation coefficients (CC) were more superior than or comparable to, correlations observed in other validation studies (Willett, Sampson et al. 1985, Munger, Folsom et al. 1992, Sharpe, Page et al. 1993, Bolch 1994, Bell, Swinburn et al. 1999, McKeown, Day et al. 2001, Ambrosini, Mackerras et al. 2003, Marks, Hughes et al. 2006, Esfahani, Mirmiran et al. 2010, Francis and Stevenson 2013). For example, the reported spearman correlations for sugars in a validation study of the Dietary Fat and free Sugar-Short Questionnaire (DFS) ranged between 0.22 and
0.37 (Francis and Stevenson 2013), when using between a 4 day EDR as the reference method. The DFS includes 11 questions pertaining to sugar intake versus 33 in our Kai with Māori FFQ. The DFS was designed for public use as a screener, or simple self check tool for sugar and fat intake (Francis and Stevenson 2013). It was validated in a university student population rather than a general population and does not contain a question pertaining to sugar intake from alcoholic beverages, despite the fact that students are likely to have regularly consumed alcohol in the previous year (Reavley, Jorm et al. 2011). Therefore it is probable the stronger correlations of our FFQ arise from a not only a more comprehensive list of important sugar containing foods but also sugar containing foods reflecting the consumption patterns of our the target population.

In addition we pre-tested the FFQ using cognitive interviewing to ensure that the FFQ questions were clearly expressed and easy to understand. Pretesting of the DFS was not reported by Francis and Stevenson (2013). In addition the FFQ from previous studies are long, assess multi-nutrients and request intake information over a longer period of time (Table 2.1). For example, the FODMAP FFQ has 279 items and assess intake over the past year, the Kai with Māori FFQ assess intake over the previous month (Barrett and Gibson 2010). Despite that sugar intake is relatively consistent over the year; increased time frames can challenge participant’s memories (Willett 1998, Thompson and Subar 2008). Long dietary questionnaires may increase boredom and fatigue, impairing concentration and reducing accuracy of estimates from the FFQ (Willett 1998, Gibson 2005).
Bland-Altman analyses showed a greater agreement with the 24hr recalls for mean fructose, glucose and total sugars intake and a similar agreement for mean sucrose intake than reported in four previous studies (Table 2.2) (Ambrosini, Mackerras et al. 2003, Marks, Hughes et al. 2006, Barrett and Gibson 2010, Sam 2012). These studies validated long (>127 items) multi-nutrient FFQs designed to assess intake over the previous 6 months (Marks, Hughes et al. 2006) and 1 year (Ambrosini, Mackerras et al. 2003, Barrett and Gibson 2010, Sam 2012). The shorter recall period of the Kai with Māori study FFQ (1 month) may have influenced the higher agreement, as memory recall over a shorter timeframe is not as cognitively challenging for participants, therefore allowing more accurate responses. Additionally, these studies used diet records as the reference method. The diet records ranged from 8 to 28 days (Ambrosini, Mackerras et al. 2003, Barrett and Gibson 2010, Sam 2012). This can place a high respondent burden on the participants, decreasing their motivation to complete the records accurately (Gibson 2005). Whilst FFQs do not have as much shared measurement error with weighed diet records as they do with 24hr recalls, estimated records still rely on the participants ability to accurately convey a portion size (Willett 1998, Gibson 2005). In our study we used repeated 24hr recalls to reduce respondent burden and increase accuracy of intake estimates since our target population has a relatively low literacy level (Satherley, Elliot et al. 2009).

The Bland-Altman limits of agreement (LoA) represent the 95% likely range for the difference between sugar values of the two FFQ administrations. The LoA in our study were comparable to or wider than those reported in other studies (Table 5.3). For example the LoA for fructose was 32 – 318 in our study in comparison with previous validation
studies reporting LoAs in the order of 56 – 347 (Sam 2012) and 90 – 271 (Barrett and Gibson 2010). These studies included 135 (Sam 2012) and 72 (Barrett and Gibson 2010) participants. The increased width seen with our FFQ is probably due to our small sample size (n=35), resulting in wider confidence intervals. This indicates that although the FFQ can be used to estimate group sugars intakes, it is not suitable for measuring individual intakes. However, as indicated by the widths of the LoA of the published FFQs, no instrument has yet been able to accurately estimate an individual’s sugar intake. Therefore although a larger sample size is likely to reduce the LOA it is highly unlikely that the FFQ would be suitable for measuring intakes at the individual level.

