

The Māori Kai semi-quantitative food frequency questionnaire:
relative validity and reliability for assessing usual sugar intakes in
New Zealand East Coast Māori

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Abstract

Background: The rising prevalence of non-communicable diseases (NCDs) such as obesity, diabetes, cardiovascular disease and gout is contributing to global socioeconomic burden. In order to address this issue, the risk factors associated with NCDs need to be identified. Free dietary sugars, and in particular fructose, have been linked to unfavourable metabolic changes associated with these diseases. As New Zealand (NZ) Māori have higher rates of NCDs versus non-Māori, it is of interest to investigate the extent to which dietary sugars intakes might be an explanatory factor. To determine whether sugars intakes influence NCD risk amongst Māori there is a need to develop a culturally-appropriate dietary assessment tool for assessing sugars intakes that is both valid and reliable.

Objective: To assess the relative validity and reliability of a culturally appropriate, semi-quantitative food frequency questionnaire (FFQ) intended to measure usual intakes of fructose, glucose, sucrose and total sugars in a Māori adult population.

Design: A 33-item FFQ, designed and pretested in Māori adults residing in Gisborne, NZ was used to determine usual sugar intakes over a one month period. FFQ items comprised of important sugary food and drink sources consumed in the target population. The FFQ was validated by comparison with dietary intake data collected through repeat-24 hour recalls (n=3) and reliability measured through re-administration of the tool at a one month interval. 72 Māori adults (24 men and 48 women) provided three 24-hour diet records and completed two administrations of the FFQ and were included in the analyses. Reliability of the FFQ was assessed by cross-classification agreement with weighted Kappa scores, and Spearman correlation coefficients. Mean sugars intakes were evaluated as group means using paired-t tests, and the strength of agreement between the two dietary assessment methods was assessed by the Bland-Altman method. Reliability of the FFQ was assessed by intraclass correlation coefficients.

Results: 95% to 97% of participants were classified in the same or adjacent quartiles for all sugars intakes with weighted Kappa scores indicating excellent ability for the FFQ to rank individuals. Cross-classification agreement was even stronger for sugars intakes from non-alcoholic beverages. Mean sugars intakes corresponded well between the FFQ and repeat-24 hour recalls for fructose, glucose and total sugars, but sucrose was significantly different ($P<0.05$). Bland-Altman analyses showed good agreement between the tools for all sugars except sucrose which was overestimated by 12-51% by the FFQ. Intraclass correlation coefficients from re-administration of the FFQ showed excellent reproducibility for total sugars and sucrose (>0.75).

Conclusion: Overall, the Māori Kai FFQ provided repeatable measurements of sugars intakes with good validity, and was able to correctly rank individuals by intake quartiles. Advantages of our FFQ lie in its relatively low response burden, ease of administration, cost effectiveness and cultural appropriateness for use on Māori in epidemiological research. Prospective validation of the FFQ with anthropometric and biochemical markers will provide a means for exploring the diet-disease relationship of sugar.

Keywords: Food frequency questionnaire; Validity; Reliability; Dietary assessment; Māori; Sugar

Preface

This validation and reliability study was completed as part of a wider project aiming to develop and validate a semi-quantitative food frequency questionnaire (FFQ) assessing sugars intake in a Māori adult population. The FFQ is intended for use in the ‘Gout and Co-morbidities’ research led by Associate Professor Tony Merriman, as well as other future research projects involving Māori populations.

The original 33 item-FFQ was developed by Dr Louise Mainvil and pretested and adapted based on user feedback to the final version by another MDiet student, Hannah Walter. Assessment of the relative validity and reliability of the FFQ was performed in the period of March to September of 2013 by Hannah Walter (March to May) and myself (July to September). Data collection was conducted in Gisborne, New Zealand. Dr Lisa Te Morenga and Dr Louise Mainvil designed the validation study which included evaluation of the short-FFQ against repeat 24-hour recalls and re-administration of the short-FFQ one month apart to assess reliability. Dr Lisa Te Morenga provided me with primary supervision throughout the duration of the research project and conducted the statistical analysis.

Further validation of the short-FFQ through anthropometric and biochemical indices is anticipated to be concluded by mid-2014 by another MDiet candidate.

My roles in this research included the following:

- Recruited 37 participants in the Gisborne region through word-of-mouth, face-to-face contact, flyers, posters and GP practices.
- Was responsible for co-ordinating 37 participants to attend four interviews each, which included home and work visits, phone calls and text and email reminders about appointments.

- Conducted 148 interviews, which comprised of gaining participant consent, gathering contact and demographic information, administering the two versions of the FFQ and performing repeat 24-hour recalls.
- Visited the supermarket on a weekly basis to arrange grocery vouchers as koha for participants.
- Completed data entry of 111 days of 24-hour diet recall data into Kai-culator and data from 74 completed FFQs into a pre-developed Microsoft Excel spreadsheet.
- Developed a macro in Microsoft Excel to separate and extract sugar intakes from food groups (specifically non-alcoholic beverages and fruit) from 216 24-hour dietary recalls for analysis.
- Double checked all 24-hour diet recall and FFQ data.
- Performed logarithmic transformations on sugars intakes and categorised intakes into quartiles to prepare data for statistical software.
- Back-transformed values from statistical output and interpreted findings presented as intraclass correlation coefficients, Spearman's rank correlation coefficients, paired t-tests, cross-classification analyses with weighted kappa scores and Bland-Altman analyses.
- Liaised with the Māori health provider Ngati Porou Hauora to organise future research and trained the 'Gout and co-morbidities' study nurse to use the short-FFQ.

