Development, validation and test-retest reliability of a short food frequency questionnaire that measures sugar intake in Pukapuka Pacific Islanders living in Auckland, New Zealand

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Abstract

Background: Sugar intakes have increased worldwide in parallel with the obesity, diabetes and cardiovascular disease epidemics indicating that sugar may be partly responsible. In New Zealand (NZ) the prevalence of these conditions are higher in the Pacific Island population than in the general population. Thus there is a need to develop a valid and reliable instrument to measure sugar intakes to establish whether high sugars intake, particularly fructose, are associated with chronic disease risk. The food frequency questionnaire (FFQ) is a relatively quick, simple and cost effective method to measure food and beverage consumption in large epidemiological studies.

Objective: The present study aimed to develop, pretest and conduct a preliminary investigation into the validity and test-retest reliability of a 33-item, open-ended, self-administered, semi-quantitative food frequency questionnaire (FFQ) designed to measure usual sugars intakes over the previous month in Pukapuka Pacific Islanders living in South Auckland, NZ.

Design: Two versions of the FFQ (open- and closed-ended) were pretested among a sample of ten Pacific Island adults living in South Auckland using cognitive interviews. Minor amendments were made to the preferred open-ended format prior to validation. Thirty-three Pukapuka Pacific Islanders, aged 18-59 years, then completed the final Pukapukan Kai FFQ administered on two occasions three weeks apart to assess test-retest reliability. The relative validity of the FFQ was assessed by comparing the data from the second administration of the FFQ (FFQ2) to the mean of three 24-hour (24h) recalls.
collected over three weeks prior to FFQ2. Validation was assessed using paired t-tests, Bland-Altman analysis, cross-classification, the weighted kappa and spearman correlations (SC). Differences in the mean between FFQ administrations and intraclass correlation coefficients (ICCs) were used to assess the reliability of the FFQ.

**Results:** The FFQ adequately estimated the group’s geometric mean intake of fructose, glucose and total sugars (but not sucrose, P<0.05) over the previous month compared to the reference method. According to the Bland-Altman analysis, the mean percentage of agreement ranged from 97 for fructose to 125 for sucrose. However, the limits of agreement (LoA) were wide. Classification into the same or adjacent quartile ranged from 82% for fructose to 91% for sucrose and weighted kappas were at least 0.47 for all sugars. Spearman correlations ranged from 0.62 for glucose to 0.77 for total sugars. The ICCs between FFQ administrations ranged from 0.58 to 0.73 indicating good test-retest reliability.

**Conclusion:** This study provides initial evidence that the FFQ has the capability to adequately estimate a group’s usual mean intake of fructose, glucose and total sugars over the previous month, but not sucrose. It can also rank a group of individuals according to their sugars intake and as a result can be used in large-scale epidemiological studies to examine the association between sugar intakes and chronic diseases in Pukapuka Pacific Island adults. Similar to other FFQs, this instrument lacks precision to estimate an individual’s precise sugars intake and is unsuitable for use in clinical practice. Further validation and reliability testing, using biomarkers of intake, among a larger sample of a wider range of Pacific Island people would be beneficial.
Keywords: Food frequency questionnaires; Sugar; Validity; Reliability; Pukapuka Pacific Island adults
Preface

This MDiet project is a part of a larger study that aims to validate a short food frequency questionnaire (FFQ) to measure sugar intakes in Pukapuka Pacific Islanders living in South Auckland, New Zealand (NZ).

The FFQ used in this research went through several iterations during its development in January and February 2013. An academic staff member designed the original closed-ended version of the FFQ with inspiration from several sources (Section 4.1.1)

In February 2013 the student pretested both the closed- and open-ended versions of the FFQ among a sample of ten Pacific Islanders living in NZ. Participants preferred the open-ended format of the FFQ, which was then modified to include additional sugar-containing foods and beverages commonly consumed by Pukapuka Pacific Islanders living in South Auckland, additional photos of food items and amounts, and other minor wording and format changes to improve readability and comprehension of the task.

The questionnaire was finalised as a 33-item, open-ended, self-administered, semi-quantitative FFQ. From March 2013 the evaluation study began which consisted of each participant completing the same self-administered FFQ twice (three weeks apart) to assess the test-retest reliability of the FFQ and three 24h recalls to test the relative validity of the
FFQ (its second administration, covering the same time period). Ongoing validation inclusive of 24h 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 by analysing the 2008/09 NZ Adult Nutrition Survey (ANS) data and conducting the environmental audit
• made the open-ended version of the closed-ended FFQ
• pretested two versions (open- and closed-ended) of the FFQ in a sample of ten Pukapuka Pacific Islanders living in South Auckland, 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
• attended community events at the Pukapuka Community Centre
• conducted all 24h recall interviews and FFQ completion 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
• participated in skype meetings with the supervisors of the project
• drafted and revised thesis chapters
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I am most grateful to the participants of the Pukapukan Kai study and the members of the Pukapuka Community Centre who welcomed me with kindness and willingly gave up their time to assist in this project. Special thanks are due to Nuku Rapana and Terito Ine for their help with recruitment.
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<td>USA</td>
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1. Introduction

The rate of chronic diseases including obesity, diabetes and cardiovascular disease, has increased significantly worldwide. In 2001 chronic diseases accounted for 60% of total deaths and is expected to increase to 75% of all deaths by 2020. It is widely known that diet is a risk factor for chronic diseases (World Health Organization & Food Agriculture Organization of the United Nations 2003). Most interventions aimed at preventing chronic diseases have focused on decreasing the fat intake of populations (World Health Organization 2011; Lustig et al. 2012). Although low fat diets have been promoted, chronic disease rates continue to increase worldwide, suggesting that there may be other causes (Johnson 2007).

Excessive intake of added sugars, particularly fructose, has been linked to diabetes, cardiovascular disease, obesity and gout (Johnson 2008). In New Zealand (NZ), the prevalence of these diseases is higher in Pacific Islanders than the general population (Statistics New Zealand & Ministry of Pacific Island Affairs 2011). However whether sugar intakes have a role in the development of gout, cardiovascular disease and type 2 diabetes in Pacific people has not yet been clearly established. To do this research, a valid and reliable method of adequately estimating usual sugars intakes in Pacific populations is required. The method needs to collect meaningful data from Pacific people with lower literacy and numeracy levels (Statistics New Zealand & Ministry of Pacific Island Affairs 2010). Furthermore, it needs to be cost-effective and easy to administer, code and analyse. The interviewer-administered 24-hour recall method may produce the best estimates of
usual sugars intakes in this population; however, it requires highly skilled staff and time for repeated data collection and analysis. Compared to other dietary assessment methods, the FFQ has the lowest respondent burden and is the quickest and easiest to administer and analyse.

There are currently few FFQs that measure sugars intakes specifically, and none exist in NZ. A number of long FFQs assessing total diet have been validated for their ability to estimate sugars intake in NZ, but the burden on participants and time required for coding and processing the data limit their use (Sharpe et al. 1993; Bolch 1994; Marshall 1994; Bell et al. 1999; Sam 2012). In addition, these FFQs have a limited number of questions pertaining to sugary foods and drinks, so they may not provide sufficiently precise data on sugar intakes to allow relationships between sugars intakes and health outcomes to be observed. As a result there is a need to create a short FFQ (less than 40 items) that specifically measures usual sugar intakes over the previous month and to test its relative validity against a more robust dietary assessment method, in this case repeat 24-hour recalls over the same time period. Therefore the aim of this study is to develop, pretest and validate a culturally appropriate short FFQ that adequately estimates usual sugars intakes over the previous month in a Pukapuka Pacific Island population living in NZ.
2. Literature Review

Dietary assessment methods at the individual level are an important aspect of nutritional research worldwide (Willet 1998; Gibson 2005). This literature review discusses the health implications of sugar consumption, in particular fructose, as well as populations with high risks of metabolic diseases. Subsequently, it describes dietary assessment methods to measure sugars intake, the limitations and advantages of these methods in relation to measuring sugars intake in a Pukapuka Pacific Island population living in New Zealand (NZ) and finally the availability of validated dietary assessment instruments to measure sugars intake worldwide and in NZ.

One would think the widespread use of the word “sugar” would be easily defined. Unfortunately, this is not the case and terms such as sucrose, sugar(s), added or free sugars, intrinsic, refined sugar, extrinsic are used interchangeably which ultimately results in misunderstanding (Sigman-Grant 2003; Ruxton 2009). For the purpose of this review sugar will be defined as “free sugars” which are all monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and fruit juices. Fructose is a monosaccharide that predominantly comes from sucrose, a disaccharide consisting of 50% fructose and 50% glucose (Johnson 2008).
2.1 Sugar and health implications

In general, western diets that are high in fat are also high in sugar. As sugar intakes have increased worldwide, so too have the obesity and diabetes epidemics, which has lead to the hypothesis that excessive sugar intake may be partly responsible (Johnson 2008). It has been proposed that a specific sugar (fructose) may exert metabolic effects such as increased insulin resistance, depleted ATP levels and production of inflammatory proteins, which are associated with the metabolic syndrome (Johnson 2008). Increased fructose intake has also been associated with obesity, cardiovascular disease and hypertension (Johnson 2007). In the United States of America (USA), high intakes of sugar-sweetened beverages, which contain a high content of fructose, have been shown to be associated with type 2 diabetes and the metabolic syndrome through long-term prospective cohort studies (Malik 2010). Furthermore, a cohort study in the USA has also suggested that increased intake of fructose is associated with an increased risk of gout in men (Choi & Curhan 2008). It is thought that fructose could play a role in these diseases due to its propensity to increase uric acid levels (Nakagawa 2005). Gout, hypertension, metabolic syndrome, type 2 diabetes and cardiovascular disease have been found to be more prevalent in those with higher levels of serum urate (Johnson 2008; Richette & Bardin 2010). Although there is a wealth of observational data showing a potential causal role of excessive sugar intake and health implications, there is little evidence showing causation.

In NZ there are marked health disparities between Pacific Islanders and NZ Europeans. From 2006 to 2007 the rate of diagnosis of diabetes among Pacific people was three times
the rate of the total NZ population (Statistics New Zealand & Ministry of Pacific Island Affairs 2011). Gout and cardiovascular disease are also significantly higher in the Pacific population than in the general population (Sundborn et al. 2008; Winnard 2012). These are all diseases that have been linked with excess fructose intake (Johnson 2008; Lustig et al. 2012). It is of interest to examine whether the higher prevalence of diabetes, gout and cardiovascular disease in Pacific Islanders might be partly explained by higher sugars or in particular fructose intakes.

2.2 Sugar intake and Pacific Islanders

The most recent (2008/09) New Zealand Adult Nutrition Survey (ANS) reported that Pacific Island males had a mean daily intake of 125g of total sugar, which is less than the total population mean for males of 128g (University of Otago & Ministry of Health 2011a). Pacific Island females had a mean daily intake of 106g of total sugar, which is slightly higher than the total population mean for females of 103g. However, the differences between Pacific and non-Pacific adults were not significantly different. Non-alcoholic beverages accounted for the greatest intake of total sugars for Pacific Island males and females, 24.1% and 20.4%, respectively. The other major contributors were sugar and sweets (18% and 16.5%), fruit (13.4% and 18.7%) and milk (7.1% and 8.4%).

The mean daily intake of sucrose for Pacific Island males and females was 64.4g and 54.3g, respectively (University of Otago & Ministry of Health 2011a). Again this was slightly higher than the total population mean daily intake of 61g and 48.1g, respectively. The major sources of sucrose for Pacific Islanders (males and females) were sugar and sweets.
(29% and 27.1%), non-alcoholic beverages (25.1% and 21%), fruit (11.1% and 16.1%) and cakes and muffins (2.8% and 6.4%).

The mean daily intake of fructose for Pacific Island males and females was 21.7g and 19.3g, respectively (University of Otago & Ministry of Health 2011a). This is lower than the total population mean daily intake of 23.4g and 19.6g, respectively. The most common sources of fructose in Pacific Island diets (males and females) were fruit (22.9% and 31.3%), non-alcoholic beverages (25.4% and 22.5%), vegetables (12.6% and 10.6%) and sugar and sweets (3.5% and 5.5%).

Information about the frequency of consuming various food groups was also collected as part of the ANS using an unvalidated dietary habits questionnaire (University of Otago & Ministry of Health 2011b). Pacific males (45%) and females (31.7%) were significantly more likely to report drinking soft drinks or energy drinks three or more times a week than non-Pacific people (Ministry of Health 2012). Soft drinks and energy drinks are a major source of sucrose, which is likely to have contributed to the higher intakes of sucrose seen in the Pacific population.

It is likely that both sucrose and fructose intake is underestimated in the ANS data as sugar is a difficult nutrient to measure and is typically under-reported, especially in low-income populations such as Pacific Islanders (Livingstone & Black 2003) (University of Otago & Ministry of Health 2011b). Consequently, to determine the relationship between sugar intake and metabolic risk factors for gout, diabetes and cardiovascular disease, there is a
need to develop and validate a dietary assessment instrument to measure sugar intake in this high-risk population.