Nonetheless, FFQs are not typically designed to estimate absolute nutrient intake, but to rank individuals according to sugar intake, and to then examine associations between nutrient intakes and disease at a population level. Cross classification analyses provide an estimate of the relative validity of an instrument to correctly rank individuals by intake level (Masson, McNeill et al. 2003). Weighed Kappa values provide a measure of the degree to which the FFQ and the reference method concur in their respective ranking whilst considering what similarities may have occurred via chance (Masson, McNeill et al. 2003). For a FFQ to be considered valid more than 50% of subjects should be correctly classified into the same tertile, less than 10% of subjects should be misclassified, and weighted kappa values of >0.4 are desirable (Masson, McNeill et al. 2003). The Kai with Māori FFQ cross classification and weighted Kappa statistics indicated good performance with regard to ranking individuals, and performed better than previous published validation studies (Brunner, Stallone et al. 2001, McKeown, Day et al. 2001,
Marks, Hughes et al. 2006, Bingham, Luben et al. 2007, Barclay, Flood et al. 2008, Esfahani, Mirmiran et al. 2010). Again the explanation for the superior performance of our FFQ is likely to be due to its design, comprehensibility and comprehensiveness resulting in more accurate estimations of sugars intakes.

6.2 Test-retest Reliability

Test-retest reliability of the Kai with Māori FFQ was excellent with reliability coefficients for sugars estimated in repeated administrations of the FFQ ranging from 0.81 for fructose and glucose to 0.85 for sucrose (Table 5.8). Bland Altman analyses also showed strong agreement between the two administrations of the FFQ (Table 5.7).

Intra class correlation coefficients for the two FFQ administrations were greater than 0.80 for each sugar indicating near perfect agreement (Table 5.8). In comparison to previous validation studies including studies where the time between repeated administrations periods ranged from two weeks (Lalonde 2008, van den Heuvel, Hörchner et al. 2011) to two years (Munger, Folsom et al. 1992), our coefficients were better for fructose and glucose, and comparable for sucrose and total sugar (Willett, Sampson et al. 1985, Munger, Folsom et al. 1992, Ajani, Willett et al. 1994, McKeown, Day et al. 2001, Lalonde 2008, Barrett and Gibson 2010, Esfahani, Mirmiran et al. 2010, van den Heuvel, Hörchner et al. 2011, Francis and Stevenson 2013)(Table 2.3 and 5.8). Higher correlations are often seen in repeat administrations of FFQ one month or less apart(Gibson 2005). However this may reflect the pretesting and refinement process we used when developing our FFQ to ensure it was clear and comprehensible, as well as
inclusive of all important sugary food and beverage items consumed by our target population group. Thus it is plausible that the unambiguous nature of the FFQ allowed for increased consistency in comprehension, and as such intake responses.

When examining reproducibility the Bland-Altman analysis provided some interesting insights into the validation process. We found that mean sugars intakes were slightly higher in the first administration of the FFQ (FFQ1) than in the second administration of the FFQ (FFQ2) although the differences were not statistically significant ($p = 0.6 – 0.8$, respectively). This suggests that completing the first FFQ and successive 24hr recalls may have had an “intervention effect” raising awareness in our participants of their intake of sugary foods and drinks and their ability to limit their intakes (Willett 1998, Gibson 2005). This can be partially seen by, 42% of participants indicating they consumed less food, sugar, fruit juice, sugary drinks and alcohol during the month of FFQ2. This theory is supported via the wide LoA from the Bland Atman analysis indicating substantial change in sugars intake between administrations by some individuals (Table 5.7).

6.3 Strengths and Limitations

The design of the FFQ is a strength of the study. Firstly we examined data from Māori participants in the ANS08/09 to identify important sources of sugary foods and drinks in our target population (University of Otago and Ministry of Health 2011). Additionally, the format of the FFQ was pretested in open and closed version through cognitive interviewing. This allowed for observation of participant comprehension and feedback to be provided for refinement of the FFQ. Thus the final FFQ is well suited to the NZ Māori
population (Subar, Thompson et al. 1995). Furthermore food and beverage photographs were used as a memory aid and to help quantify portion sizes, providing combat to inherent weaknesses of FFQ (Cade, Thompson et al. 2002, Gibson 2005). The FFQ measures usual intake over the previous month, this is cognitively simpler for participants to estimate their usual intake in comparison to a longer time frame such as one year thus providing more accurate estimates (Willett 1998, Cade, Burley et al. 2004). As sugar intakes tend to be relatively consistent throughout the year, it is likely that the FFQ is representative of usual sugars intake.