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To Mum, if motherhood reaped fame, you would be the Beyoncé in my life. Thanks for being my inspiration, my idol and my muse to strive to be the best me.

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List of Abbreviations

Abbreviation	Meaning
95%C.I.	95 percent confidence interval
Apo-B	Apolipoprotein-B
ANS08/09	Adult Nutrition Survey 2008/2009
BGL	Blood glucose levels
BMI	Body mass index
CVD	Cardiovascular disease
FFQ	Food frequency questionnaire
FFQ1	Food frequency questionnaire first administration
FFQ2	Food frequency questionnaire second administration
g	grams
HDL-C	High-density lipoprotein cholesterol
HFCS	High fructose corn syrup
K _w	Weighted Kappa statistic
LDL-C	Low density lipoprotein cholesterol
MetS	Metabolic syndrome
MDiet	Master of Dietetics
NAB	Non-alcoholic beverages
NCD	Non-communicable disease
NHANES	National Health and Nutrition Examination Survey
NO	Nitric oxide
NZ	New Zealand
RCT	Randomized controlled trial
SES	Socio-economic status
SSB	Sugar sweetened beverages
SSSD	Sucrose-sweetened soft drink
T2DM	Type-two diabetes mellitus
UK	United Kingdom
US	United States
USDA	United States Department of Agriculture
WHO	World Health Organisation

1. Introduction

Comparing Māori with non-Māori New Zealanders, it is evident that the two groups are differentially affected by obesity and preventable lifestyle diseases including obesity, type-two diabetes mellitus (T2DM), gout and cardiovascular disease (CVD). Māori have a markedly higher prevalence of these conditions, and pronounced inequalities in health outcomes.

Māori men are 1.7 times more likely and Māori women twice as likely to be obese than non-Māori men and women (University of Otago and Ministry of Health, 2011a). Diabetes and ischaemic heart disease are among the top five major causes of death for Māori (Ministry of Health, 2012b). Close to one in ten Māori suffer from diabetes, with one in five remaining undiagnosed (University of Otago and Ministry of Health, 2011a). Raised blood pressure, a significant contributor of CVD, is more prevalent in Māori than non-Māori. Another predictor for CVD is the ratio of total to high-density lipoprotein cholesterol (HDL-C), with <4.5 defined for optimal health. 37% of Māori men and 17% of Māori women exceed this cut-off, indicating that a large proportion of the Māori population are at increased CVD risk (University of Otago and Ministry of Health, 2011a). In rural settings, Māori are affected to an even greater degree by diet-related metabolic disease than their urban equivalents (Cameron et al., 2012). Cameron et al. (2012) found Māori based in rural areas to have higher rates of obesity, hypertension, dyslipidaemia, hyperuricaemia and T2DM. Considering this, one can see the necessity of discovering and controlling the modifiable risk factors for these diseases.

Diet, as a risk factor, comes under inspection for its association with disease. As certain diseases, such as CVD, have the potential to be largely reversed or managed through dietary changes, then finding strong evidence of diet-health relationships is invaluable to providing adequate healthcare for those afflicted by them.

Controversially, sugar has been highlighted as a prominent risk factor for these metabolic diseases (R. J. Johnson et al., 2009). In contrast, the global sugar industry, who is estimated to produce 175 million metric tons over 2013/2014 (United States Department of Agriculture & Foreign Agricultural Service, November 2013) contests this association, producing their own research to prove otherwise (Ruxton, Gardner, & McNulty, 2010). This highlights the need for good research into sugar to be done.

Population sugar intakes in New Zealand (NZ) can be gauged from the latest Adult Nutrition Survey 2008/09 (University of Otago and Ministry of Health, 2011a). Mean daily intakes of different types of sugars, as well as sugary foods and beverages, are reported for the population as a whole and by ethnic group, gender and age-class. In comparison with NZ European men and women, Māori men and women tended to report higher intakes of total sugars and sucrose and lower intakes of fructose. However, the intake of sugars is difficult to record, with under-reporting common in overweight/obese individuals as the intake of high-sugar foods is viewed as socially undesirable (Livingstone & Black, 2003). Further, assessing sugar intake in groups of low literacy and numeracy can also prove challenging, especially if the assessment is left to self-reporting (Johnson, Soultanakis, & Matthews, 1998).

For these reasons, the development of a culturally-appropriate dietary assessment tool will be the initial step in measuring sugar consumption in our Māori population. Additionally, assessment of the tool's relative validity and reliability is crucial to ensuring it will accurately and precisely measure sugar intakes. Ensuing this, exploring the link between sugars consumption and biomarkers may leave vital clues to their relationship with disease.

2. Literature Review

This literature review endeavours to explore the scope of research conducted to date that investigates sugar, in its various forms, and its metabolic effect. Delving into this background is critical in raising awareness of the significance of developing and validating a dietary assessment tool that reliably measures sugars intakes in Māori. Research was sourced from the article databases Medline (via Ovid SP), Scopus, Science Direct and Google Scholar, in addition to searching references lists from applicable studies. Key search terms include “fructose”, “sugars”, “metabolic disease”, “gout”, “type two diabetes mellitus”, “cardiovascular disease”, “obesity”, “food frequency questionnaire”, “validation”, “reliability”.