### 2.3 Dietary assessment methods

Dietary assessment methods are used in nutritional research in order to measure a group’s or an individual’s usual dietary intake, or usual intake of a specific nutrient or nutrients. Methods include diet records, 24h recalls, diet history interviews and food frequency questionnaires (FFQs); each has its strengths and weaknesses. The objective, length and funding of the study will help determine which dietary assessment method is most feasible (Biró 2002). Other characteristics such as literacy levels, education and language skills are also important determinants in deciding on a method to use, and are of particular importance in Pacific populations (Statistics New Zealand & Ministry of Pacific Island Affairs 2010).

The diet record, especially weighed diet records, are the most precise method for estimating an individual’s actual intake or usual intake if multiple days are collected, and as a result are considered gold standard (Gibson 2005). The subject records a detailed list of all food and beverages consumed on one or more days and if completed at the time of consumption this method does not rely on memory (Willet 1998). However, it requires the subject to be well trained in the process of record keeping, motivated and literate (Thompson & Subar 2008). Respondents may change their usual diet to reduce the burden of keeping a record and when the aim is to measure unaltered dietary behaviour this is a major weakness (Thompson & Subar 2008). Studies have also shown that sweet foods
such as confectionary, cakes, pastries and biscuits are significantly under-reported in dietary records (Pryer 1997; Lafay 2000). Due to the demographics of the population, the high cost that is associated with coding dietary information and the potential for significant underreporting of the nutrient of interest the diet record method is unlikely to be an appropriate method to collect dietary information from relatively low literacy Pacific populations (Pryer 1997; Lafay 2000; Thompson & Subar 2008).

A simpler method for assessing usual intakes is the 24h recall. The 24h recall consists of a highly trained interviewer asking a subject to recall their exact food intake during the previous 24 hours (Gibson 2005). High literacy levels are not required in the 24h recall method and the respondent burden is lower than for diet records, suggesting it would be a viable method in the study population (Biró 2002). It has been shown that four, multiple-pass 24h recalls are the most appropriate method to collect dietary intakes in low-income households and can enable estimates of individuals usual intake (Willet 1998; Vucic et al. 2009). A limitation of the 24h recall method is that it relies on the subject’s memory and ability to convey accurate portion sizes (Gibson 2005), which is problematic for sugary foods and drinks. Including a forgotten foods list can assist with recall (Raper et al. 2004). Finally, this method relies on highly trained staff for data collection and analysis, so may not be appropriate for use in large epidemiological studies.

The diet history interview, originally designed by Burke in 1947, is used to capture an individual’s usual dietary intake over a relatively long period of time (6-12 months) (Burke 1947; Willet 1998). There are many variants of the diet history method and it is often a
combination of the other three methods (Biró 2002). When detailed information is collected, it can take up to two hours per subject (Gibson 2005), which is a similar amount of time to three 24h recalls. Like 24h recalls, highly trained staff are needed for data collection and analysis. It is more often used in clinical practice rather than population studies (Gibson 2005).

2.3.1 Food frequency questionnaires

In the 1940’s a checklist Burke developed as part of the diet history interview technique was developed even further to generate the FFQ (Burke 1947). FFQs are commonly used in epidemiological studies with large sample sizes to assess the relationship between dietary habits and disease (Teufel 1997; Gibson 2005; Thompson & Subar 2008). A FFQ measures a group’s usual food intake and the list of foods can focus on a specific nutrient, such as sugar (Gibson 2005). These instruments are generally suitable for ranking individuals based on their usual intake, rather than measuring actual intake (Biró 2002; Gibson 2005; Thompson & Subar 2008).

A FFQ is inexpensive to administer, collect and process. Depending on the participants and instrument type it may only require 15 to 30 minutes to complete (Gibson 2005). Hence, respondent burden is much lower for FFQs than other dietary assessment methods (Thompson & Subar 2008). Participants do not have a chance to change their eating patterns as they may do when completing diet records and thus usual food intake can be collected (Biró 2002). Holmes et al. (2008) compared three dietary assessment methods against a 4-day weighed diet record in a low-income English population and found that most respondents preferred the FFQ method. Repeat 24h recalls and the FFQ also generated higher estimates of energy and nutrient intakes than semi-weighed and weighed...
diet records (Holmes et al. 2008). Furthermore, Vucic et al. (2009) reviewed dietary assessment methods used among low-income populations and concluded that the FFQ was more appropriate than the diet record method to measure intakes in populations with low-literacy and low motivation.

The main limitation of FFQs is that they rely on respondents having a good memory of their past food intake. Data collected may be influenced by the participant’s recent intake as they may find it hard to differentiate usual intake from a specific day (Vucic et al. 2009). If the FFQ aims to address long-term intake, for example intake over the past year, then this bias is even more likely to occur. FFQs can also contain a considerable amount of measurement error. Inaccuracies may result from exclusion of foods in the list that may play a particular contribution to food intake (Thompson & Subar 2008). For example, leaving out a popular sugar containing food item that is frequently consumed in the target population may result in a significant underestimation of sugars intakes. Semi-quantitative and quantitative FFQs are also restricted by how well they quantify food intake as inaccuracies can result from poor estimations of past portion sizes or the use of standard portion sizes (Biró 2002).

FFQs have been used in a number of large population studies, for example, country specific FFQs were used in the European Prospective Investigation into Cancer and Nutrition (EPIC) study to estimate individual usual food intakes (Bingham et al. 2001). Although the FFQ is not the most accurate dietary assessment method, it is the most feasible method, given the low respondent burden, low cost and high respondent rate, to study the the relationship between sugar intake and metabolic diseases (Gibson 2005).
2.3.2 Design of a food frequency questionnaire

FFQs can be developed from scratch or be modified from existing questionnaires (Cade 2002). Developing a new FFQ typically consists of using existing dietary data from weighed diet records or multiple 24h recalls in order to compile a food list and then using a step wise regression analysis to eliminate uncommon food items. This requires a large sample size and a long period of time to collect data (Willet 1998; Gibson 2005).

Earlier FFQs consisted of a food list and a frequency response component (Willet 1998). More recently FFQs have been quantified by adding a portion size component to certain food items to estimate relative or absolute nutrient intakes, making them quantitative or semi-quantitative (Gibson 2005; Thompson & Subar 2008). Questionnaires have been found to have greater validity when a subject can describe their own portion size compared with the portion size being specified or having no portion size component (Cade 2004). In contrast, a review by Molag (2007) found that inclusion of a portion size component did not alter the ranking of different nutrients, although estimates of alcohol intake were improved. It was concluded that this may be due to the difficulty of quantifying how much of a particular item was eaten, especially when they are part of mixed dishes, whereas, alcohol consumption might be easier to quantify.

A FFQ can be self-, interviewer- or computer-administered (Gibson 2005). Correlation coefficients between the reference method and FFQ have been shown to be higher in interviewer-administered questionnaires than self-administered questionnaires (Cade 2004).
The most widely used FFQs are those devised by Block *et al.* (1986) (the NCI/Block Health Habits and History Questionnaire) and Willet and colleagues (the Harvard Semiquantitative Food Frequency Questionnaire) (Willet 1987). Many subsequent questionnaires have been modified from them (Cade 2002). Both these FFQs contain long food lists as they have been developed to assess total diet. However when data is required for a single nutrient, or small numbers of related nutrients such as sugars, these FFQs require an unnecessary time and resource burden for both subjects and researchers. Moreover in unmotivated and illiterate subjects these 100+ item FFQs may lead to fatigue and boredom, resulting in diminished concentration and accuracy (Willet 1998). In this case a list of 15-30 food items may be sufficient (Thompson & Subar 2008), but it should be recognized that short-list FFQs may result in underreporting for nutrients associated with a perceived socially undesirable behaviour such as excess sugar consumption (Rockett *et al.* 2007).

### 2.3.3 Food frequency questionnaire evaluation

With any newly developed dietary assessment tool, evaluation is necessary to determine the degree to which it measures true dietary intake (Willet 1998). Evaluation can identify potential measurement error, which affects the performance of the FFQ (Willet 1998; Cade 2002). Evaluation of the validity and reproducibility of the instrument also allow FFQs in the literature to be compared.

Validity refers to “the degree to which the questionnaire actually measures the aspect of diet that it was designed to measure” (Willet 1998). Only relative validity can be measured,
as absolute validity cannot be determined because the truth will never be known with absolute certainty (Barrett 2010). Relative validity of FFQs can be measured by comparing it with a superior “reference method”. If the “test method” is a FFQ, the reference method should measure usual dietary intake and errors in the methods should be as independent as possible, for example, both methods should not rely on memory or use the same method for estimating portion size (Willet 1998; Gibson 2005; Gibson & Ferguson 2008). FFQs are usually validated against multiple diet records or 24h recalls (Gibson 2005).

Reproducibility, also referred to as repeatability or reliability, are terms used to describe the consistency of measurements attained from a FFQ administered more than once to the same subjects (Willet 1998; Cade 2004; Gibson 2005). Reproducibility can reflect both random measurement error and true change in dietary intake (within-subject variation), which unfortunately cannot be differentiated (Willet 1998; Gibson 2005).

2.3.4 Food frequency questionnaires that measure sugar intake

There are few published and validated FFQs designed to measure sugar intake per se, however a number of long FFQs designed to measure dietary intakes of multiple nutrients have been validated for their ability to measure sugar intake and/or been tested for their reproducibility (Table 2.1).

A range of reference methods (diet records, 24h recalls and/or biomarkers) have been used to validate FFQs for sugars (Table 2.2). Not surprisingly, correlation coefficients have been found to be significantly higher when the reference method is carried out for a longer period of time (8-14 days compared with 1-7 days) (Molag 2007). However, in reality an extensive validation study is not always possible.
Table 2.1: Description of previous food frequency questionnaires (FFQs) which measure sugar intakes in adults that have been validated and/or reliability tested

<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,</td>
<td>Qual</td>
<td>Interviewer (in-person)</td>
<td>1y</td>
<td>18</td>
<td>10 (never - ≥5/d)</td>
</tr>
<tr>
<td></td>
<td>calcium and dairy foods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></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</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 be associated with cancer or heart disease</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 estimate usual food and nutrient intakes in older women</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</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></td>
<td>assess food group intake</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Dietary Fat and free Sugar-Short</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>
<tr>
<td>Questionnaire (DFS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FFQ=Food Frequency Questionnaire; Qual=qualitative; Semi=semi-quantitative; Self=self-administered; y=year; m=month; 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; CCS=Cancer Control Supplement
<table>
<thead>
<tr>
<th>FFQ</th>
<th>Validation study</th>
<th>Reference method</th>
<th>Participants</th>
<th>Statistical test</th>
<th>Suc. (g)</th>
<th>Fruc. (g)</th>
<th>Gluc. (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvard 80 Out</td>
<td>Willet, 1985</td>
<td>4 x 7d EDR</td>
<td>173 F US residents, 34 - 59y</td>
<td>Crude PC; E-adjusted PC</td>
<td>0.60; 0.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvard Booklet</td>
<td>Willet, 1988</td>
<td>4 x 7d EDR</td>
<td>150 F US residents, 34 - 59y</td>
<td>Crude PC; E-adjusted PC</td>
<td>0.50; 0.45</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 US residents, 55-69y</td>
<td>Crude PC; E-adjusted PC</td>
<td>-0.04; -0.07</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>
</tr>
<tr>
<td>CHIS 05</td>
<td>OPEN Study(^{a})</td>
<td>4 x 24h recall (1/season)</td>
<td>484 M&amp;F US residents, 40 - 69y</td>
<td>PC</td>
<td>M=0.69(^{b}), F=0.66(^{b})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EATS Study(^{a})</td>
<td>4 x 24h recall (1/season)</td>
<td>1640 M&amp;F US resident, 20 - 70y</td>
<td>PC</td>
<td>M=0.59(^{b}), F=0.66(^{b})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHIS 09</td>
<td>OPEN Study(^{a})</td>
<td>4 x 24h recall (1/season)</td>
<td>484 M&amp;F US residents, 40 - 69y</td>
<td>PC</td>
<td>M=0.71(^{b}), F=0.61(^{b})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EATS Study(^{a})</td>
<td>4 x 24h recall (1/season)</td>
<td>1640 M&amp;F US resident, 20 - 70y</td>
<td>PC</td>
<td>M=0.59(^{b}), F=0.70(^{b})</td>
<td></td>
<td></td>
<td></td>
</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 US residents, 40 - 69</td>
<td>Deattenuated PC</td>
<td>M=0.68(^{b}), F=0.66(^{b})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EATS Study(^{a})</td>
<td>4 x 24h recall (1/season)</td>
<td>1640 M&amp;F US resident, 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>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>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------</td>
<td>------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
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<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>EPIC-Norfolk</td>
<td>McKeown, 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</td>
<td>F=0.54; 0.70</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</td>
<td>F=0.43; 0.48</td>
<td></td>
</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></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></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E-adjusted % agreement (LoA)</td>
<td>131 (83-205)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue Mountains</td>
<td>Barclay, 2008</td>
<td>3 x 4DWD</td>
<td>78 M&amp;F Australian residents, &gt;49y</td>
<td>Crude PC; Deattenuated PC</td>
<td>0.42; 0.62; 0.49; 0.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye Study</td>
<td></td>
<td></td>
<td></td>
<td>Crude PC; Deattenuated PC</td>
<td>117 (66-206)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block Alive</td>
<td>Lalonde, 2008</td>
<td>2 x 24h 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>
</tr>
<tr>
<td>FODMAP FFQ</td>
<td>Barret, 2010</td>
<td>4 x 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; 0.66; 0.48; 0.65; 0.39; 0.48; 0.48</td>
<td>125 (70-220)</td>
<td>156 (90-220)</td>
</tr>
</tbody>
</table>

Note: PC = Pearson correlation; SC = Spearman correlation; E = Eta correlation; LoA = Limits of Agreement; WDR = Within-day replication; EDR = Every-day replication.
<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>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-detattenuated SC</td>
<td>M=0.77&lt;sup&gt;c&lt;/sup&gt;;0.77&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>F=0.65&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>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;</td>
<td>0.28;</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Dietary Fat and free Sugar-Short Questionnaire (DFS)</td>
<td>Francis, 2013</td>
<td>4d EDR</td>
<td>40 M&amp;F Australian university students, mean age:21.3y</td>
<td>Crude 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></td>
<td>0.38&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.45&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.1&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

FFQ=food frequency questionnaire; 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; US=United States; 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.