The validation study included volunteers with a wide age range (20 – 65). This is a strength as the age range allows the FFQ to be used across the general population. Additionally, our participants were relatively well educated (with 86% with school certificate qualifications or higher compared with 60% of the total Māori population having school certificate or higher (Statistics New Zealand 2006), and motivated to support the research, and as such may have been more accurate and honest with their responses, and less affected by social desirability bias, in both completing the FFQs and during the recall interviews. While this allows for a more robust validation and reliability study, individuals with higher education have been found less likely to underreport intake than those with less education (Horner, Patterson et al. 2002). In addition education is coupled with a higher literacy score it is possible that the FFQ could present greater comprehension difficulties in the general Māori population, reducing the accuracy sugars estimate. Thus the FFQ may not be able to accurately estimate intake in some demographics, for example, women with less education, individuals with a higher body
mass index and those who are dissatisfied with their body size (Horner, Patterson et al. 2002).

A limitation is the low sample size of the study, whilst previous preliminary validation studies for FFQs have been conducted in a similar number of participants (Block 2000, Van Assema 2001, Kristjansdottir 2005, Francis and Stevenson 2013). A small sample size affects the extent to which the FFQ can be applied to populations subgroups, such as middle-aged men for example, as the number of participants fitting into such subgroups in the validation study was very small. Thus it would be of benefit to further validate the FFQ using a larger sample size. This could be further strengthened by using a direct measure of diet such as urinary and blood biomarkers as they are independent of reported dietary intake. Urinary biomarkers for fructose and sucrose have previously been used to estimate intake of sugars (Bingham, Luben et al. 2007). Furthermore, anthropometric data could be collected in order to investigate likelihood of under reporting. This will decrease any bias caused by social desirability (Cade, Burley et al. 2004, Rockett, Berkey et al. 2007). Additionally, the time period of one month is a limitation as development of chronic disease occurs slowly over a longer period of time. Therefore, despite a relative consistency of sugars intake over a year, the questionnaire is not able to provide data of sugars intake throughout the development of the chronic condition, which may have occurred through various life stages where dietary patterns and subsequently sugars intake may be diverse from current intake.
6.4 Conclusion

This preliminary study provides initial evidence that the 33-item, self-administered, semi-quantitative Kai with Māori FFQ that is not only reliable but can adequately rank individuals according to their sugars intake as well as estimate group mean intakes. Therefore the FFQ provides a simple, efficient and cost effective method to measure sugar intake within the Māori population, with lower respondent and time burdens than other dietary assessment methods such as 24hr recalls or diet records. Provided further evaluation yields satisfactory results, then this instrument could be used in large-scale epidemiological studies to investigate the association between sugars intake and metabolic diseases in Māori adults. In due course, if the information obtained from such studies can show an association between sugars and health risk, public health recommendations regarding limits on sugars intakes in Māori for disease prevention could be strengthened.
7. Application to Practice

In New Zealand, there are major health inequalities within different ethnic groups (Ministry of Health 2012). This can be evidenced in one way through the higher prevalence of chronic diseases such as gout, diabetes and cardiovascular disease found in the Māori population (Ministry of Health 2012). This study shows that the Kai with Māori food frequency questionnaire can be used to rank individuals and estimate group mean intakes for fructose, glucose and total sugars. This tool is the first step in ensuring that research can be conducted into examining these health inequalities and what causes them. It will allow for the association between sugars, in particular fructose, and chronic disease in Māori to be scrutinized.

Robust evidence on sugar intake and health associations will first and foremost provide all dietitians with sound scientific evidence from which to base interventions, programs, goals and advice. Additionally, evidence could be used to inform public health recommendations for sugar intake and, if appropriate, used to advocate for changes in public health policies and interventions aiming to reduce sugar intakes. Public health dietitians may be involved in generating and implementing sugar reduction health policies, designing and implementing interventions along with working with groups and communities to decrease their sugar intakes.
7. References


Crutchley, P. (2012). The effects of soft drink, fruit juice and flavoured milk on serum uric acid and associated risk factors for the metabolic syndrome in insulin resistant individuals., University of Otago.


McNeil, M. (2013). Suitability of a sugar consumption questionnaire developed for the DRINKS study in a Maori population, University of Otago.