2.1 Sugar

2.1.1 Definition and sources

A fundamental problem with analysing evidence surrounding sugar intakes is the discrepancy in its definition. Over time, sugar terminology has changed, enabling the food industry to add sugar to foods without explicitly claiming to do so. For example, using the sugar found in fruit purees to sweeten foods to preserve claims of ‘no added sugar’. For the purpose of our research, the definition for free sugars will be used i.e. “monosaccharides and disaccharides added to food by the manufacturer, cook and consumer, plus sugars naturally present in honey, syrups and fruit juices” (Huaidong, 2010; van Dam & Seidell, 2007; WHO & FAO, 2003). Therefore, sugars can be additions introduced to foods already produced such as sugar added to tea or maple syrup to porridge, or those manufactured in by the food company such as high fructose corn syrup (HFCS) and honey. An extensive list of free sugars would also include corn syrup, corn syrup solids, malt syrup, sweetener, liquid fructose, anhydrous dextrose and crystal dextrose (Sigman-Grant & Morita, 2003).

The monosaccharide fructose is a frequent component of these free sugars with its largest dietary sources deriving from table sugar or sucrose and HFCS (primarily in North

America) (R. J. Johnson et al., 2009; Park & Yetley, 1993). In nature, fructose exists in fruits and honey. Most major epidemiological studies examining the effects of sugars on cardiometabolic risk factors come from the US, where HFCS is the major sweetener (H. K. Choi & Curhan, 2008; H. K. Choi, Willett, & Curhan, 2010; de Koning et al., 2012; de Koning, Malik, Rimm, Willett, & Hu, 2011; Schulze et al., 2004). However, there is no evidence that the effects of sugars would be different in other countries, such as Europe and Australia, where sucrose is the predominant sweetener (Cook, Rutishauser, & Seelig, 2001; Dubuisson et al., 2010; Pietinen, Paturi, Reinivuo, Tapanainen, & Valsta, 2010). Sucrose, a disaccharide originating from sugar cane and sugar beet, is metabolised to its component sugars glucose and fructose in the body (R. J. Johnson et al., 2009). In NZ, fruits, sucrose, confectionary and sugar-sweetened soft drinks are all prevailing sources of fructose (University of Otago and Ministry of Health, 2011a).

2.1.2 Assessing intakes

Food frequency questionnaires (FFQ) are assessment tools used frequently in epidemiological research to measure habitual dietary patterns and intakes of individuals and groups (Gibson, 2005; W. Willett, 1998). To reflect this habitual intake, FFQ are designed to investigate nutrient intakes over a long period of time, for example, the previous year. However sugars intakes are relatively stable over time (Goldbohm et al., 1995) and a one month FFQ would be appropriate for gathering estimates of usual sugar intakes as well as improving memory recall with the shorter timeframe. Other advantages of using FFQs include their relatively low response burden, ease of administration and low cost (Gibson, 2005; W. Willett, 1998). Furthermore, FFQ that are designed to be population specific ensure foods and drinks commonly consumed by the target group are detailed in the questionnaire, therefore increasing overall accuracy of the FFQ (Gibson, 2005; W. Willett, 1998). Developing a population-specific FFQ for Māori adults is fundamental to identifying both traditional and commonly consumed foods that are high in sugar and would contribute to overall validation

of the FFQ. Dietary sugars intakes estimated from validated FFQs, in conjunction with metabolic indices, can provide evidence of an association between sugar intakes and the risk factors for disease (Gibson, 2005; W. Willett, 1998).

As a dietary assessment tool, FFQ require quality evaluation with respect to reproducibility and validity (J. E. Cade, Burley, Warm, Thompson, and Margetts (2004)). Reproducibility ensures the FFQ is precise and therefore has consistency in measurements when re-administered as long as re-administration occurs within a time interval where dietary pattern is unlikely to experience a considerable change (Gibson, 2005). To assess the validity of an FFQ, a more reliable dietary assessment tool and/or anthropometric and biochemical markers can be used as reference standards against which the FFQ's performance is compared. Three to seven day weighed diet records are typically used as a gold-standard reference method (Gibson, 2005), however these require a high level of literacy and numeracy. This presents a challenge for our population as fewer Māori have a formal schooling qualification compared with the population average (Statistics New Zealand, 2013). Dietary recalls are another method for measuring usual intakes, particularly at a population level (Gibson, 2005; W. Willett, 1998). However, as Willett (1998) draws attention to, the reliance on memory and estimation techniques has the ability to produce similar error to the FFQ. The use of objective anthropometric and biochemical markers in conjunction with FFQ data can be used quantify and adjust for this error and increase accuracy of intake estimates (Kipnis et al., 2001). Tasevska et al. (2005) have demonstrated the strong correlation between urinary fructose and sucrose as determinants of total dietary sugar intake, as well as sucrose intake alone. Additional research has shown biomarkers to be better predictors of extrinsic sugar intake rather than intrinsic, which is useful when measuring total sugars in the diet (Trasevska 2009). Furthermore, identifying relationships between categories of sugar consumption and biochemical indices are worthwhile not only to validate the tool, but to determine sugars role in disease.

2.2 Sugar and metabolic syndrome

The metabolic syndrome (MetS) is a condition represented by the clustering of a group of clinical and metabolic abnormalities, and which is associated with increased risk of diabetes and CVD (Mann & Truswell, 2012). There are various definitions for the MetS which differ depending on whether obesity or impaired glucose metabolism is assumed to be the underlying unifying causal factor.