<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
Although the questionnaires in Table 2.2 have been evaluated for their validity in at least one study population, they have not been validated among NZ adults so they should not be used to assess sugar intakes in NZ populations until their validity has been established. For example, American and European populations may have different dietary patterns from NZ due to the differences in food availability, culture and upbringing (Cade 2002; Cade 2004). Nevertheless, existing instruments can inform the development of a FFQ for assessing sugar intakes in a Pacific population. While the majority of FFQs were developed to be self-administered, a number were designed to be interviewer-administered either in person or via the telephone. Most of these questionnaires included 6 to 10 items specifying foods with added sugar. The frequency response categories ranged from 5 to 10 options and a number used an open-ended response. Finally, about two-thirds of the FFQs included a portion size component. Portion size information can be collected in a number of ways. Firstly, a portion size can be specified, for example, asking how often a slice of bread is consumed. Secondly, the questionnaire might ask the participant to select each items portion size, for example, by providing pictures of portion sizes as a multiple-choice question. Lastly, descriptions of usual portion sizes can be left open-ended (Willet 1998).

According to Thompson and Subar (2008), most published FFQs have test-retest reliability coefficients of around 0.6-0.7. Table 2.3 shows correlation coefficients for sugars between FFQ administrations for a number of studies.
Table 2.3: Previous reliability studies including the statistical test and results for test-retest reliability of food frequency questionnaires (FFQ) for sugar intakes.

<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 US residents, 34 - 59y</td>
<td>PC; ICC</td>
<td>0.71</td>
<td>0.71</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 US residents, 55-69y</td>
<td>Crude PC: FFQ1vsFFQ2; FFQ1vsFFQ3; FFQ2vs:FFQ3</td>
<td>0.49; 0.40; 0.53</td>
<td></td>
<td></td>
<td></td>
<td>3 admin. of the same FFQ</td>
</tr>
<tr>
<td>Eye Disease Case-Control Study FFQ</td>
<td>Ajani, 1994</td>
<td>12-18m</td>
<td>281 M&amp;F US 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>McKeown, 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; 0.62 F=0.78; 0.73</td>
<td></td>
<td></td>
<td></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>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 Study</td>
<td>Esfahani, 2010</td>
<td>14m</td>
<td>132 M&amp;F Tehran residents, 20 - 70y</td>
<td>Crude ICC; E-adjusted ICC</td>
<td>Simple sugars M=0.86; 0.77 F=0.83; 0.74</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2.3 continued

<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>Dutch Sweet Eating</td>
<td>van den Heuvel,</td>
<td>2w</td>
<td>138 F Dutch residents undergone bariatric surgery, 22 - 62y</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>Questionnaire</td>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Dietary Fat and free</td>
<td>Francis, 2013</td>
<td>145-</td>
<td>29 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>168d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(DFS)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FFQ=food frequency questionnaire; Int=Interval; Suc.=sucrose; Fruc.=fructose; Gluc.=glucose; y=year; m=month; w=week; d=day; F=female; M=male; US=United States; UK=United Kingdom; PC=Pearson correlation coefficient; ICC=Intraclass correlation coefficient; admin=administration; E=energy; Corr.=correlation; NS=not specified
<table>
<thead>
<tr>
<th>Author, year</th>
<th>Origin Type</th>
<th>FFQ</th>
<th>Freq. response (range)</th>
<th>Purpose</th>
<th>Time period</th>
<th>Reference method</th>
<th>Participants (age) location</th>
<th>Ethnicity</th>
<th>Sugar (g)</th>
<th>Fruc. (g)</th>
<th>Suc. (g)</th>
<th>Additional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharpe, 1993</td>
<td>Willet Semi Self</td>
<td>75 6 (never-daily)</td>
<td>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>a)0.58a b)0.53a</td>
<td></td>
<td></td>
<td></td>
<td>a) 4 serving size options b) standard single serving</td>
</tr>
<tr>
<td>Marshall, 1994</td>
<td>Semi Self</td>
<td>132 6 (never-daily)</td>
<td>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>0.46-0.52d</td>
<td></td>
<td></td>
<td></td>
<td>Validated in human nutrition students</td>
</tr>
<tr>
<td>Bolch, 1994</td>
<td>Mars Semi Self</td>
<td>132 6 (never-daily)</td>
<td>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>0.58c 0.58d</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bell, 1999</td>
<td>Willet Quan Self</td>
<td>89 7 (never-daily)</td>
<td>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>0.32a 0.28b</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sam, 2011</td>
<td>UK Semi Self</td>
<td>154 7 (never ≥2/day)</td>
<td>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%NZE</td>
<td>0.38a 0.47a</td>
<td>0.55b 0.46b</td>
<td>140 (50-347) 317</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FFQ=food frequency questionnaire; Admin=administration; Freq.=frequency; Semi=semi-quantitative; Quan=quantitative; Self=self-administered; y=year; 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; a=Crude Spearman CC (correlation coefficient); b=Energy-adjusted Spearman CC; c=Crude Pearson CC; d=Energy-adjusted Pearson CC; e=mean % agreement (LoA); LoA=Limits of Agreement.
2.3.5 New Zealand validated food frequency questionnaires

When modifying a FFQ, four factors need to be considered: purpose, target population, when the FFQ was developed and validation (Cade 2002). Since no sugar-specific FFQ has been developed for use in NZ, Table 2.4 describes five FFQs that have been validated to measure multiple nutrient intakes, including sugars, in NZ adults. One was developed specifically to study an association between dietary habits and cardiovascular disease risk (Sharpe et al. 1993).

While correlation coefficients are not the best test of validity (Bland & Altman 2010), it has been suggested that a correlation coefficient of about 0.5 for most nutrients and 0.8 for alcohol between methods indicates that the FFQ has the capability to rank individuals according to nutrient intake (Brunner 2001). NZ-based FFQs that have been validated for sugars have crude correlation coefficients between 0.32 and 0.58 (Table 2.4).

Two FFQs have been specifically developed for Polynesians in NZ, although their validity to measure sugar intakes has not been clearly established (Metcalf 1997; Bell et al. 1999). Metcalf (1997) carried out a validation study of a 142-item FFQ which included foods favoured by Maori and Pacific Islanders but unfortunately did not test the validity of the FFQ for sugars. The FFQ developed by Bell et al. (1999) was tested for validity against a 7-day diet record among a NZ Samoan population (n=55), but the adjusted correlation coefficient for sugar was 0.28 indicating poor validity for this nutrient. The authors felt the FFQ was likely to give a better representation of usual intake in this population than the weighed diet record, which they felt underestimated dietary intake. They reported some
participants did not use the scales and cup measurements to accurately report portion sizes. This evidence suggests that weighed diet records may not be an appropriate reference method for this Samoan population (Bell et al. 1999).

The majority of these questionnaires were developed in the 1990’s and thus they may not incorporate common foods eaten today. In 2010, Sam (2012) validated a FFQ, which is likely to reflect current food habits in NZ. The food list from the UK EPIC project was adapted to include commonly consumed foods from the 1997 national nutrition survey. Supermarket inspections and focus group feedback were also used to develop the FFQ (Gould 2009; Jaafar Amstak 2009).

Although all these FFQs have had validation studies carried out on them, the study design needs to be taken into consideration. A questionnaire developed by Marshal (1994) assesses yearly intake but the reference method is a 7-day diet record completed within a month, which is not sufficient to capture seasonal or other variations in dietary intake over a year. In contrast, the FFQ validation study carried out by Sam (2012) was validated in NZ Adults living in Dunedin against the ‘gold standard’ of 8-day weighed diet-records (2-day diet records per season). Energy-adjusted correlation coefficient between methods of 0.46 for sucrose and 0.55 for fructose were marginal. Furthermore, 99% of the participants in this study were not Pacific Island people.

2.4 Summary

Repeat 24h recalls are likely to produce the best estimates of usual sugars intakes in a Pacific population with lower literacy and numeracy. This reference method can be used to
assess the relative validity of a FFQ developed from existing instruments. The advantages of using a FFQ in large studies designed to assess the relationship between sugar intake and metabolic diseases are its low cost and low respondent burden. Although a number of both international and NZ FFQs that have been validated for assessment of sugars intakes have been reported, none is suitable, nor current enough for accurately assessing sugar intakes in Pacific populations living in NZ. Thus there is a need create a sugar specific FFQ and evaluate it in a Pacific population to test the performance of the questionnaire.
3. Objective Statement

It has been hypothesised that excessive fructose consumption may be linked to the increasing prevalence of obesity and metabolic diseases such as diabetes, gout and cardiovascular disease (Johnson 2008). In NZ, Pacific Islanders have higher rates of these diseases compared to the general population (Sundborn et al. 2008; Statistics New Zealand & Ministry of Pacific Island Affairs 2011; Winnard 2012). The evidence shows that there are very few short FFQs (<40 items) that measure sugar intake specifically, and none currently exist in NZ. There are longer FFQs that have been developed in NZ, and other countries, to assess intakes for multiple nutrients, including sugar. However, for population studies that aim to examine associations between sugars intakes and health outcomes specifically, these long FFQs create unnecessary respondent burden and complexity for researchers. Therefore the overall aim of this study is to develop, pre-test and evaluate the validity and reproducibility of a culturally appropriate short FFQ that measures sugars intakes in a Pacific Island population. This tool will be used to study the relationship between sugar intake and disease, and if necessary, inform public health recommendations.

Objectives:

1. To assist with the development of a short FFQ (< 40 items) to measure sugar intakes over the previous month among Pukapuka Pacific Island adults, living in South Auckland, NZ

   • To identify major dietary sources of sugar in Pacific Island people using the 2008/09 NZ Adult Nutrition Survey data (University of Otago & Ministry of Health 2011a)
To identify other major dietary sources of sugar in Pukapuka Pacific Island adults, living in South Auckland using stakeholder interviews and environmental audits of food outlets, supermarkets and the Pukapuka Community Centre

2. To pretest two versions (closed- and open-ended) of the FFQ among a small sample of Pukapuka Pacific Island adults, living in South Auckland using cognitive interviews
   - To explore the readability and cultural appropriateness of the FFQ
   - To explore participants’ comprehension of the dietary assessment task and their ability to accurately record their usual intake
   - To refine the preferred FFQ taking into account participants’ feedback

3. To test the relative validity of the refined FFQ to assess usual sugar intakes over the previous month (week 4) among Pukapuka Pacific Island adults, living in South Auckland using usual sugar intakes estimated from three five-step 24-hour recalls collected during weeks 1 to 3

4. To assess the test-retest reliability of the refined FFQ to assess usual sugar intakes using repeated administrations of the same FFQ (3 weeks apart).
4. Subjects and Methods

The aim of the Pukapukan Kai Study was to develop and evaluate a short FFQ to measure usual sugars intake in Pukapuka Pacific Islanders living in South Auckland, NZ.

Recommendations from an international consensus on the development, validation and utilisation of FFQs were used throughout the design, pre-testing and validation phases of the study (Cade 2004)

This study was approved by the University of Otago Human Ethics committee (Appendix A) and written informed consent was obtained from all participants (Appendix B).