8. Appendices
Appendix 1: Ethical Approval

Dr L Te Morenga
Department of Human Nutrition
Division of Sciences

26 February 2013

Dear Dr Te Morenga,

I am writing to let you know that, at its recent meeting, the Ethics Committee received a copy of the Reporting Sheet relating to your Category B ethics proposal entitled “Development and validation of a sugar screener for Pacific adults living in New Zealand”.

For your future reference, the Ethics Committee’s reference code for this project is: D13/053.

The Committee appreciates that Category B proposals may commence as soon as approval has been obtained at departmental level and that, in some instances, the research or teaching may be well advanced or even completed by the time the Reporting Sheet is received by the Committee.

Nonetheless, in the case of this particular proposal (D13/053), the Ethics Committee has recorded a status for it of Approved HOD at this stage, and has asked me to pass on its views to you as follows:

The Committee would be grateful if you could review the Consent Form, as all items need to be written in the first person (“I,” “My”).

Yours sincerely,

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

c.c. Emeritus Professor L J Holloway  Head  Department of Human Nutrition
Appendix 2: Final Questionnaire

Māori Kai Study

Kia ora whānau! We would like to learn more about eating patterns, for example:

- **How often** do you usually eat or drink certain foods, and
- **How much** do you usually eat or drink each time?

**How can you help?**

- Answer each question as best as you can.
- Please tell us about **YOU**
- Tick or fill in **ONE answer** for **EACH question**.
  (Erase or scribble out mistakes.)
This is an example of how to answer the questions

Think about your *usual* eating pattern *over the past month*...

Tena koe, I am Ryan. In the last month you say… I drink water around 4 times a day. I have about a cup each time.

*For this question:*

Over the last month, on average, **how often** do you drink **Water**?

*Ryan writes:*

4 times ✓ a day
☐ a week
☐ a month

How much do you drink usually **each time**?

1 cup OR

☐ ml OR

☐ litre

**PLEASE NOTE:** Each item has 2 questions:

1. “How often”
2. “How much”
These photos may help you estimate **how much** you usually drink each time:

= 1 cup = 250mls
Think about your usual eating pattern over the past month...

1. Over the last month, on average, how often did you drink fruit DRINK (not 100% fruit juice) (e.g. Golden Circle, Thextons, Ribena)?

☐ never (go to next question)

_____ times
☐ a day
☐ a week
☐ a month

How much do you usually drink each time?  
____ cup (photo on page 3) OR  
____ ml (photos on page 3) OR  
____ litre

2. Over the last month, on average, how often did you drink 100% fruit JUICE (no added sugar)? (e.g. Just Juice, Charles, NZ Natural)

☐ never (go to next question)

_____ times
☐ a day
☐ a week
☐ a month

How much did you usually drink each time?  
____ cup (photo on page 3)  
____ ml (photos on page 3)  
____ litre
3. Over the last month, on average, how often did you drink regular cordial? (eg. Raro, Refresh, Vitafresh)

☐ never (go to next question)  
_____ times ☐ a day  
☐ a week  
☐ a month

How do you prepare the cordial?  
☐ strong (less water added)  
☐ following packet instructions (1 packet = 1 litre)  
☐ weak (more water added)

How much do you usually drink each time?  
_____ cup (photo on page 3)  
_____ ml OR  
_____ litre

4. Over the last month, on average, how often did you drink low-calorie cordial? (eg. Thriftee, vitafreash low calorie)

☐ never (go to next question)  
_____ times ☐ a day  
☐ a week  
☐ a month

How much do you usually drink each time?  
_____ cup (photo on page 3)  
_____ ml  
_____ litre
5. Over the last month, on average, **how often** did you drink **low-calorie/diet soft drink**? (eg. Coke Zero, Diet lemonade) Or sugar-free energy drink (ie. Sugar-free V or sugar-free Red Bull)

☐ never (go to next question)

_____ times
☐ a day
☐ a week
☐ a month

*How much* do you usually drink each time?

_____ cup (photo on page 3)  OR  
_____ ml (more photos on page 3)

_____ litre

6. Over the last month, on average, **how often** did you drink **regular soft drink** (eg. Coke, lemonade)?

☐ never (go to next question)

_____ times
☐ a day
☐ a week
☐ a month

*How much* do you usually drink each time?