Fructose has been pinpointed for its role in MetS, more so than other sugars (Hallfrisch, 1990; Nakagawa, Tuttle, Short, & Johnson, 2005). On entering the blood stream, fructose is rapidly delivered to the liver and metabolized, generating glycerol-3-phosphate, a key compound in the production of triglycerides, resulting in elevated hepatic and plasma triglyceride concentrations (Teff et al., 2004). Increased circulating triglycerides can result in increased intramyocellular triglycerides potentially leading to insulin resistance (Zammit, Waterman, Topping, & McKay, 2001). Fructose consumption has also been linked to increased serum uric acid levels.

Three cross-sectional studies have shown intake of sugar-sweetened beverages (SSB) to be linked with risk of the MetS (Denova-Gutierrez, Talavera, Huitron-Bravo, Mendez-Hernandez, & Salmeron, 2010; Dhingra et al., 2007; Høstmark, 2010). All showed that SSB consumption was associated with MetS risk factors; elevated blood glucose, triglycerides, blood pressure, central obesity/waist circumference, body mass index (BMI) and a decrease in HDL-C. Surprisingly, one of these studies also found that consumption of sugar-free soft drinks gave a similar risk estimate of MetS to drinking SSB (OR=1.17 versus 1.15) (Høstmark, 2010). This implies that the association between SSB consumption and MetS may not be explained by sugar. The authors suggest that people who drink sugar-free soft drink may also consume SSB but not report doing so. Moreover, participants may have made recent alterations to their diet owing to their current health status. Conversely, serial cross-sectional observations across four National Health and Nutrition Examination Surveys (NHANES)

cohorts (1999-2006) have shown no association with fructose and MetS risk factors, BMI or uric acid (Sun, Anderson, Flickinger, Williamson-Hughes, & Empie, 2011). The analysis may be limited though by the use of several food databases to classify sugar intakes and use of singular diet recalls.

Cross-sectional studies cannot be used to infer causality between sugar intake and risk of MetS as confounding factors such as changes to dietary sugar intakes cannot be controlled for. Prospective cohort studies are considered better evidence and dietary intervention trials are considered superior (Margetts & Nelson, 1997). The Coronary Artery Risk Development in Young Adults study was a prospective cohort of young US men and women that examined the effects of SSB consumption on cardiometabolic outcomes (Duffey, Gordon-Larsen, Steffen, Jacobs, & Popkin, 2010). With 20 years of follow-up, they found significant trends across quartiles of SSB intake, with higher consumption leading to increased risk of high waist circumference ($p < 0.001$), high triglycerides ($p = 0.033$), elevated low-density lipoprotein cholesterol (LDL-C) ($p = 0.018$) and hypertension ($p = 0.023$). SSB intake was also associated with increased risk of high fasting glucose, low HDL-C and metabolic syndrome, although these effects were not significant. In a randomised controlled trial Perez-Poso et al. (2010) showed that fructose consumption had a deleterious effect on some risk factors for the metabolic syndrome which were mediated by the serum uric acid-raising effects of fructose. Subjects receiving an additional 200g fructose per day demonstrated a significant rise in serum uric acid, BMI and blood pressure, along with adverse lipid changes. In subjects who concurrently received allopurinol (a drug that reduces serum uric acid), there was no increase in blood pressure, in conjunction with a decline in serum uric acid levels.

2.3 Evidence for an association between sugar intake, body composition and obesity

Globally, more than 1.4 billion adults were estimated to be overweight in 2008, of which five hundred million were classified as obese (Finucane et al., 2011; World Health

Organization, 2011). Although many factors contribute to weight gain, the most basic factor is that weight gain occurs when energy intake exceeds energy expenditure (Mann, 2012; van Dam & Seidell, 2007). Sugary foods and fluids tend to be energy-dense and palatable, easily leading to overconsumption that contributes to a positive energy balance (van Dam & Seidell, 2007). Such foods also tend to be less satiating, provide little dietary fibre and micronutrients, thus offering little in the way of nutritional value, contributing only ‘empty calories’ (Huaidong, 2010; Ruxton et al., 2010; van Dam & Seidell, 2007). Fructose, unlike glucose, has been specifically implicated in weight gain due to reducing satiety (Teff et al., 2004). Blood glucose levels (BGL) would normally increase after a meal containing glucose is ingested, releasing insulin and the satiety hormone leptin. Conversely, fructose ingestion has been shown to decrease postprandial BGL causing a decline in serum insulin and leptin, thus attenuating the feeling of ‘fullness’ after a meal. A high fructose meal could therefore lead to overconsumption more so than other sugars and the positive energy balance contribute to weight gain.

Te Morenga et al. (2013) recently published a systematic review and meta-analysis of randomised controlled studies (RCTs) and cohorts reporting on the associations between body weight and free sugars in both adults and children. Analysis of RCTs in adults showed that a reduction in sugars intake was associated with a weight decrease of 0.80kg (95%C.I. -1.21, -0.39) whereas an increase in sugar intakes compared to no increase, associated with a significant weight gain in adults [0.75kg (95%C.I. 0.30, 1.19)]. Findings from cohort studies supported those from RCTs, with the majority showing significantly positive associations between sugar intakes and body weight/composition outcomes.

However this review and a systematic review by Sievenpiper (2012) found no evidence that the effect of sugars on weight gain was due to a specific effect of fructose. In their analysis of feeding trials, Sievenpiper (2012) found high doses of fructose to cause significant weight gain [0.53 kg (95%C.I. 0.26, 0.79)], but this was only where fructose was

supplemented to provide excess energy (hypercaloric trials). Isocaloric trials in contrast showed no effect between fructose and body weight [-0.14 kg (95% C.I. -0.37, 0.10)]. This suggests that the excess energy intake was responsible for weight gain.