4.1 FFQ development and pretesting

4.1.1 FFQ design

A 33-item, self-administered, semi-quantitative FFQ aiming to assess usual sugar consumption over the previous month was developed for Pukapuka Pacific Island adults living in South Auckland, NZ. A one-month recall period was used as in the future this FFQ is intended to establish the association between sugars intake and disease risk biomarkers, namely, serum uric acid, lipids and blood pressure of which change relatively quickly in response to diet (Hedrick et al. 2012b). Furthermore, participants are likely to find reporting intake over the past four weeks rather than a year much easier (Subar et al. 1995). Two versions of the paper-based FFQ were created. 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. The open-ended version of the FFQ contained the same food items but the frequency and most quantity questions were open-ended so participants could record exactly what they consumed.

Sugar containing food and beverage items were sourced from various locations: 1) a sugar consumption questionnaire developed for the DRINKS Study (Crutchley, forthcoming), which had been based on the format of the FOOD-FFQ (Food Options of Dunedinites) (Sam 2012) and tested for suitability in a Maori population during a summer studentship in 2012/2013 (Mcneil 2013); 2) a fruit FFQ previously validated with NZ adults (Mainvil et al. 2011); 3) a sugar-sweetened beverages FFQ validated with USA adults (Hedrick et al. 2012a); and 4) NZ adult nutrition surveys (Russel 1999; University of Otago & Ministry of Health 2011a). An environmental audit of three local food outlets, two supermarkets, and the Pukapuka Community Centre in Mangere, South Auckland, including observations of the target audience at the Pukapuka Community Centre, were carried out to ensure food items represented major sources of sugars intakes in the Pukapuka South Auckland 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 (Venter et al. 2000; Gibson 2005; Gibson & Ferguson 2008; Hedrick et al. 2012a). Photos were sourced from the Department of Human Nutrition’s Dietary Assessment Photos (University of Otago, 1996-7, 2000).
Previous qualitative research investigating low-income NZ adults’ thought processes while completing a FFQ (Mainvil, personal communication, 2013) suggested that an open-ended (not tabular) format might be suitable for this target audience. Therefore, an open-ended version of the closed-ended FFQ was developed based on a template, partially inspired by the work of Kristjansdottir et al. (2006).

### 4.1.2 FFQ pretesting and refinement

Both versions of the FFQ were pretested among ten Pacific Island participants from the Pukapuka Community Centre (3 males, 7 females), aged 37 to 57 years, using individual cognitive interviews. The think-aloud method was used to encourage participants to verbalise their thought processes as they answered the questions in order to explore their comprehension of the dietary assessment task and their ability to accurately record their usual intake (Subar et al. 1995). The open- and closed-ended versions of the FFQ were administered in an altering sequence with a short wait time in between to help address training effect biases. At completion, the participants were asked which format they preferred, suggestions to improve the questionnaire and the suitability of the food items for the Pukapuka community living in NZ. The interviewer wrote detailed notes during the interviews and, if agreed upon, an audio recording of the interview was made and transcribed so the feedback could be used to refine the FFQ.

The majority of participants preferred the open-ended version of the FFQ and most reported that the closed-ended questionnaire was confusing and overwhelming. As a
result the open-ended version of the FFQ was refined for use in the validation and reliability study (Appendix C). Some examples of modifications include:

- Participants found the word “piece” referring to raw fruit confusing so it was changed to “whole piece of fruit”;
- “Dessert spoon” was changed to “big spoon” as a lot of participants did not know what a dessert spoon was;
- A “never” tick box was added as participants were confused as to what to do if they did not consume the food item;
- More pictures of food items were added as, in the words of a participant, “it makes it more visual and easier to understand”

The finalised questionnaire contained 33 questions that asked about the intake of sugar containing foods and beverages over the past month (Appendix C). Most questions required a quantitative answer for which all foods were quantified in ‘natural’ units such as number of biscuits and pieces of fruit. For the breakfast cereal item the FFQ asks participants to identify the type of breakfast cereal usually consumed, as there is considerable variability of sugar contents in the wide range of breakfast cereals available on the NZ market. Two additional questions asking about whether the subject had changed their diet and gained or lost weight during the past year (FFQ1) or month (FFQ2) were included at the end of the questionnaire to help interpret test-retest reliability results.
Table 4.1: The forgotten food list used as in the 5-step multiple-pass 24h recall

<table>
<thead>
<tr>
<th>Category</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fizzy</td>
<td>Fruit juice (100% fruit juice) (no added sugar) e.g. Just Juice</td>
</tr>
<tr>
<td></td>
<td>Cordials or fruit drinks</td>
</tr>
<tr>
<td></td>
<td>Milkshakes</td>
</tr>
<tr>
<td></td>
<td>Alcoholic drinks</td>
</tr>
<tr>
<td></td>
<td>Lollies or chocolate</td>
</tr>
<tr>
<td></td>
<td>Desserts/puddings</td>
</tr>
<tr>
<td></td>
<td>Foods from the Pukapuka Centre kitchen e.g. doughnuts</td>
</tr>
<tr>
<td>Fruit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vegetables</td>
</tr>
<tr>
<td></td>
<td>Biscuits, cake or muffins</td>
</tr>
<tr>
<td></td>
<td>Bread, doughnuts or fried bread</td>
</tr>
</tbody>
</table>

4.2 Validation and reliability study

4.2.1 Sampling

A convenience sample of 30 Pukapuka Pacific Islanders was recruited face-to-face at the Pukapuka Community Centre in Mangere, South Auckland with the help of the Centre’s president and community navigators. Recruitment was conducted between the 25th February and the 9th April 2013.

Eligibility was based on the following criteria:

- Pukapuka Pacific Island ethnicity living in South Auckland, NZ
- Aged between 18-60 years old
- Those intending to stay in South Auckland for the next month
- Those physically and mentally capable to provide informed written consent to participate

The sample size was calculated based on what was feasible given the length of time for the study (Gibson 2005). It is recommended that a sample size of at least 50 subjects is desirable in a validation study (Cade 2002). This preliminary investigation is part of a wider study in which ongoing validation is going to occur which will increase the sample size and strengthen the results.

4.2.2 Reference method

Repeat 24h dietary recalls were selected as the most appropriate dietary assessment reference method to validate the FFQ given earlier reports of diet record underreporting (Bell et al. 1999), the potential for low levels of literacy amongst the Pukapuka population (Cade 2004; Statistics New Zealand & Ministry of Pacific Island Affairs
2010) and most importantly, multiple 24h recalls can determine individuals usual intake of nutrients (Gibson 2005). The United States Department of Agriculture (USDA) five-step multiple-pass 24h recall method was followed (Raper et al. 2004). This recall method is similar to the four-stage method used in NZ national nutrition surveys but it includes an extra step in which the participants are probed for frequently forgotten foods using a predetermined list of snacks and beverages that contain sugar (Table 4.1).

4.2.3 Procedures for data collection

Data was collected in four sessions. At the first session participants were given an information sheet on the study (Appendix D) and were required to read and sign a consent form (Appendix B). Consenting participants were asked to complete a contact details form (if not already completed) (Appendix E) and a demographic questionnaire (Appendix F).

Participants were interviewed weekly for four weeks in order to administer the FFQ and to capture 24h recalls representing different days of the week. Participants were given the option of being interviewed at their own homes or at the Pukapuka Community Centre in Mangere, South Auckland.

At the first, second and third interviews, 24h recalls were completed for each participant, which included two weekdays and one weekend day (Saturday or Sunday) in order to estimate usual dietary intake that month. Three-dimensional food models and photographs were used to assist the participants to accurately estimate their intakes. At
the end of each 24h recall, participants were asked whether it represented their usual intake and if not, why not.

In order to examine the test-retest reliability of the FFQ, participants were asked to complete the FFQ twice. The first administration of the FFQ (FFQ1) occurred in the first two weeks of the study, in most cases during the first interview. The second administration (FFQ2) was administered in week 4 and was intended to capture the dietary intakes measured by the repeated 24h recalls. Upon completion of the FFQ the interviewer checked it for completion and clarified any queries.

At the end of each interview the participants were reimbursed with a $10 supermarket voucher for their time.

4.3 Data analysis

4.3.1 Food frequency questionnaires

Individual FFQ data was entered into a Microsoft Excel (Microsoft Office 2008) spreadsheet to estimate each participant’s usual intake of fructose, glucose, sucrose and total available sugars (Appendix G). In this study 50% of the sucrose content counted in both the fructose and glucose estimates. The spreadsheet multiplied the reported frequency of consumption for each food item by the corresponding nutrient profile (explained below). This was subsequently converted to daily sugars intake per food item, based on the amount consumed, and then summed to obtain each individual’s daily estimated sugars intake for that month.
The nutritional profile of food items in the FFQ was determined using the Pacific Island data from the ANS (University of Otago & Ministry of Health 2011a). For items with multiple foods listed, the foods included in the group were weighted by the percentage of the reported frequency from the ANS dataset. For example, the FFQ item “spirits with mixer” was composed of 26% “vodka base” and 74% “bourban/whiskey base”, obtained from the frequency of consumption of these drinks by Pacific Islanders in the ANS. In the same way, the nutritional profile of “Milo, powder drinking chocolate or other milk mix” was composed of 77% “Milo”, 20% “Chocolate, drinking, powder” and 3% “Nesquik, powder”. Based on pretesting and observation at the Pukapuka Community Centre, it was established that doughnuts were an important food item not represented by the ANS data. As a result they were given a weighting of 80% for the “sweet buns, iced buns, doughnuts or pastries” item. The percentage weighting of each food was multiplied by the fructose, glucose, sucrose and total available sugar contents for that food. This was obtained from the latest version of the NZ food composition tables (NZ FOODfiles 2010v2) (Department of Human Nutrition). The sugars content for each food was then summed to calculate the nutrient profile of each item in the FFQ.

4.3.2 24h recalls

The 24h recall data was analysed using ©2013 Kai-culator [0.85] including FOODfiles 2010v2 dietary assessment software (Department of Human Nutrition). The three 24h recalls were averaged to obtain each individual’s usual daily intake of fructose, glucose, sucrose and total sugars.
4.4 Statistical analyses

The geometric mean usual sugars intake, along with the 95% confidence interval (CI) were calculated from both FFQs and the mean intake of the three 24h recalls. The data was log transformed prior to statistical analyses to normalize the distributions and the geometric means and 95% confidence levels are reported (Gibson 2005). The geometric mean usual sugars intake were compared to the ANS data for Pacific Islanders. A two-sided paired t-test was used to examine the geometric mean differences in intake between the FFQ2 and the mean 24h recall and between FFQ1 and FFQ2 (Gibson 2005; Gibson & Ferguson 2008).

4.4.1 Group mean intake estimates

To test whether the FFQ can be used to estimate a group’s mean intake, a two-sided paired t-test was used to examine the geometric mean differences in intake between the FFQ2 and the mean 24h recall (Gibson 2005; Gibson & Ferguson 2008).

4.4.2 Precise individual-level agreement

Due to measurement error, it is unlikely that the FFQ and mean 24h recall would show precise agreement at an individual level for clinical use, but this type of test can reveal valuable information about the instrument’s performance. The Bland-Altman method was used to measure the agreement between FFQ2 and the mean 24h recall intake for sugars using log-transformed values to account for the non-normal distributions (Bland & Altman 2010). The mean difference, or bias, for each sugar was calculated by averaging the difference between the FFQ2 and 24h recall data. The 95% limits of agreement
(LoA)—an interval of the mean difference in which 95% of the measurements are expected to lie within were also calculated.

The mean difference and the LoA were then back transformed to give results in a FFQ:24h recall ratio. To enable easier interpretation the ratios were multiplied by 100 to be expressed as percentages (i.e. mean percentage agreement). A mean percentage of agreement of 100% represents perfect agreement between the 24h recalls and the FFQ. However, a mean percentage of agreement with a lower 95% confidence interval higher than 100 indicates that the FFQ significantly over-estimates the nutrient intake and vice versa, if the upper 95% confidence interval is lower than 100. The width of the LoA indicates the degree of agreement between the two methods (Cade 2002; Bland & Altman 2010)

4.4.3 Individual ranking

To test whether the FFQ can be used to rank individuals according to their intake, cross-classification of nutrient intakes from the FFQ2 and the mean 24h recalls was undertaken. The percentage of participants correctly classified into the same quartile, adjacent quartile and grossly misclassified into extreme quartiles was calculated. The Cohen’s weighted kappa was calculated for each sugar from the observed and expected proportions on a 4 x 4 table of frequency. Kappa values fall between zero (indicating complete disagreement) and one (indicating complete agreement) for each category. Values of 0.80 are considered to show very good agreement, 0.61 to 0.8 good agreement, 0.41-0.6 moderate agreement, 0.21 to 0.4 fair agreement and 0.2 or less, poor agreement (Masson et al. 2003).
4.4.4 Strength of the association

Since the sugars intakes were not normally distributed Spearman correlations were calculated to assess the strength of the association between FFQ2 and mean 24hr recall estimates (Willett 1998; Cade 2002). As total diet was not assessed by the FFQ, analyses could not be adjusted for total energy intake.