_____ cup (photo on page 3)

_____ ml (more photos on page 3)

_____ litre
7. Over the last month, on average, **how often** did you drink regular **energy drink** (eg. V, Red Bull, Mother)?

- ☐ never (go to next question)
- ____ times
  - ☐ a day
  - ☐ a week
  - ☐ a month

**How much** do you usually drink **each time**?

- ____ small can (250 ml)
- ____ medium can or bottle (375 ml)
- ____ large can (500 ml)

8. Over the last month, on average, **how often** did you drink **sports drink** (eg. Gatorade, Powerade)?

- ☐ never (go to next question)
- ____ times
  - ☐ a day
  - ☐ a week
  - ☐ a month

**How much** do you usually drink each time?

- ____ cup (photo on page 3)
- ____ ml
- ____ litre
9. Over the last month, on average, how often did you drink flavoured milk (eg. Primo, Calci Yum)?

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month

How much do you usually drink each time?

_____ cup OR
_____ ml OR
_____ litre
Think about your usual eating pattern over the past month…

PLEASE NOTE: For the following questions:
This photo may help you estimate how much you usually drink each time:

10. Over the last month, on average, how often did you drink beer, lager or cider?
   ☐ never (go to next question)
   _____ times ☐ a day
   ☐ a week
   ☐ a month

   How much do you usually drink each time?
   _____ bottle (330ml)
   _____ can (355 ml)
   _____ large bottle (745 ml)
   _____ pint or handle (400 ml)
   _____ jug (1000 ml) = 1 litre
   _____ ml (photos above)
11. Over the last month, on average, **how often** do you drink **wine**?

☐ never (go to next question)

_____ times ☐ a day

☐ a week

☐ a month

*How much* do you usually drink each time?  _____ wine glass (photo above) (150ml)

_____ wine bottle (750ml)

_____ ml

12. Over the last month, on average, **how often** do you drink **port, sherry** or **liqueurs**?

☐ never (go to next question)

_____ times ☐ a day

☐ a week

☐ a month

*How much* do you usually drink each time?  _____ small sherry glass (60ml)

_____ wine glass (150ml) - photo page 7

_____ ml
13. Over the last month, on average, **how often** do you drink **spirits with mixer** (eg. RTDs, gin and tonic, rum and coke)?

- ☐ never (go to next question)
- _____ times □ a day
- □ a week
- □ a month

**How much** do you usually drink **each time**?

- _____ spirit glass (150ml) with 1 nip
- _____ spirit glass (150ml) with 2 nips
- _____ tall glass (200ml) with 1 nip
- _____ tall glass (200ml) with 2 nips
- _____ small bottle/can (330ml)

14. Over the last month, on average, **how often** do you drink **straight spirits (no mixer)** (eg. Bourbon, rum, vodka, whiskey, tequila)?

- ☐ never (go to next question)
- _____ times □ a day
- □ a week
- □ a month

**How much** do you usually drink **each time**?

- _____ nip (30ml)
- _____ double nip (60ml)
- _____ ml
Think about your *usual* eating pattern *over the past month*…

15. Over the last month, on average, **how often** did you add sugar or honey to your *tea or coffee*?

- □ never (go to next question)
- ____ times □ a day
- □ a week
- □ a month

*How much* do you usually add *each time*?  □ teaspoon
□ tablespoon

*How much* is on *each spoon*? (please circle ONE)

16. Over the last month, on average, **how often** did you add sugar or honey to Milo, hot water/chocolate or *other drinks*?

- □ never (go to next question)
- ____ times □ a day
- □ a week
- □ a month

*How much* do you usually add *each time*?  □ teaspoon
□ tablespoon

*How much* is on *each spoon*? (please circle ONE)
17. Over the last month, on average, **how often** did you add Milo, powdered drinking chocolate or other milk mix to your drink?

☐ never (go to next question)

_____ times ☐ a day  
☐ a week  
☐ a month

**How much** do you usually add **each time?**  
____ teaspoon  
____ tablespoon

**How much** is on **each spoon?** (please circle ONE)

18. Over the last month, on average, **how often** did you eat jam, honey, syrup, chutney or Nutella on bread/toast?

☐ never (go to next question)

_____ times ☐ a day  
☐ a week  
☐ a month

**How many** slices of bread do you usually eat **each time?**  
____ slices

**How much** do you usually add **each time?** (Please circle)  
Photo A  
Photo B  
Photo C
19. Over the last month, on average, **how often** did you add tomato sauce, BBQ or sweet chilli sauce to your foods?