Research into the metabolic effects of sugars often focuses on the intake of SSB as they are widely consumed, amounts are easy to report and availability and consumption are largely unaffected by seasonality. A systematic review and meta-analysis has been conducted to collate the evidence between SSB intake and body weight in adults and children (Malik, Pan, Willett, & Hu, 2013). Across 32 prospective cohort studies and RCTs, Malik et al. (2013) evidenced a similar positive association between SSB consumption and body weight as Te Morenga (2013) did for sugar consumption and body weight.

Excess intake of sugars beyond daily energy requirements are stored as fat in the body. In comparison to glucose, fructose has been shown to stimulate de novo lipogenesis although the mechanism for this is unclear (Samuel, 2011). Interestingly, it appears that sugar ingestion may influence the storage sites of fat, as shown in one Danish intervention study (Maersk et al., 2012). Over a six-month period, they revealed that once daily sucrose-sweetened soft drink (SSSD) intake resulted in significantly higher visceral adipose tissue and liver fat accumulation compared to intake of artificially-sweetened soft drink, water and milk (Maersk et al., 2012). This finding is of concern as visceral adiposity is considered a risk factor for metabolic disease (Wajchenberg, 2000). Moreover, these findings suggest there is an effect of sugars on weight gain which is independent of energy contribution to diet since participants consuming isocaloric milk were free from developing these effects.

2.4 Sugar intake, serum uric acid levels and gout

High fructose intakes can lead to an increase in serum uric acid concentrations. On absorption fructose is transported directly to the liver where it is rapidly metabolised involving unregulated phosphorylation by fructokinase. When fructose is consumed in excess of energy needs this phosphorylation can lead to depletion of adenosine triphosphate (a

coenzyme) stores, resulting in an upregulation of the purine synthesis pathway and increased uric acid production (Nakagawa et al., 2005).

A link between fructose and hyperuricaemia has been observed in cross-sectional studies conducted on nationally representative samples in the United States (US) (J. W. Choi, Ford, Gao, & Choi, 2008; Gao et al., 2007). Choi et al. (2008) reported a significant association between serum uric acid levels and both SSB ($p < 0.001$) and orange juice ($p = 0.009$) consumption. The association tended to be stronger in men than women. In another study, Gao et al. (2007) found no association between SSB and serum uric acid in women (Gao et al., 2007).

Hyperuricaemia, or elevated serum uric acid, is characteristic of gout (Riches, Wright, & Ralston, 2009), a form of painful arthritis caused by inflammatory response to the accumulation of uric acid crystals in the joints (Riches et al., 2009). As excessive fructose consumption can induce hyperuricaemia (J. W. Choi et al., 2008; Nakagawa et al., 2006), it may be an important risk factor for gout. Choi et al. have examined the relationship between consumption of fructose-containing beverages and foods and risk of incident gout in two large prospective cohort studies (H. K. Choi & Curhan, 2008; H. K. Choi et al., 2010). In both studies daily consumption of SSB was associated with increased risk of gout amongst the predominantly white, middle-aged cohorts. Participants consuming SSB once daily had an increased risk of gout of 74% (95% C.I. 19% to 155%) in women and 45% (95% C.I. 2% to 108%) in men in comparison with those consuming less than one serving per month. Additionally, intakes of orange or apple juice and whole oranges or apples were also significantly associated with risk of incident gout over 12- and 22-year follow up periods. Separate analyses were conducted to determine risk of incident gout with fructose intake.

2.5 Sugar and type two diabetes mellitus

With the growth in worldwide prevalence of T2DM, the role of sugars and in particular, fructose, is gaining attention. Elevated blood uric acid levels appear to inhibit nitric

oxide synthase, resulting in reduced synthesis of nitric oxide (NO) (Nakagawa et al., 2006). Endothelial NO modulates glucose transport and increases blood flow to skeletal muscle. Insulin consequently relies on NO in order to stimulate glucose uptake (Balon, 1997; Nakagawa et al., 2006). By inducing hyperuricaemia, excess dietary fructose intake may therefore impair the action of insulin, increasing likelihood of hyperglycaemia and heightening T2DM risk. Excess intake of free sugars, can also result in weight gain which is a known risk factor for T2DM (Mokdad et al., 2003). Furthermore, increased total sugars intakes have also been linked to T2DM risk by impairing beta cell function in the pancreas and acute insulin responses (Davis et al., 2005). Beta cell failure is thought to occur through long-term increased demand for insulin secretion to deal with the constant exposure to high blood glucose levels (Ludwig, 2002).

As fructose is hypothesised to increase T2DM risk, then populations with a high intake of fructose in their diets could be at increased T2DM risk. Goran et al. (Goran, Ulijaszek, & Ventura, 2013) examined whether the availability of HFCS in 43 countries was associated with the prevalence of type two diabetes mellitus. They found a 20% greater prevalence of T2DM and significantly higher fasting glucose concentrations ($p=0.03$) in countries with high availability of HFCS versus those with little to no availability of HFCS. Odegaard et al. (2010) investigated the association between sucrose-sweetened soft drink (SSSD) and juice consumption and T2DM risk in a prospective cohort of Singaporean-Chinese. In participants of the highest quartile of SSSD consumption, there was a small, but significant weight gain of 0.53kg ($p<0.001$) compared to those who had only monthly consumption. Weekly consumption of two or more SSSD was also associated with 34% (95% C.I. 17% to 52%) increased risk of T2DM compared to subjects who almost never consumed SSSD (p for trend <0.0001). T2DM risk also increased by 24% with consumption of juice two or more times per week compared to almost none, but this was not significant (p for trend 0.09).