4.4.5 Test-retest reliability

Test-retest reliability 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 3 weeks apart. Because ICCs take into account both within- and between-subject variation this method is considered the gold standard for assessing reliability (Kottner et al. 2011). An ICC of 0.5 or above is considered acceptable (Cade 2004).
5. Results

5.1 Participants

A total of 37 Pacific Island male and female NZ residents were recruited at baseline and 33 NZ resident Pukapuka Pacific Island participants (89%) completed both FFQs and three 24h recalls. All data from the 33 participants was able to be included in the analysis of validity and reliability of the FFQ. Table 5.1 shows the characteristics of the Pukapukan Kai study participants. There were a higher proportion of females than males and the age distribution of the participants was skewed towards the youngest age category (18-29 years old). Furthermore, half of the participants had a secondary school certificate, but one-third did not. One-third of participants had at least one co-morbidity.

5.1.1 Mean sugars intake

Mean usual intakes of fructose, glucose, sucrose and total sugars derived from the repeat 24h recalls are shown in Table 5.2. Estimates for fructose, sucrose and total sugars from the mean 24h recall were comparable with the estimates for Pacific adults reported in the 2008/09 ANS (Table 5.2)

5.2 Relative validity

Group mean intake estimates

The FFQ2 produced geometric mean estimates of fructose, glucose and total sugars that were not significantly different to the mean 24h recall estimates (Table 5.2), showing this FFQ can adequately estimate a group’s mean intake of these nutrients. Conversely, the geometric mean difference in sucrose intakes between the methods was significant, in
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Baseline (n=37)</th>
<th>Completers (n=33)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
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<tr>
<td>Males</td>
<td>14</td>
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</tr>
<tr>
<td>Females</td>
<td>23</td>
<td>62</td>
</tr>
<tr>
<td><strong>Age, years</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>17</td>
<td>46</td>
</tr>
<tr>
<td>30-39</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>40-49</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>50-59</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pukapuka Pacific Islander</td>
<td>36</td>
<td>97</td>
</tr>
<tr>
<td>Cook Island Maori</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Highest educational qualification</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No secondary school qualification</td>
<td>12</td>
<td>33</td>
</tr>
<tr>
<td>Secondary school</td>
<td>19</td>
<td>53</td>
</tr>
<tr>
<td>Technical/trade school, polytechnic or university</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td><strong>Co-morbidities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High blood pressure</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Type 2 diabetes</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>High cholesterol</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Asthma</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

n=number
Table 5.2: Geometric mean and 95% confidence interval (CI) for daily intake of sugars among participants in the Pukapukan Kai study (n=33) and Pacific Island participants in the 2008/09 Adult Nutrition Survey (ANS)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Fructose</th>
<th>Glucose</th>
<th>Sucrose</th>
<th>Total sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean 24h recall</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometric mean</td>
<td>21.3</td>
<td>19.2</td>
<td>54.0</td>
<td>111.0</td>
</tr>
<tr>
<td>CI</td>
<td>15.9-29.0</td>
<td>14.3-25.8</td>
<td>41.6-70.0</td>
<td>86.2-142.0</td>
</tr>
<tr>
<td><strong>FFQ2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometric mean</td>
<td>20.8</td>
<td>20.0</td>
<td>67.7</td>
<td>114.0</td>
</tr>
<tr>
<td>CI</td>
<td>15.3-28.2</td>
<td>14.4-26.8</td>
<td>52.1-87.9</td>
<td>89.4-145.0</td>
</tr>
<tr>
<td>Geometric mean difference&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.97</td>
<td>1.04</td>
<td>1.25*</td>
<td>1.03</td>
</tr>
<tr>
<td>CI</td>
<td>0.78-1.2</td>
<td>0.82-1.3</td>
<td>1.02-1.5</td>
<td>0.89-1.2</td>
</tr>
<tr>
<td><strong>ANS mean&lt;sup&gt;b&lt;/sup&gt;</strong></td>
<td>18.6</td>
<td>56.4</td>
<td>108.8</td>
<td></td>
</tr>
</tbody>
</table>

24h=24 hour; CI=Confidence Interval; FFQ2=second administration of the Pukapukan Kai FFQ; ANS=2008/09 NZ Adult Nutrition Survey

<sup>a</sup> Geometric mean difference between FFQ2 and mean 24h recall using a two-sided paired t-test

<sup>b</sup>Mean sugar intakes among 684 Pacific Islanders living in New Zealand aged 19+, as reported in the 2008/09 New Zealand Adult Nutrition Survey report using one 24h recall (University of Otago & Ministry of Health 2011a)

*P<0.05
Table 5.3: Strength of agreement (presented in percentage) using the Bland-Altman method between sugar intake derived from the mean 24h recalls and FFQ2

<table>
<thead>
<tr>
<th>Sugar</th>
<th>Mean % agreement (CI)</th>
<th>LoA (%)</th>
<th>Mean % agreement (CI) from other studies</th>
<th>LoA (%) from other studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>97 (79-121)</td>
<td>29-327</td>
<td>140(129-151)</td>
<td>56-347 156</td>
</tr>
<tr>
<td>Glucose</td>
<td>104 (82-132)</td>
<td>28-392</td>
<td>163</td>
<td>97-277</td>
</tr>
<tr>
<td>Sucrose</td>
<td>125 (102-154)</td>
<td>39-407</td>
<td>126(117-137)</td>
<td>50-317 125</td>
</tr>
<tr>
<td>Total sugars</td>
<td>103 (89-119)</td>
<td>45-236</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CI=Confidence Interval; LoA=Limits of Agreement

aData from the FFQ and 24h recalls were collected from 33 participants, natural log-transformed for the Bland-Alman analysis, back-transformed, and multiplied by 100% for ease of interpretation

bMean % agreement=(sugar intake of FFQ/sugar intake of mean 24h recall or reference method) x 100%

cThe width of the LoA represents the range in which 95% of the differences between the FFQ and mean 24h recall or reference method are expected to fall.

dBland-Altman method carried out on four international studies measuring sugars (table 2.2) (Ambrosini 2003; Marks 2006; Barclay 2008; Barrett 2010) and one NZ study (table 2.4) (Sam 2012)

Table 5.4: Cross-classification of Pukapukan Kai study participants (n=33) by quartiles of sugars intake between the mean 24h recall and FFQ2 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>55</td>
<td>27</td>
<td>3</td>
<td>0.47</td>
</tr>
<tr>
<td>Glucose</td>
<td>48</td>
<td>36</td>
<td>0</td>
<td>0.47</td>
</tr>
<tr>
<td>Sucrose</td>
<td>55</td>
<td>36</td>
<td>0</td>
<td>0.47</td>
</tr>
<tr>
<td>Total sugars</td>
<td>52</td>
<td>36</td>
<td>0</td>
<td>0.52</td>
</tr>
</tbody>
</table>

aPercentage of participants classified into the same quartile of sugar intake

bPercentage of participants classified into the adjacent quartile of sugar intake

cPercentage of participants grossly classified into the extreme quartile of sugar intake
which the FFQ2 intake was 25% higher than the mean 24h recall intake, which limits the use of this FFQ to measure a group’s mean sucrose intake.

**Precise individual-level agreement**

Similar results were found with the Bland-Altman analyses showing that the mean percentage of agreements for fructose, glucose and total sugars ranged from 97 (for fructose) to 104 (for glucose) and all 95% confidence intervals included 100 (Table 5.3), indicating good agreement at a group level. In contrast, the FFQ significantly over-estimated the group’s sucrose intake compared to the mean 24h recall (Table 5.3).

Compared with other studies that used the Bland-Altman method, the present study’s FFQ has a greater percentage of agreement with the reference method for fructose, glucose and total sugars and similar agreement for sucrose.

The lower limits of agreement (LoA) ranged from 28% for glucose to 45% for total sugar and the upper from 236% for total sugar to 407% for sucrose (Table 5.3). While these LoA are wider than those reported in most previous studies (Table 5.3), all of these studies found considerable lack of agreement at an individual level. Hence, the FFQ is not validated for clinical use to estimate an individual’s precise sugars intake.

**Individual ranking**

The percentage of participants classified into the same, adjacent and extreme quartiles for fructose, glucose, sucrose and total sugars obtained from the mean 24h recall and FFQ2 are shown in Table 5.4. Classification into the same or adjacent quartile ranged from 82% for
Table 5.5: Correlation coefficients (CC) between FFQ2 and mean 24h recall daily intakes of sugars amongst Pukapukan Kai study participants (n=33) and results from previous validation studies for sugars

<table>
<thead>
<tr>
<th>Sugar</th>
<th>$R^a$</th>
<th>$R$ from previous studies$^{bc}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>0.62*</td>
<td>0.25-0.38$^d$</td>
</tr>
<tr>
<td>Glucose</td>
<td>0.69*</td>
<td>0.22$^d$</td>
</tr>
<tr>
<td>Sucrose</td>
<td>0.67*</td>
<td>-0.04-0.60$^a$</td>
</tr>
<tr>
<td>Total sugars$^f$</td>
<td>0.77*</td>
<td>0.28-0.77$^g$</td>
</tr>
</tbody>
</table>

$^a$Correlation coefficient  
$^b$Spearman correlation coefficients  
$^c$Crude correlation coefficients derived from FFQs validated for sugars. Refer to Table 2.2 and 2.4 for detailed information on the studies.  
$^d$Twelve studies used Pearson correlations; eleven studies used Spearman correlations  
$^e$Data were available for ≤ 3 studies  
$^f$Data were available for 5 studies  
$^g$Four studies examined “added sugars” and one study “simple sugars”  
*$^*$P<0.05

Table 5.6: Geometric mean and confidence interval (CI) for daily intake of sugars among participants in the Pukapukan Kai study (n=33) as measured by the Food Frequency Questionnaires (FFQs)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Fructose</th>
<th>Glucose</th>
<th>Sucrose</th>
<th>Total sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFQ1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometric mean</td>
<td>27.5</td>
<td>29.2</td>
<td>86.2</td>
<td>154</td>
</tr>
<tr>
<td>CI</td>
<td>20.5-36.9</td>
<td>21.6-39.4</td>
<td>63.3-117</td>
<td>118-202</td>
</tr>
<tr>
<td>FFQ2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometric mean</td>
<td>20.8</td>
<td>20</td>
<td>67.7</td>
<td>114</td>
</tr>
<tr>
<td>CI</td>
<td>15.3-28.2</td>
<td>14.4-26.8</td>
<td>52.1-87.9</td>
<td>89.4-145</td>
</tr>
<tr>
<td>Mean difference$^a$</td>
<td>1.32*</td>
<td>1.46*</td>
<td>1.27</td>
<td>1.35*</td>
</tr>
<tr>
<td>CI</td>
<td>1.08-1.63</td>
<td>1.16-1.82</td>
<td>0.99-1.65</td>
<td>1.13-1.63</td>
</tr>
</tbody>
</table>

$^a$Mean difference between FFQ1 and FFQ2 using a two-sided paired t-test  
*$^*$P<0.05

CI=Confidence interval
fructose to 91% for sucrose. The only nutrient with any degree of gross misclassification was fructose (3%). Weighted kappas were 0.47 for fructose, glucose and sucrose and 0.52 for total sugars indicating moderate agreement (Masson et al. 2003).