☐ never (go to next question)

____ times ☐ a day

☐ a week

☐ a month

**How much** do you usually add **each time**?  

____ teaspoon  

____ tablespoon  

____ mls

**How much** is on **each spoon**? (please circle ONE)

[Images of spoons with different amounts of sauce]
Think about your usual eating pattern over the past month…

20. Over the last month, on average, how often did you eat dried fruit (eg. sultanas, prunes, dried apricots)?

☐ never (go to next question)

_____ times  ☐ a day  ☐ a week  ☐ a month

How much do you usually eat each time?  ____ cup  ____ level handful

21. Over the last month, on average, how often did you eat canned fruit, stewed or baked fruit or frozen fruit?

☐ never (go to next question)

_____ times  ☐ a day  ☐ a week  ☐ a month

How much do you usually eat each time?  ____ cup  ____ cans (425grams)
22. Over the last month, on average, **how often did you eat fresh raw fruit?** (eg. apple, banana, orange, pear, grapes)

☐ never (go to next question)

_____ times
☐ a day
☐ a week
☐ a month

**How much do you usually eat each time?**

_____ whole piece(s) of fruit
_____ handfuls
_____ cup

23. Over the last month, on average, **how often did you eat yoghurt, diary food, milk pudding, mousse or custard?**

☐ never (go to next question)

_____ times
☐ a day
☐ a week
☐ a month

**How much do you usually eat each time?**

_____ pottle(s)
_____ cup
24. Over the last month, on average, **how often** do you eat ice cream, ice blocks, jelly or frozen yoghurt?

☐ never (go to next question)

_____ times

☐ a day
☐ a week
☐ a month

**How much** do you usually eat **each time**?

_____ Photo A
_____ Photo B
_____ Photo C
_____ ice block

25. Over the last month, on average, **how often** did you eat breakfast cereals?

☐ never (go to next question)

_____ times

☐ a day
☐ a week
☐ a month

Which **type of cereal** do you **eat most often**?

☐ Weetbix
☐ Coco pops
☐ Cornflakes
☐ Nutra-grain
☐ Ricies
☐ Porridge
☐ Other: ______________________

**How much** do you usually eat **each time**?

_____ Photo A OR
_____ Photo B OR
_____ Photo C OR
_____ weetbix
26. Over the last month, on average, **how often** did you add sugar, honey or sweet sauce (chocolate, strawberry) to **other foods**? (e.g. cereal, ice cream, pancakes)

☐ never (go to next question)

_____ times  ☐ a day
☐ a week
☐ a month

**How much** do you usually add **each time**?  
____ teaspoon
____ tablespoon
____ mls

27. Over the last month, on average, **how often** did you eat muesli bars, cereal bars or nuts bars?

☐ never (go to next question)

_____ times  ☐ a day
☐ a week
☐ a month

**How much** do you usually eat **each time**?  
____ bars
____ grams
28. Over the last month, on average, how often did you eat chocolate biscuits (eg. Tim Tam, Toffee Pop) or cream-filled sweet biscuits (e.g cameo cream)

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month

How much do you usually eat each time?  _____ biscuit

29. Over the last month, on average, how often did you eat other sweet biscuits (eg. wine biscuits, gingernuts)?

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month

How much do you usually eat each time?  _____ small biscuit (eg. wine)
  _____ large biscuit (eg. Cookie Time)
  _____ packet (200 gm)

30. Over the last month, on average, how often did you eat iced buns, sweet buns, sweet pastries or doughnuts?

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month

How much do you usually eat each time?  _____ doughnut
  _____ bun
  _____ sweet pastry
31. Over the last month, on average, **how often** did you eat **cake, sponge, muffins** or baked pudding?

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month

**How do you usually eat each time?** (please circle)

Photo A
Photo B
Photo C
OR _____ g
Think about your usual eating pattern over the past month…

32. Over the last month, on average, how often did you eat lollies (eg. Jet planes, mints, toffees, liquorice)?

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month

How much did you usually eat each time?  ____ lollies

_____ family packet (200grams)

33. Over the last month, on average, how often did you eat chocolate or chocolate bars (eg. Moro, Crunchie)?

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month

How much do you usually eat each time?  ____ squares

____ gs

100 gm 200 gm 350 gm
34. Have you **changed your diet** in the past year?