To evaluate the effect of particular sugars on T2DM risk, The Finnish Mobile Clinic Health Examination Survey investigated the effects of glucose, fructose, maltose, lactose, sucrose and total sugars intakes in a prospective cohort study conducted in Finnish men and women with 12 years of follow-up (Montonen, Jarvinen, Knekt, Heliovaara, & Reunanen, 2007). Only glucose and fructose exhibited a significant relationship with T2DM risk. In comparison to the lowest quartile of fructose and glucose combined intake, the highest quartile had a 57% (95%C.I. 0 to 148%) increased risk of T2DM. However, limitations are apparent as the diet history relied on memory recall over the previous year of dietary intake, producing poor reproducibility for glucose and fructose data.

Aside from increasing risk of T2DM, sugar has also been seen to affect the lifespan of people already suffering from diabetes mellitus. In an analysis involving 6192 subjects with type 2 diabetes participating in the European Prospective Investigation in Cancer study, it was shown that a high sugar intake was associated with increased mortality risk in normal weight, normal energy reporters (Burger et al., 2012).

2.6 Sugar and cardiovascular disease

Research into CVD has focused on sugar and in particular fructose because of its association with the risk factors of elevated blood pressure and dyslipidaemia (C. M. Brown, Dulloo, Yepuri, & Montani, 2008; I. J. Brown et al., 2011; de Koning et al., 2012; Duffey et al., 2010; Jalal, Smits, Johnson, & Chonchol, 2010; Stanhope et al., 2011). Fructose in SSB intake was analysed in the prospective cohort of the Health Professionals Study (de Koning et al., 2012). Participants from the highest quartile of SSB intake had an 18% (95%C.I. 6 to 31%) increased risk for coronary heart disease compared to the lowest quartile of SSB intake (p for trend <0.01).

Fructose-induced hyperuricaemia, which causes an inhibition of the vasodilator NO, can lead to increased blood pressure (Nakagawa et al., 2006). Cross-sectional studies from the US and the United Kingdom (UK) have evidenced this correlation (I. J. Brown et al., 2011;

Jalal et al., 2010). The International Study of Macro/Micronutrients and Blood Pressure demonstrated that intake of one SSB per day was associated with a 1.1mmHg increase in blood pressure (I. J. Brown et al., 2011). Jalal et al. (2010) conducted a cross-sectional analysis on NHANES (2003 to 2006) data showing that daily fructose intake of ≥ 74 g from added sugars was associated with an increased risk of elevated blood pressure.

A link between fructose intake and blood pressure has been observed in dietary intervention trials (C. M. Brown et al., 2008; Maersk et al., 2012), but not consistently (Stanhope et al., 2011). In a randomized cross-over trial, Brown et al. (2008) tested the acute cardiovascular effects of consuming water, water containing 60g fructose and water containing 60g glucose in young, healthy, normal-weight volunteers. Compared to baseline, diastolic and systolic blood pressure increased significantly ($p < 0.01$) with fructose ingestion but not with water or glucose ingestion. A response in blood pressure to fructose started within 30 minutes of consumption, remained for the duration of post-ingestion testing and peaked at a systolic blood 6.2 ± 0.8 mmHg. A significant ($p < 0.01$) increase in heart rate and cardiac output was shown for both fructose and glucose ingestion, but not for water, compared to baseline. This study was, however, limited by the small sample size ($n=15$) and acute effects seen may not translate to long-term increases in blood pressure, heart rate and cardiac output. A longer dietary intervention trial of six months, investigated the effects of SSSD, isocaloric milk, artificially-sweetened soft drink and water on cardiometabolic outcomes, including blood pressure (Maersk et al., 2012). Although SSSD did not significantly increase blood pressure from baseline, consumption of isocaloric milk and artificially-sweetened soft drink significantly decreased systolic blood pressure by 10-15% compared to consumption of SSSD ($p < 0.05$). Diastolic blood pressure also decreased, but this was not statistically significant.

Fructose ingestion is additionally thought to increase the rate of hepatic de novo lipogenesis and simultaneously decrease the activity of heparin lipoprotein lipase resulting in

both increased hepatic fat stores and increased circulating plasma VLDL and triglycerides (Stanhope & Havel, 2010). However other dietary sources of sugar such as glucose may also have deleterious effects on blood lipids. Stanhope et al. (2011) investigated the effects of consuming glucose, fructose and high fructose corn syrup (HFCS) at 25% of total energy requirements on risk factors for cardiovascular disease. After two weeks of dietary intervention, the consumption of fructose and HFCS beverages significantly increased 24-hour triglyceride under the curve (fructose $p=0.0032$, HFCS $p=0.0035$), concentrations of fasting LDL-C (fructose $p=0.0023$, HFCS $p<0.0001$), non-HDL-C (fructose $p=0.0081$, HFCS $p<0.0001$), apolipoprotein B (apo-B) (fructose $p=0.0005$, HFCS $p<0.0001$), and apo-B to apolipoprotein-A ratio (fructose $p=0.0006$, HFCS $p<0.0001$) compared to baseline. Conversely, glucose had no significant effect on these outcomes, suggesting the mechanism in which fructose is metabolised differentially affects these risk factors. A recent randomised controlled trial in healthy, non-diabetic subjects further supports these associations after a six-month intervention period (Maersk et al., 2012). Compared to baseline, their soft-drink intervention group developed an 11% increase in total cholesterol and 32% increase in triglycerides after consumption of one litre daily SSSD (50% glucose to 50% fructose). In comparison to the consumption of isocaloric milk, artificially-sweetened soft drink and water, this was a significant increase ($p < 0.01$). The longer intervention period and more realistic modification of sugar intakes through SSSD intake were strengths over the study conducted by Stanhope et al.