**Strength of the association**

Spearman correlation coefficients for estimates of fructose, glucose, sucrose and total sugars intake derived from the mean 24h recall and FFQ2 are shown in Table 5.5. All correlation coefficients were greater than 0.6. With the exception of total sugars, correlation coefficients for the FFQ were greater than crude results previously reported in the literature (Table 5.5)

**5.3 Test-retest reliability**

**Mean sugars intake between administrations of the FFQ**

Table 5.6 shows the mean daily intakes of sugars as measured by FFQ1 and FFQ2. FFQ1 gave consistently higher estimates of sugar compared to FFQ2. Estimates were significantly different for fructose, glucose and total sugar, but not sucrose. The consistently lower sugars estimates measured by FFQ2 may be partly explained by the results of the additional questions at the end of the FFQ asking about changes in diet and weight (Table 5.7). Twenty one percent of participants reported that they consumed less sugar during the month FFQ2 measured. Furthermore, 30% reported they consumed less food, 18% consumed less fruit juice, 12% consumed less sugary drinks and alcohol and 9% consumed less fruit (Table 5.7). Thirty six percent also reported that they had lost weight during the past month, which may indicate that some participants possibly consumed less sugary food and beverages during that month without knowing.
Table 5.7: Participants that reported changes in their diet and/or weight during the past 30 days that FFQ2 measured (as asked in the last two questions of FFQ2)

<table>
<thead>
<tr>
<th>Question</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of participants that reported they changed their diet in the past 30 days</td>
<td>39</td>
</tr>
<tr>
<td>I eat less food</td>
<td>30</td>
</tr>
<tr>
<td>I eat less sugar</td>
<td>21</td>
</tr>
<tr>
<td>I eat less fat</td>
<td>18</td>
</tr>
<tr>
<td>I eat less fruit</td>
<td>9</td>
</tr>
<tr>
<td>I eat less fruit juice</td>
<td>18</td>
</tr>
<tr>
<td>I drink fewer sugary drinks</td>
<td>12</td>
</tr>
<tr>
<td>I drink less alcohol</td>
<td>12</td>
</tr>
<tr>
<td>I eat more food</td>
<td>12</td>
</tr>
<tr>
<td>I eat more sugar</td>
<td>9</td>
</tr>
<tr>
<td>I eat more fat</td>
<td>6</td>
</tr>
<tr>
<td>I eat more fruit</td>
<td>12</td>
</tr>
<tr>
<td>I drink more fruit juice</td>
<td>9</td>
</tr>
<tr>
<td>I drink more diet drinks</td>
<td>12</td>
</tr>
<tr>
<td>I drink more alcohol</td>
<td>0</td>
</tr>
<tr>
<td>Percent of participants that reported weight loss in the past 30 days</td>
<td>36</td>
</tr>
</tbody>
</table>

% = Percentage of participants

Table 5.8: Intraclass correlation coefficient (ICC) for sugars intake between FFQ1 and FFQ2 and reliability correlation coefficients from previous relevant reliability studies

<table>
<thead>
<tr>
<th>Sugar</th>
<th>ICC</th>
<th>CC from previous studiesa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fructose</td>
<td>0.73*</td>
<td>0.65-0.73</td>
</tr>
<tr>
<td>Glucose</td>
<td>0.69*</td>
<td>0.75</td>
</tr>
<tr>
<td>Sucrose</td>
<td>0.58*</td>
<td>0.40-0.85</td>
</tr>
<tr>
<td>Total sugars</td>
<td>0.68*</td>
<td>0.58-0.86</td>
</tr>
</tbody>
</table>

ICC = Intraclass correlation coefficient; CC = Correlation Coefficient

a Range of CC (including crude and energy-adjusted Pearsons, Intraclass and Partial) derived from reliability studies of FFQs measuring sugars. Refer to Table 2.3 for detailed information on the studies

b Reliability CC from Sam (2012) not shown in tables

*P<0.05
**Intraclass correlation coefficients**

Intraclass correlations (ICCs) for the repeated FFQs are shown in **Table 5.8**. ICCs varied from 0.58 for sucrose to 0.73 for fructose, which is acceptable. With the exception of glucose, the test-retest reliability of the FFQ for sugars are comparable to other studies (**Table 5.8**).
6. Discussion

In this study a 33-item, semi-quantitative, Pukapukan Kai FFQ was designed to measure the usual intake of fructose, glucose, sucrose and total sugars during the past month in Pukapuka Pacific Island adults living in South Auckland, NZ. The relative validity of the self-administered FFQ was evaluated for use in epidemiological studies against three 24h recalls collected over three weeks prior to administering the FFQ. Test-retest reliability of the FFQ was also evaluated.

Whilst the high correlation coefficients indicate a strong relationship between the FFQ and reference method, the Bland-Altman analysis, which indicates the absolute agreement between the methods, suggests that the FFQ overestimates most sugars intake at an individual level (Bland & Altman 1999). However, the FFQ adequately estimates a group’s usual mean intake of fructose, glucose and total sugars (not sucrose) over the past month, which is beneficial in epidemiological studies. Furthermore, the FFQ can rank individuals according to their usual intake of fructose, glucose, sucrose and total sugars, which means participants with high sugars intake can be differentiated from those with low sugars intake.

Although FFQ1 consistently produced higher sugar estimates, the FFQ2 values are much closer to the mean 24h recall values. Furthermore, the ICCs were moderate to strong which indicates the FFQ can adequately detect change at the individual level. Therefore it is
likely that the 24h recalls may have sensitized participants to their food intake, which resulted in the FFQ2 estimating lower sugar intakes (Gibson 2005). Twenty one percent of participants did report that they consumed less sugar during the month FFQ2 measured and a number reported that they consumed less, food, fruit juice, sugary drinks and alcohol, which may explain these results (Table 5.7).

6.1 Relative validity of the FFQ

Group mean intakes

T-test analyses suggest that the Pukapuk Kai FFQ can adequately estimate a group’s mean intake of fructose, glucose, and total sugars, but it overestimates mean sucrose intake by 25% (Tables 5.2).

Compared with other studies that used the Bland-Altman analysis, the Pukapukan Kai FFQ showed greater agreement with the reference method for mean fructose, glucose and total sugars intakes and similar agreement for mean sucrose intake (Table 5.3) (Ambrosini 2003; Marks 2006; Barclay 2008; Barrett 2010; Sam 2012). This may be due to the FFQ’s one-month recall period compared with other studies that requested information over a longer period of time (at least 6 months). Undoubtedly, FFQs requesting intake information over the past month are not as challenging for participants’ memory. Other notable differences include the greater number of food items (over 120) in other FFQs and the difference in reference method, as all the comparable studies used either estimated (Ambrosini 2003; Barrett 2010) or weighed diet records (Marks 2006; Barclay 2008; Sam 2012).
Although the mean percentage of agreements in this study are good, the limits of agreement (LoA) are wide. Similar to other studies (Table 5.3), this FFQ is not able to estimate an individual’s precise intake of sugars. For example, the FFQ could estimate an individual’s total sugars intake to be between 55% lower to 136% higher than the mean of three 24h recalls (Table 5.3). The limits of agreement in this study are wider than in other studies (Ambrosini 2003; Marks 2006; Barclay 2008; Barrett 2010; Sam 2012), which may be due to the smaller sample size and thus wider confidence limits. The other studies had sample sizes of 72 (Ambrosini 2003; Barrett 2010), 78 (Barclay 2008), 115 (Marks 2006) and 135 (Sam 2012). Our results support previous literature that it is difficult for FFQs to estimate absolute nutrient intake, but they can be used to rank individuals according to sugar intake.

**Ranking individuals according to their intake**

The Pukapukan Kai FFQ can be used to rank individuals according to their sugars intake. According to Masson 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.

In the present study, the proportion of participants correctly classified into the same quartile using the test and reference method was above 50% for fructose, sucrose and total sugars and 48% for glucose, only 3% of subjects were misclassified for one sugar (fructose) and weighted kappa values were at least 0.47 for all sugars (Table 5.4),
indicating moderate agreement (Kottner et al. 2011). As recommended, the Cohen’s weighted kappa statistic was presented, as cross-classification is limited by the fact it will include agreement that occurs by chance (Cade 2002; Gibson 2005).

In comparison to all but one study (Barrett 2010), the present cross-classification and weighted kappa statistic results are more favourable (Bingham et al. 1994; Brunner 2001; McKeown et al. 2001; Marks 2006; Barclay 2008; Esfahani 2010; Pakseresht 2010).

**Correlation coefficients**

Spearman correlation coefficients (SC) for all sugars lay in the range of 0.6-0.8, which are considered “good” suggesting that the FFQ has the capability to rank individuals according to sugar intake (Willett 1998; Brunner 2001; Cade 2002). With the exception of total sugars, which are comparable to previous results, the crude correlations for sugars are higher than those previously reported in the literature (Willett et al. 1985; Willett et al. 1988; Munger et al. 1992; Sharpe et al. 1993; Bingham et al. 1994; Bolch 1994; Bell et al. 1999; Brunner 2001; McKeown et al. 2001; Ambrosini 2003; Marks 2006; Barclay 2008; Lalonde et al. 2008; Esfahani 2010; Pakseresht 2010; Kaartinen et al. 2012; Sam 2012; Francis & Stevenson 2013).

Weekly 24h recalls in this study may have sensitized participants to their food intake, thus, making it easier for them to complete FFQ2 in line with their 24h recall responses. This “sensitization effect’’ may have created artificially strong correlation coefficients between the methods which may not be observed in the target population who have not completed
24h recalls (Willet 1998; Gibson 2005). However, to determine validity the second administration of the FFQ had to be used as it covered the same period the 24h recalls were carried out.

**6.2 Test-retest reliability**

**Differences between the mean**

According to Gibson (2005), no significant difference between group mean intakes of the two sets of FFQ data indicates agreement and thus reproducibility. The current results show that there are significant differences between administrations of the FFQ for fructose, glucose and total sugar, with the first administration of the FFQ consistently producing higher intake estimates of these sugars. This may be due to an intervention effect caused by the number of 24h recalls or the short spacing between the administrations of the FFQ (Gibson 2005). Firstly, the high number of 24h recalls in a short time period may have made the participants more aware of their food intake and thus influenced them to make “healthier choices”. These choices may have led participants to decrease their intake of sugar containing foods and/or beverages resulting in the second FFQ producing lower intake estimates (**Table 5.7**). Secondly, the short spacing between the FFQ administrations may have resulted in participants remembering and learning from completing FFQ1 (Gibson 2005; Gibson & Ferguson 2008). Due to the short time frame, it is unlikely that the effect of seasonal changes or food habits influenced these results (Gibson 2005). However, it could be that FFQ1 measured a month in which participants consumed a high intake of sugar-containing foods and beverages perhaps due to attending more special events or having more money to spend on food.
Intraclass correlation coefficients

Reliability of the FFQ was also assessed using intraclass correlation coefficients (ICCs). The ICCs were strong for fructose and moderate for glucose, sucrose and total sugars, demonstrating good overall agreement between the two sets of data (Gibson 2005). These results are comparable to other studies (Table 5.8), which used FFQ administration intervals ranging from two weeks to two years. The high ICCs in the present study may be due to the short time period between FFQ administrations as correlations are usually higher for repeat administrations one month or less apart compared with those administered up to a year apart (Cade 2002).

6.3 Study strengths and limitations

Self-administered FFQs are a cost-effective and practicable dietary assessment method to measure usual sugar intakes in large epidemiological studies as they are quick and easy to administer, code and analyse and they place less burden on participants than other methods.

A strength of the FFQ development is the use of the Pacific ANS data to establish common sugar containing foods consumed specifically in Pacific Islanders rather than the general population. The fact two versions (open- and closed-ended) of the FFQ were pretested and cognitive interviewing was used significantly strengthens the pretesting phase and implies the final FFQ was well suited to the Pukapuka Pacific Island population (Subar et al. 1995). In saying that, the FFQ was designed to be self-administered but some participants
required assistance from the interviewer. These participants tended to be older and thus English may have been their second language. In the future the FFQ would be best administered with interview assistance and possibly translating it to the Pukapukan language may be beneficial.

In the Pukapukan Kai FFQ, food and beverage photographs were used to act as a memory aid and a number of questions used photographs to quantify portion sizes—an approach many experts in the field promote (Cade 2002; Gibson 2005). Furthermore, the Pukapukan Kai FFQ only takes 15-25 minutes to complete which makes it more advantageous to use in epidemiological studies rather than dietary assessment methods such as diet records that take longer to complete.

After examining NZ national nutrition survey data for Pacific Island adults, conducting an environmental audit and pretesting the two versions of the FFQ with a small sample of Pukapukans, it was assumed that the FFQ captured all major sources of dietary fructose, glucose, sucrose and total sugar in this study population. However during the validation phase some minor limitations became apparent. It appeared that participants did not classify traditional Pacific Island desserts under the dessert category. Furthermore, the FFQ did not include a sugar-free energy drink item and consequently participants who frequently consumed these may have reported consuming regular (sugar-laden) energy drinks, resulting in the FFQ over-estimating sugar intake. Thompson and Subar (2008) recommend that if a FFQ is going to be used in an ethnic group, examination of food intake by means of diet recalls or records should be used to modify the food list prior to
validation. Due to the time constraints this was not feasible in the present study but may have alleviated certain drawbacks. Minor changes to the FFQ, such as adding a sugar-free energy drink item and including examples of Pacific Island desserts, could improve the instrument.

A strength of the validation study was the diversity of participants ranging in age from 18-60 years. However, the sample size was small and a more uniform distribution of males and females would strengthen the study as it would allow sex- and age group-specific tests of FFQ performance. Due to the small sample size, results may be a product of random error and the effect of between-subject variation on mean intakes could be large (Gibson & Ferguson 2008). As the participants in this study volunteered they may have been more motivated than the general study population, so they might provide more accurate responses (Gibson 2005). Furthermore, it would have been of interest to measure BMI in these participants. Underreporting is consistently associated with higher BMI and as more than half of NZ Pacific Islanders are obese (56.2% of Pacific males and 59.5% of Pacific females), there is a possibility that underreporting took place in this study (Macdiarmid & Blundell 1998; Gibson 2005; Ministry of Health 2012). A study investigating sugar and fat intake in Australia measured socially desirability bias using the Marlowe and Crown Social Desirability Scale (Francis & Stevenson 2013). Although they found their results were not affected by socially desirability bias, it may have been wise to assess this, as sugary food and beverage intakes are susceptible to social desirability bias (Gibson 2005).
In theory, the sources of error between the FFQ and reference method should be as unrelated as possible (Cade 2002). Both the 24h recall and FFQ rely on participants’ memory and perception of portion size (Gibson 2005). While the weighed diet record is considered the “gold standard” to evaluate the validity of a FFQ, it was considered inappropriate in this potentially low-literate Pacific Island population and thus multiple 24h recalls were deemed the most feasible method (Willet 1998; Bell et al. 1999; Cade 2002). Furthermore, 24h recalls have a tendency to underestimate actual intakes by about 10%, which may explain the slightly lower sugar intakes compared with the FFQ2 (Willet 1998). Therefore, the ability of the FFQ to adequately measure sugar intakes may be underestimated in this study.