☐ No  (go to next question)

☐ Yes

**If yes, how** has it changed? (tick all that apply)

☐ I eat *less* food.  ☐ I eat *more* food.

☐ I eat *less* sugar.  ☐ I eat *more* sugar.

☐ I eat *less* fat.  ☐ I eat *more* fat.

☐ I eat *less* fruit.  ☐ I eat *more* fruit.

☐ I drink *less* fruit juice.  ☐ I drink *more* fruit juice.

☐ I drink *fewer* sugary drinks.  ☐ I drink *more* diet drinks.

☐ I drink *less* alcohol.  ☐ I drink *more* alcohol.

☐ Other: _______________________________________________________

35. Have you **lost weight** in the past year?

☐ No

☐ Yes

**Ka pai! You made it to THE END**...please check every page to see if you have answered every question

*Tēnā rawa atu koe for helping me with this important project!*
Validation of a sugar screener for Māori populations
INFORMATION SHEET FOR PARTICIPANTS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you and we thank you for considering our request.

What is the Aim of the Project?
Excessive consumption of sugars such as Fructose has been shown to increase the onset of obesity and hypertension, factors which contribute to the metabolic syndrome. However, assessment of consumption is under-reported due to memory recall and personal bias. This can lead to inaccurate provision of recommendations for sugars intake. This research aims to develop a simple, paper-based dietary questionnaire for assessing the intakes of different types and sources of sugars by Māori people. The dietary questionnaire will help to determine whether high sugar intakes are related to increased health risks.

What Type of Participants are being sought?
We are looking for approximately 30 Māori volunteers who are currently living in the Gisborne area who are willing to talk to about the foods and drinks they usually eat with a University of Otago student dietitian. At the end of the study volunteers will have the opportunity to talk to the student and ask questions about healthy eating.

What will Participants be Asked to Do?
Should you agree to take part in this project, you will be asked to participate in 4 interviews with the student dietitian over a one month period. These interviews will take place in your own home or, if you prefer, we will arrange a meeting place somewhere else suitable in Gisborne (such as a local health clinic). At the first interview, after mihimihi, you will be asked to answer a questionnaire asking about how often you eat different sorts of foods and drinks. Following this the student will collect information about everything you ate and drank the day before. You will be asked questions about what foods you ate and at what time, what was the size of your food servings, what brands of products you used, and how you cooked your food. The total amount of time you spend with the student at each interview session could be up to 1.5 hours. If it is okay with you the student may ask to record the interview. You will receive a $10 supermarket voucher at the completion of each interview.
Please be aware that you may decide not to take part in the project without any disadvantage to yourself of any kind. At the second and third interviews the student dietitian will again record information about everything you ate and drank the day before. At the last interview the student will just ask you to fill in the simple questionnaire again.

**What Data or Information will be Collected and What Use will be Made of it?**
We will only collect data about your diet and your responses to the food questionnaire and some general information about you age, occupation and living arrangements. We will not collect any personal information that could be used to identify you unless you would like us to send you further information or an analysis of your diet.

The data collected will be securely stored in such a way that only those mentioned below will be able to gain access to it. At the end of the project any personal information will be destroyed immediately except that, as required by the University's research policy, any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed.

The student will prepare a written report on the findings of the interviews. You will not identifiable in this report. The report will be used to help us to develop a questionnaire that can reliably measure sugar intakes in Maori populations so that we can find out if eating too much sugar increases the chance of developing diseases like gout, diabetes and heart disease.

This project involves an open-questioning technique. The general line of questioning includes your opinions on the sugar questionnaire, and questions relating to what you ate and drank during the previous day including the types, amounts and brands of foods, portion sizes, sauces and condiments added to foods, and how you cooked your food. The precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops. In the event that the line of questioning does develop in such a way that you feel hesitant or uncomfortable you are reminded of your right to decline to answer any particular question(s) and also that you may withdraw from the project at any stage without any disadvantage to yourself of any kind.

**Can Participants Change their Mind and Withdraw from the Project?**
You may withdraw from participating in the project at any time and without any disadvantage to yourself in any way.