2.7 Sugars consumption in a Māori population

To ascertain the current consumption of total sugars and fructose in Māori, we can appraise commonly eaten sugary foods and drinks as well as investigate the overall sugar content of the diet. The recent Ministry of Health Adult Nutrition Survey 2008/09 (ANS08/09) (University of Otago and Ministry of Health, 2011a) reported intakes of fruits, soft drinks and energy drinks in Māori versus Non-Māori adults. Amongst Māori, they found

50.4% of men and 56.7% of women were meeting the Ministry of Health's recommendation of 2+ servings of fruit per day. Fewer Māori men and women were meeting this guideline compared to non-Māori, with the difference significant for Māori women ($p<0.05$). Despite less Māori men meeting the recommendation, a larger percent were now reaching it than the 30.7% recorded in the 1997 National Nutrition Survey.

Soft drinks and energy drinks have higher sugar contents and can provide a substantial source of energy to diets (Ministry of Health, 2003). Māori women were 1.5 times more likely than non-Māori women to report consuming soft-drinks and/or energy drinks three or more times per week. Around 40% of Māori men drank soft-drinks and/or energy drinks three or more times per week, which was slightly higher than non-Māori men, but not significantly different. Additionally, Māori were significantly ($p<0.05$) less likely to be consuming soft drinks and/or energy drinks less than once a week or never compared to non-Māori, indicating a greater overall consumption of these beverages (Ministry of Health, 2012a). Supplementary tables from the ANS08/09 suggested fruits were the main dietary source of fructose for Māori women and non-alcoholic beverages as the main source for Māori men. Non-alcoholic beverages also appeared to be the greatest contributor of total sugars in the diet and 'sugar & sweets' of sucrose for both Māori men and women.

In terms of nutrients, the mean daily intake of total sugars was 131g for Māori men and 110g for Māori women. This was slightly higher than the recorded intakes from New Zealand European men and women which were 128g and 101g, respectively. Sucrose was the main constituent of total sugars for all ethnicities, with Māori men consuming 67.4g sucrose per day and Māori women consuming 55.8g sucrose per day. Mean fructose intakes for Māori men were 21.8g per day and for Māori women, 19g per day. There was also a trend of older Māori adults (those over the age of 51) to consume less total sugars, sucrose and fructose than their younger counterparts (University of Otago and Ministry of Health, 2011a). The Diabetes Heart and Health Study (Metcalf et al., 2008) defined sugar intakes in different ethnicity

groups. On average, the study found that Māori men were consuming 61g sucrose per day and Māori women were consuming 58g sucrose per day. In the Māori study participants, this equated to approximately 10% of total energy contribution to their diet and would be a principal source of fructose as well. Contrasting this, data from the ANS08/09 observed Māori men to have a higher sucrose intake at 67.4g per day and Māori women a slightly lower intake (University of Otago and Ministry of Health, 2011a). Metcalf et al. (2008) conducted their study in Auckland, where Māori have higher educations and incomes, and lower unemployment rates compared to the rest of New Zealand (Statistics New Zealand, 2006). These factors are highly influential in dietary decisions and could explain why the wider Māori population in the ANS08/09 measured slightly higher intakes for men.

Although the ANS08/09 suggests that sugar intakes for Māori are not particularly high, it is important to acknowledge the limitations of collecting information on dietary sugar intakes. Consumption of carbohydrates (particularly sugary foods and beverages) and fats are frequently underreported as they are seen as socially undesirable to consume (Lafay et al., 2000). Underreporting tends to be more pronounced in certain subgroups including women, overweight/obese individuals and older adults (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; Macdiarmid & Blundell, 1998; Pryer, Vrijheid, Nichols, Kiggins, & Elliott, 1997). Moreover, underreporters tend to recall less snack foods than adequate reporters, which can be key sources of sugar in the diet (Briefel et al., 1997). In the US, the NHANES have tried to reduce this effect by using the United States Department of Agriculture (USDA) 5-step dietary recall method which includes a ‘forgotten foods’ list (Bliss, 2004). The ‘forgotten foods’ list can be individualised for the population and specifically probes for foods and drinks that are often missed such as sweets, soft drinks, fruit and alcoholic beverages. Several studies have proven this method to be successful in garnering accurate food and fluid intakes against other dietary assessment techniques (Blanton, Moshfegh, Baer, & Kretsch, 2006; Conway, Ingwersen, & Moshfegh, 2004; Conway, Ingwersen, Vinyard, & Moshfegh,

2003; Moshfegh et al., 2008). As a high proportion of Māori are overweight/obese, and the ANS08/09 did not include this forgotten foods list, underreporting may be masking a higher sugar intake in Māori than reported. Considering this, it is vital that reliable information on sugar intakes in Māori is first measured to allow for associations between sugars and biomarkers for metabolic disease to be explored.