6.4 Future Work

These preliminary results show that this FFQ can adequately estimate group mean intakes for fructose, glucose and total sugars and rank individuals according to their sugar intake; however, additional validation, especially against biomarkers, is necessary. These promising results indicate that this instrument could be used to examine the associations between sugar intake and health (specifically metabolic diseases) in Pukapuka Pacific Island adults living in South Auckland.

Increasing the sample size will minimize the effect of between-subject variation on the group mean intakes and decrease the likelihood of errors occurring due to chance (Gibson & Ferguson 2008). Extending the validation population to other Pacific Island groups could enable greater investigation of sugar intakes and health implications.
It would also be of benefit to validate the FFQ with a more direct measure of diet, namely, urinary and blood biomarkers. Biomarkers provide an estimate of dietary intake that is independent of the participant’s self-reported dietary intake. As sugar intake is affected by a social desirability bias and thus prone to underreporting, validation with biomarkers may be useful (Cade 2002; Rockett et al. 2007). Urinary sucrose and fructose can reflect usual intakes of sucrose, fructose and total sugar intake (Tasevska 2005; Bingham 2007).

Although biomarkers do not suffer from the same errors as dietary assessment methods, they do have limitations. They are generally expensive, invasive, highly specific and usually measure short-term rather than long-term intakes (Hedrick et al. 2012b).

Finally, a separate test-retest reliability study (independent of validation) should be conducted so the reference method cannot affect the results. While increasing the time period between administrations of the FFQ could decrease the likelihood of the second administration being influenced by the first (Gibson & Ferguson 2008), the instrument needs to measure a similar time period (the same previous month).

**6.5 Conclusion**

The present study provides initial evidence that the 33-item, self-administered, semi-quantitative Pukapukan Kai FFQ adequately estimates group mean intakes for fructose, glucose and total sugars and ranks individuals according to their sugars intakes when compared with an appropriate dietary assessment reference method. The FFQ has the capability to rank individuals by sugar intakes, which permits the calculation of the relative risk of disease in relation to sugar intake (Gibson 2005). However, the instrument cannot be used in the clinical domain to estimate an individual’s intake of sugars.
The Pukapukan Kai FFQ offers an easy, quick and cost-effective method for measuring sugar intakes in Pukapuka Pacific Island adults living in South Auckland, NZ. If satisfactory results are obtained from ongoing validation work, then this instrument could be used in large-scale epidemiological studies to investigate the association between sugars intake and metabolic diseases in Pacific Island adults. Ultimately, these studies could inform public health recommendations on sugars intakes for Pacific Island adults.
7. Application to Practice

The present study shows that the Pukapukan Kai FFQ can be used to estimate group mean intakes for fructose, glucose and total sugars and to rank Pukapuka Pacific Island adults according to their sugar intakes. There are major inequalities between Pacific people and other New Zealanders in terms of the prevalence of gout, type 2 diabetes and hypertension. This tool will enable researchers to determine whether sugars intakes, particularly fructose, are associated with these health inequalities. More robust evidence on sugar intakes and health implications can inform public health nutrition recommendations on sugar intakes, and if the evidence supports it, the evidence can be used to advocate for public health policies and interventions aiming to reduce sugar intakes (Johnson 2008; Statistics New Zealand & Ministry of Pacific Island Affairs 2011). Public health dietitians may be involved in generating and implementing sugar reduction policies, designing and implementing interventions, and working with communities to decrease their sugar intakes.
8. References


Crutchley P (forthcoming). 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. Master of Science, University of Otago.


Gibson RS & Ferguson EL (2008). *An interactive 24-hour recall for assessing the adequacy of iron and zinc intakes in developing countries*. Washington, DC and California: IFPRI and CIAT.


## 8. Appendices

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Appendix A: Human ethics application form and approval letter

HUMAN ETHICS APPLICATION: CATEGORY B
(Departmental Approval)

1. University of Otago staff member responsible for project:
   
   Te Morenga Lisa, Dr

2. Department: Human Nutrition

3. Contact details of staff member responsible:
   
   office: 479-3978
   
lisa.temorenga@otago.ac.nz

4. Title of project: Development and validation of a sugar screener for Pacific adults living in Auckland

5. Indicate type of project and names of other investigators and students:

<table>
<thead>
<tr>
<th>Staff Research</th>
<th>Names</th>
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<tbody>
<tr>
<td>X</td>
<td>Lisa Te Morenga</td>
</tr>
<tr>
<td></td>
<td>Louise Mainvil</td>
</tr>
<tr>
<td></td>
<td>Tony Merriman (Biochem)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student Research</th>
<th>Names</th>
</tr>
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<tbody>
<tr>
<td>X</td>
<td>Petra Teufl</td>
</tr>
<tr>
<td></td>
<td>M.Diet</td>
</tr>
</tbody>
</table>

   Level of Study (e.g. PhD, Masters, Hons)

6. When will recruitment and data collection commence?

   11 February 2013

   When will data collection be completed?

   1 July 2013

7. Brief description in lay terms of the aim of the project, and outline of research questions (approx. 200 words):

59
Western diets contain increasing amounts of added sugars from sweetened foods and sugary drinks. Excessive fructose (a sugar that is found in sweetened foods, drinks and fruits) consumption may be linked to the increasing prevalence of diseases such as diabetes, obesity, gout and cardiovascular disease. However intakes of dietary sugars (like fructose) are difficult to measure reliably and are typically under-reported, particularly in low-income populations. Thus it is difficult to determine with any certainty whether excessive sugars intakes are responsible for these diseases, and to justify public health recommendations to limit sugars intakes. This research aims to develop, pre-test and validate dietary a brief assessment instrument for assessing sugars intakes in a Pacific population living in Auckland (primarily Pukapuka Cook Islanders) We will validate the instrument by comparing the estimates of sugars intakes derived from it with usual sugars intakes measured by collection of three 24hr dietary recall interviews conducted approximately weekly over a one month period. We consider the 24hr recall method to be the best method for assessing usual dietary intakes in (potentially) low literacy populations but is time consuming and requires trained nutritionists/dietitians to administer. The intention for the instrument is that it will used to measure sugars intakes in large population studies, thus facilitating future research to examine the effect of sugars on health risks and interactions between sugar consumption and genes. This will contribute to our understanding of the role of sugar in the development of gout, diabetes and cardiovascular disease in Pacific people.

8. **Brief description of the method.** Please include a description of who the participants are, how the participants will be recruited, and what they will be asked to do:-

Volunteers for this study will be recruited from the Pukapukan community based in Mangere, Auckland via contacts with Nuku Rapana, President of the Pukapuka Island Community Inc.

Initial qualitative interviews will be conducted with 5-10 Pukapukan adults examining responses and interpretation to an existing sugar intake questionnaire designed to assess sugars intakes over the previous month (developed as a sugar intake screener for the DRINKS study). During the interview volunteers will be asked to complete the sugars FFQ while verbalising their understanding of the questionnaire. The student will take written notes reflecting these verbal responses and, if the volunteer agrees, will make an audio recording. The questionnaire will be adapted and refined on the basis of these interviews.

To validate the accuracy and reproducibility of the sugar intake questionnaire we will recruit up to 30 adults volunteers (aged 18 – 65) to participate in 4 x 1.5 hour interviews conducted approximately one week apart over a 4 week period.

At the first interview the student will establish relationships and rapport with the volunteer. Once the volunteer is comfortable and has been informed of the intention and requirements of the study and has agreed to participate they will be asked to complete the sugars FFQ. Following completion of the FFQ the student dietitian will collect a 24hr dietary recall capturing everything eaten and drunk during the previous 24 hours following a standard 3-pass recall method. At the 2nd and 3rd interviews the student will collect a 24hr recall only. At the final interview the student will administer the sugar intake questionnaire only.

Interviews will be held in the participants home where possible which provides the opportunity for the interviewer to verify typical serving sizes, preparation methods and foods consumed, or at the Pukapuka Community Centre (23 Canning Cres, Mangere). The student has read the University of Otago guidelines on conducting research with Pacific peoples and will endeavour to adhere to culturally appropriate practices during all interviews. A community research assistant, Terito Ine, will act assist the student at early visits to establish relationships with volunteers in a culturally appropriate way.

Volunteers will receive a $10 supermarket voucher at the completion of each interview.
Reproducibility of the sugar questionnaire will be assessed by examining the correlation between sugars estimates derived from the questionnaires completed in weeks one and week. Validity will be assessed by examining the correlation between sugars estimates derived from the sugar questionnaire completed in week 4 and the mean usual sugars intakes estimated from the 24hr recalls.

9. **Please disclose and discuss any potential problems:** (For example: medical/legal problems, issues with disclosure, conflict of interest, etc)

If participants are to be interviewed in their own home measures to ensure the student’s safety during visits to volunteers homes will include pre and post interview contact with the supervising investigators (LTM and LM) and the maintenance of a detailed online visit diary (Google calendar). The student will not be expected to conduct any interview where they do not feel safe.

***Applicant's Signature:* ...............................................................

*Principal Applicant: as specified in Question 1, Must not be in the name of a student*

*Signature of *Head of Department:* ...............................................................

**Name of Signatory (please print):** ...............................................................

**Date:** ..................................................................................

**Departmental approval:** I have read this application and believe it to be scientifically and ethically sound. I approve the research design. The Research proposed in this application is compatible with the University of Otago policies and I give my consent for the application to be forwarded to the University of Otago Human Ethics Committee.

IMPORTANT: The completed form, **together with copies of any Information Sheet, Consent Form and any recruitment advertisement for participants**, should be forwarded to the Manager Academic Committees or the Academic Committees Assistant, Registry, **as soon as the proposal has been considered and signed at departmental level**. Forms can be sent hardcopy to Academic Committees, Room G23 or G24, Ground Floor, Clocktower Building, or scanned and emailed to gary.witte@otago.ac.nz
Notes concerning Category B Reporting Sheets

1. This form should **only be used** for proposals which are **Category B** as defined in the policy document "Policy on ethical practices in research and teaching involving human participants", and which may therefore be properly considered and approved at departmental level;

2. A proposal can only be classified as Category B if **NONE** of the following is involved:-
   - Personal information - any information about an individual who may be identifiable from the data once it has been recorded in some lasting and usable format, or from any completed research;
     *(Note: this does not include information such as names, addresses, telephone numbers, or other contact details needed for a limited time for practical purposes but which is unlinked to research data and destroyed once the details are no longer needed)*
   - The taking or handling of any form of tissue or fluid sample from humans or cadavers;
   - Any form of physical or psychological stress;
   - Situations which might place the safety of participants or researchers at any risk;
   - The administration or restriction of food, fluid or a drug to a participant;
   - A potential conflict between the applicant’s activities as a researcher, clinician or teacher and their interests as a professional or private individual;
   - The participation of minors or other vulnerable individuals;
   - Any form of deception which might threaten an individual's emotional or psychological well-being.
   - The research is being undertaken overseas by students.

   [If any of the above is involved, then the proposal is Category A, and must be submitted in full to the University of Otago Human Ethics Committee using the standard Category A application form, and before the teaching or research commences];

3. Please ensure the Consent Form, Information Sheet and Advertisement have been carefully proofread; the institution as a whole is likely to be judged by them;

4. A Category B proposal may commence as soon as departmental approval has been obtained. No correspondence will be received back from the University of Otago Human Ethics Committee concerning this Reporting Sheet **unless the Committee has concerns**;

5. Please submit a Category B Reporting Sheet immediately after it has been signed by the Head of Department to the Human Ethics Committee:
   **Manager,**
   **Academic Committees**
   **Academic Services**
   **Room G23, Clocktower Building**
   **University of Otago**
   [gary.witte@otago.ac.nz](mailto:gary.witte@otago.ac.nz)
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 it’s 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 B: Pukapukan Kai study consent form

Development and validation of a sugar screener for Pacific 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 C: The Pukapukan Kai FFQ

The Pukapukan Kai Study

We would like to learn more about Pukapukan eating patterns in New Zealand.

How can you help?

• Please tell us about YOU (not someone else in your household)
• Please be honest
• Answer each question as best as you can
• Tick or fill in ONE answer for EACH question
  (Erase or scribble out mistakes)

Atawai wolo (thank you very much) for helping us with this important project!

Subject ID: __________
Date completed QFFQ-2: __________
INSTRUCTIONS: This is how you answer the questions

Ke Ola, Ko Pewea Koe,
I am Tere and over the past month I usually drunk water 4 times a day. I have about a cup each time!