**What if Participants have any Questions?**
If you have any questions about our project, either now or in the future, please feel free to contact either:-

<table>
<thead>
<tr>
<th>Hannah Walter</th>
<th>Dr. Lisa Te Morenga</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Human Nutrition</td>
<td>Department of Human Nutrition</td>
</tr>
<tr>
<td>0212339235</td>
<td>021 0427 283</td>
</tr>
<tr>
<td><a href="mailto:walterha@hotmail.com">walterha@hotmail.com</a></td>
<td><a href="mailto:lisa.temorenga@otago.ac.nz">lisa.temorenga@otago.ac.nz</a></td>
</tr>
</tbody>
</table>

This study has been approved by the Department stated above. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479-8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.
Development and validation of a sugar screener for Maori populations

CONSENT FORM FOR PARTICIPANTS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:-

1. My participation in the project is entirely voluntary;

2. I am free to withdraw from the project at any time without any disadvantage;

3. Personal identifying information including audio recordings will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for at least five years;

4. This project involves an open-questioning technique. The general line of questioning includes your opinions on the sugar questionnaire, and questions relating to what you ate and drank during the previous day including the types, amounts and brands of foods, portion sizes, sauces and condiments added to foods, and how you cooked your food. The precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops.

7. The results of the project may be published and available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity.

I agree to take part in this project.

................................................................. ........................................
(Signature of participant) (Date)
Appendix 4: Contact Details Form

Contact Details Form

Name:______________________________________________

Gender (please circle):  male    /     female

Date of Birth: ______________________________________

Address:________________________________________________________________
_____________________________________________________________________

Contact Number: ____________________________ (home)
__________________________ (mobile)
__________________________ (work)

Email address: ____________________________________________________

Where would you prefer to have your interviews (this can change each time if you like):

How would you prefer to be contacted (please circle):
Email   /   Text   /  Phone call

(For study staff use only)

Appointment 1 (1st FFQ and 24hr recall):

Date: ___________________________________________ (weekday/weekend)  Time:

Voucher given: yes / no

Notes:

Appointment 2 (2nd 24hr recall):

Date: ___________________________________________ (weekday/weekend)  Time:

Voucher given: yes / no

Notes:

Appointment 3 (3rd 24hr recall):

Date: ___________________________________________ (weekday/weekend)  Time:

Voucher given: yes / no

Notes:

Appointment 4 (2nd FFQ):

Date: ___________________________________________ (weekday/weekend)  Time:

Voucher given: yes / no

Notes:
Appendix 5: Demographic Questionnaire

A few questions about yourself

1. Are you?
   ○ Male ○ Female

2. Your present age: _____ years

3. Which ethnic group(s) do you belong to? *(Mark the circles that apply to you)*
   ○ New Zealand European
   ○ Māori (specify Iwi: ____________________________)
   ○ Pukapuka Islander
   ○ Cook Island Māori
   ○ Samoan
   ○ Tongan
   ○ Niuean
   ○ Chinese
   ○ Indian
   ○ Other (such as Dutch, Japanese, Tokelauan). Please State: __________

4. What is your highest educational qualification? (mark ONE only)
   ○ No high school (secondary school) qualification
   ○ School Certificate or Sixth Form Certificate (National Certificate Level 1 or 2)
   ○ University Entrance/Bursary or Higher School Certificate (completed 7th form)
   ○ Technical/trade school or polytechnic diploma (at least 3 months of full-time study)
   ○ University degree/diploma

5. What is your usual occupation? *(If retired, state occupation before retirement.)*

   ____________________________________________________

6. What is your current employment situation? (mark ONE only)
   ○ Employed, full time ○ Student
   ○ Employed, part time ○ Homemaker
   ○ Self-employed ○ Unemployed
   ○ Retired ○ Other: *(please specify)_________________


   Age of children:
9. Have you ever been told by a doctor that you have (mark all that apply)

- High blood pressure
- High cholesterol
- Heart disease or angina
- Diabetes (other than during pregnancy): Type 1 or Type 2 (Please circle)
- Cancer
- Gout
- Asthma
- Sleep apnea
- None of the above

Thank you!
### Appendix 6: Spreadsheet for Kai with Māori FFQ calculation

<table>
<thead>
<tr>
<th>Food Description</th>
<th>Never</th>
<th>Freq-day</th>
<th>Freq-week</th>
<th>Freq-month</th>
<th>Amount/ml/piece</th>
<th>Amount each time (g)</th>
<th>Freq*Amount</th>
<th>Fructose Content per 100g</th>
<th>Glucose content per 100g</th>
<th>Sucrose content per 100g</th>
<th>Total Sugar content per 100g</th>
<th>Fructose g</th>
<th>Glucose g</th>
<th>Sucrose g</th>
<th>Total sugar g</th>
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