*Tere writes:
Over the past month, on average, how often do you drink water?
☐ never (go to next question)
☐ 4 times a day
☐ times a week
☐ times a month

How much do you usually have each time?
☐ 1 cup OR
☐ ___ ml OR
☐ ___ litre

PLEASE NOTE: Each item has 2 questions:
• “how often”
• “how much”
These photos may help you estimate **how much** you usually drink:

1 cup = 250ml
1. On average, **how often** do you drink **fruit DRINK** (NOT 100% fruit juice) (eg. Golden Circle, Thextons, Ribena)?

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

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

2. On average, **how often** do you drink **100% fruit JUICE** (no added sugar) (eg. Just Juice, Fresh-Up)?

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

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

3. On average, **how often** do you drink **low-calorie cordial** (eg. Thriftee, Vitafresh Low Calorie)?

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

   **How much** do you usually drink each time?
   - ____ cup OR
   - ____ ml OR
   - ____ litre
4. On average, how often do you drink regular cordial (eg. Raro, Refresh, Vitafresh)?

☐ never (go to next question)
☐ times a day
☐ times a week
☐ times 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) OR  ____ ml OR  ____ litre

5. On average, how often do you drink diet soft drink (eg. Coke Zero, Diet lemonade)?

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

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

6. On average, how often do you drink regular soft drink (eg. Coke, Lemonade)?

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

How much do you usually drink each time?  ____ cup OR  ____ ml (more photos on page 3) OR  ____ litre
Think about your *usual* drinking pattern *over the past month*…

7. On average, **how often** do you drink **sports drink** (eg. Gatorade, Powerade)?
   - ☐ never (go to next question)
   - ☐ times a day
   - ☐ times a week
   - ☐ times a month

   **How much** do you usually drink **each time**?
   - ___ cup OR
   - ___ ml OR
   - ___ litre

8. On average, **how often** do you drink **energy drink** (eg. V, Red Bull, Mother)?
   - ☐ never (go to next question)
   - ☐ times a day
   - ☐ times a week
   - ☐ times a month

   **How much** do you usually drink **each time**?
   - ___ small can (250 ml) OR
   - ___ medium can or bottle (350 ml) OR
   - ___ large can (500 ml)

9. On average, **how often** do you drink **flavoured milk** (eg. Primo, Calci Yum, bought milkshake)?
   - ☐ never (go to next question)
   - ☐ times a day
   - ☐ times a week
   - ☐ times a month

   **How much** do you usually drink **each time**?
   - ___ cup OR
   - ___ ml OR
   - ___ litre
Think about your usual drinking pattern over the past month…

For the following questions, this photo may help you estimate how much you usually drink:

![Photo of different drink containers with volumes]

10. On average, how often do you drink beer, lager or cider?
   - ☐ never (go to next question)
   - ☐ times a day
   - ☐ times a week
   - ☐ times a month

   How much do you usually drink each time?  
   - ____ bottle (330ml) OR
   - ____ can (355 ml) OR
   - ____ large bottle (745 ml) OR
   - ____ pint or handle (400 ml) OR
   - ____ jug (1000 ml) = 1 litre OR
   - ____ ml (photos above)

11. On average, how often do you drink wine (red, white or sparkling)?
   - ☐ never (go to next question)
   - ☐ times a day
   - ☐ times a week
   - ☐ times a month

   How much do you usually drink each time?  
   - ____ wine glass (photo above) (150ml) OR
   - ____ wine bottle (750ml) OR
   - ____ ml
Think about your *usual* drinking pattern *over the past month*…

12. On average, **how often** do you drink port, sherry, vermouth or liqueurs?

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

**How much** do you usually drink **each time**?
☐ small sherry glass (60ml) OR
☐ wine glass (150ml) (photo on page 7) OR
☐ ml

13. On average, **how often** do you drink straight spirits (*no mixer*) (eg. gin, whisky, vodka, rum)?

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

**How much** do you usually drink **each time**?
☐ nip (30ml) OR
☐ double nip (60ml) OR
☐ ml

14. 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
☐ times a week
☐ times a month

**How much** do you usually drink **each time**?
☐ spirit glass (150ml) with 1 nip
☐ spirit glass (150ml) with 2 nips OR
☐ tall glass (200ml) with 1 nip OR
☐ tall glass (200ml) with 2 nips OR
☐ small bottle (330ml) (photo on page 7)
15. On average, **how often** do you add **sugar** or **honey** to your tea or coffee?

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

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

___ teaspoon  OR  ___ big spoon

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

[Level](#)  [Rounded](#)  [Heaped](#)

16. On average, **how often** do you add **sugar** or **honey** to your Milo, hot water or other drinks?

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

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

___ teaspoon  OR  ___ big spoon

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

[Level](#)  [Rounded](#)  [Heaped](#)
Think about your *usual* eating pattern *over the past month*…

17. On average, **how often** do you add Milo, powder drinking chocolate or other milk mix to your drinks?

- [ ] never (go to next question)
- [ ] times a day
- [ ] times a week
- [ ] times a month

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

- [ ] teaspoon
- [ ] big spoon

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

- level
- rounded
- heaped

18. On average, **how often** do you eat jam, honey, syrup, chutney or Nutella on your bread?

- [ ] never (go to next question)
- [ ] times a day
- [ ] times a week
- [ ] times a month

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

- [ ] slices

**How much** do you usually eat on **each slice**? (please circle ONE)

- Photo A
- Photo B
- Photo C
19. On average, how often do you eat tomato sauce on your food?

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

**How much** do you usually add each time?  
____ teaspoon OR  
____ big spoon OR  
____ ml

20. On average, how often do you eat dried fruit (eg. raisins, sultanas, prunes)?

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

**How much** do you usually eat each time?  
____ cup OR  
____ level handful (1/2 cup)

21. On average, how often do you eat canned fruit, stewed fruit or baked fruit?

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

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

22. On average, how often do you eat fresh raw fruit (eg. apple, banana, orange, pear, grapes)?

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

**How much** do you usually eat each time?  
____ whole piece of fruit OR  
____ cup
Think about your usual eating pattern over the past month…

23. On average, how often do you eat yoghurt, dairy food, milk pudding, mousse or custard?

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

How much do you usually eat each time?  

___ pottle (1/2 cup) OR  
___ cup

24. On average, how often do you eat ice cream, ice blocks, jelly or frozen yoghurt?

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

How much do you usually eat each time?  

___ Photo A OR  
___ Photo B OR  
___ Photo C OR  
___ ice block

25. On average, how often do you put sugar, jam, honey, syrup or sweet sauce on other foods (like cereal, pancakes or ice cream)?

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

How much do you usually add each time?  

___ teaspoon OR  
___ big spoon OR  
___ ml
26. On average, **how often** do you eat **breakfast cereals**?

☐ never (go to next question)

☐ times a day

☐ times a week

☐ times a month

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

☐ Weetbix

☐ Cornflakes

☐ Ricies

☐ Coco pops

☐ Nutra-grain

☐ Porridge

☐ Other: ____________________________

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

____ Photo A  OR

____ Photo B  OR

____ Photo C  OR

____ weetbix

27. On average, **how often** do you eat **muesli bars, cereal bars or nut bars**?

☐ never (go to next question)

☐ times a day

☐ times a week

☐ times a month

**How much** do you usually eat **each time**?  ____ bar  OR  ____ grams

28. On average, **how often** do you eat **chocolate biscuits** (eg. Tim Tam, Toffee Pop) or **cream-filled sweet biscuits** (eg. Cameo cream)?

☐ never (go to next question)

☐ times a day

☐ times a week

☐ times a month

**How much** do you usually eat **each time**?  ____ biscuit  OR  ____ packet (~200 gm)
Think about your usual eating pattern over the past month…

29. On average, how often do you eat other sweet biscuits (eg. wine biscuits, gingernuts)?
   - never (go to next question)
   - times a day
   - times a week
   - times a month

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

30. On average, how often do you eat sweet buns, iced buns, doughnuts or pastries?
   - never (go to next question)
   - times a day
   - times a week
   - times a month

   How much do you usually eat each time?  
   ___ doughnut / bun / pastry

31. On average, how often do you eat cake, sponge, muffins or baked pudding?
   - never (go to next question)
   - times a day
   - times a week
   - times a month

   How much do you usually eat each time?  
   ___ Photo A  OR  
   ___ Photo B  OR  
   ___ Photo C  OR  
   ___ grams
32. On average, **how often** do you eat **lollies** (eg. jet planes, mints, toffees, liquorice)?

- [ ] never (go to next question)
- [ ] times a day
- [ ] times a week
- [ ] times a month

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

- [ ] lollies OR
- [ ] family pack (150-200 gm)

33. On average, **how often** do you eat **chocolate** or **chocolate bars** (eg. Moro, Crunchie)?

- [ ] never (go to next question)
- [ ] times a day
- [ ] times a week
- [ ] times a month

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

- [ ] square
- [ ] grams (gm)

- 45 gm
- 50 gm
- 100 gm
- 200 gm
- 350 gm
34. Have you **changed your diet** in the past 30 days?

☐ No  (go to next question)

☐ Yes

**How** has it changed? (tick all that apply)

- O I eat less food.
- O I eat more food.
- O I eat less sugar.
- O I eat more sugar.
- O I eat less fat.
- O I eat more fat.
- O I eat less fruit.
- O I eat more fruit.
- O I drink less fruit juice.
- O I drink more fruit juice.
- O I drink fewer sugary drinks.
- O I drink more diet drinks.
- O I drink less alcohol.
- O I drink more alcohol.
- O Other: __________________________________________

35. Have you **lost weight** in the past 30 days?

☐ No

☐ Yes

________________________________________________________________________________________

**THE END**

Please check every page to see if you have answered every question

Atawai wolo (thank you very much) for helping us with this important project!
Appendix D: Pukapukan Kai study information sheet

Validation of a sugar screener for Pacific 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 Pacific 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 Pacific volunteers 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 the interviews to take place at the Pukapuka Community Centre in Canning Cres. At the first interview 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 Pacific 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:

*Petra Teufl* and/or *Dr. Lisa Te Morenga*  
Department of Human Nutrition  
0212343157  
petra_teufl@hotmail.com

Department of Human Nutrition  
021 0427 283  
lisa.temorenga@otago.ac.nz

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.
Appendix E: Pukapukan Kai study demographic questionnaire

A few questions about yourself

1. Are you?
   ○ Male       ○ Female

2. What is your age: _____ years old

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)_______________________

7. How many adults (18+ years old) do you live with? _____

   *Age of children:*
   □ 0-5 years    □ 6-10 years    □ 11-15 years  □ 16+ years

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!

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Appendix F: Pukapukan Kai study 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 (please circle):

At home / Pukapuka community centre

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 G: FFQ sugar calculation Microsoft Excel template

<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/cup/piece</th>
<th>Amount each time (g)</th>
<th>freq*amount</th>
<th>Sugar Content per 100 g</th>
<th>Fructose content per 100g</th>
<th>Sucrose content per 100g</th>
<th>Glucose content per 100g</th>
<th>Total Sugar</th>
<th>Fructose g</th>
<th>Sucrose g</th>
<th>Glucose g</th>
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<tbody>
<tr>
<td>01. Fruit drink</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>4.4</td>
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<td>08. Energy drink</td>
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<td>8.7</td>
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<td>5.1</td>
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<td>09. Flavoured milk</td>
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<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
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<td>10. Beer, lager, stout</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.6</td>
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<td>11. Wine</td>
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<td>0.2</td>
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<td>12. Port, sherry etc</td>
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<td></td>
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<td>0</td>
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<td>13. Straight spirit</td>
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<td>14. Spirit with mixer</td>
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<td>15. Milk to tea/coffee</td>
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<td>0</td>
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<td>16. Milk to milk etc</td>
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<td>17. Milk etc</td>
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<td>19. Tomato sauce</td>
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<td>22. Raw fruit piece</td>
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<td>23. Raw fruit cap</td>
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<td>25. Ice cream etc</td>
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<td>26. Ice block</td>
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<td>0</td>
<td>94.6</td>
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<td>27. Slab consult</td>
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<td></td>
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<td></td>
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<tr>
<td>28. Waffle</td>
<td></td>
<td></td>
<td></td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>1.75</td>
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<td>0.0</td>
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<tr>
<td>29. Cereal bars</td>
<td></td>
<td></td>
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<td>0</td>
<td>36.48</td>
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<tr>
<td>30. Carob flakes</td>
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<td></td>
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<td>1.7</td>
<td>5.6</td>
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<tr>
<td>31. Nuts grain</td>
<td></td>
<td></td>
<td></td>
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<td>0</td>
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<tr>
<td>32. Rice</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>0</td>
<td>0</td>
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<td>0.0</td>
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<tr>
<td>33. Porridge prepared with h20</td>
<td></td>
<td></td>
<td></td>
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<td>0</td>
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</tr>
<tr>
<td>34. Muesli bar etc</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>0</td>
<td>0</td>
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