2.8 Research problem

Given the associations which have been proposed linking sugars intake with cardiometabolic risk factors and the higher prevalence of obesity and non-communicable diseases (NCD) in the Māori population, it is of interest to explore the role of sugars intakes in Māori health. As excessive fructose intake is suggested to differentially affect health outcomes compared to other sugars, it is essential that fructose intakes in Māori are also examined. Although sugars intakes in Māori have been described in population surveys, intakes are likely subject to a degree of underreporting, stemming from lower literacy levels, higher obesity rates and methodological issues. Māori may therefore be consuming greater amounts of sugars than reported, further increasing the risk of developing obesity and NCDs. Thus, the need is created to develop a culturally-appropriate dietary assessment tool that is both accurate and precise in measuring sugar intakes for use in sugar-disease research.

3. Objective Statement

Interest in the role of sugars in the increasing prevalence of NCDs including obesity, type two diabetes mellitus, cardiovascular disease, gout and metabolic syndrome has grown in recent years (R. J. Johnson et al., 2009; R. K. Johnson et al., 2009; Nakagawa et al., 2005; Stanhope, 2012).

NZ Māori are differentially affected by these NCDs with significantly higher incidence rates than non-Māori. As such, it is imperative to discover if there is sugar-disease relationship and highlights an emerging need for a dietary assessment tool which can accurately and precisely measure sugar intakes in Māori.

The overall aim of this study was to validate a culturally appropriate, semi-quantitative, short-food frequency questionnaire assessing sugar intakes in Māori.

Objectives:

1. To ascertain the relative validity of the short food frequency questionnaire in assessing mean daily glucose, fructose, sucrose and total sugars intakes within a Māori population.
2. To assess the test-retest reliability of the short food frequency questionnaire in assessing mean daily glucose, fructose, sucrose and total sugars intakes within a Māori population.

4. Subjects and Methods

4.1 Development and pretesting

Principal sources of sugary foods and beverages for our Māori population were collated from existing FFQs, particularly New Zealand-based FFQs, dietary data from the ANS08/09 and an environmental audit of local food outlets and supermarkets within the Gisborne region (Crutchley, 2012; Hedrick, Comber, Estabrooks, Savla, & Davy, 2010; Mainvil, 2011; McNeil, 2013; Sam, 2012; University of Otago and Ministry of Health, 2011a; Walter, 2013). 33 separate items were selected for inclusion in the paper-based sugars FFQ which included photographic examples of each item.

Both open-ended and closed-ended versions of the FFQ were developed and pretested amongst a sample of ten Māori adults from our target population. The open-ended version allowed the participants to specify actual quantity and frequency of consumption of an item. In contrast, the closed-ended version required the participant to fit their consumption into a predetermined frequency category e.g. “6 or more times per day”. Pretesting revealed that the majority of participants preferred the open-ended format for its ease of understanding and this was chosen as the final FFQ (see Appendix 9.1). An additional two questions regarding recent changes to diet and weight were included at the end of the questionnaire to aid interpretation of the results.

4.2 Validation and reliability study

4.2.1 Sample selection

A convenience sample of 37 Māori adults between the ages of 18 and 65 were recruited from the Gisborne population in the period of July to August of 2013. Recruitment was via word-of-mouth, face-to-face contact, flyer drops in suburban areas, social media and with assistance from the healthcare providers, Turanga Health and De Lautour Medical Centre. Participants were eligible to participate if they self-identified as being of Māori ethnicity, were aged 18 to 65 years, were free from cognitive impairment which might limit their ability

to recall recent food and fluid intakes, and were living within a 25-kilometre radius of the Gisborne city centre.

This study was approved by the Human Ethics Committee of the University of Otago, NZ. All participants were required to give informed consent prior to undertaking the interviews.

4.2.2 Validation reference method

The FFQ was validated by comparing the estimates of sugars and rankings with repeated 24-hour dietary recalls. Diet recalls used the USDA 5-Step Method for 24-hour recalls which includes probing participants about consumption of foods on a ‘forgotten foods’ list of commonly overlooked foods and drinks. This key step has proved beneficial in the acquisition of accurate dietary intakes (Blanton et al., 2006; Conway et al., 2004; Conway et al., 2003).

4.2.3 Research protocol

Participants were interviewed on four occasions; weekly over a four week consecutive period with each interview lasting up to 90 minutes. Where possible, a different day (including weekends) was sought for each interview to account for variation in dietary pattern with typical and non-typical days. Interviews were conducted at a time and place of convenience to the participants, which included the home, work place, various Gisborne cafés or the Gisborne public library. In the event that a 24-hour recall interview could not be attended or suitably rescheduled, a telephone interview was conducted. Use of telephone interviews have been reported to be as valid as in-person interviews for assessing intake (Tran, Johnson, Soultanakis, & Matthews, 2000).

Prior to the first interview, participants were provided with written and verbal information regarding the study aims and objectives and the level of participation required (see Appendix 9.2). Participants were assured personal information would remain confidential and withdrawal from the study would be at no disadvantage to them. During the first

interview, written consent was obtained and demographic information including gender, age, ethnicity, education, employment status and diagnosed health conditions was collected (see Appendices 9.2, 9.3 and 9.4). The food frequency questionnaire (referred to as FFQ1) was then explained and administered with participants being prompted to reflect on their intake of food and fluid for the previous month. Participants were assisted by the researcher if they had difficulties understanding how to complete the questionnaire.

Following administration of FFQ1, the researcher conducted a 24-hour dietary recall interview to gather information regarding participant's total food and fluid intake over the previous 24-hour period. Information collected included quantities of foods and fluids, brand names, recipes, preparation and cooking methods, and the time of day items were consumed. The researcher used three-dimensional food models and coloured food photographs to assist the participant with recall of intake quantities. In the second and third weeks, 24-hour dietary recall interviews were repeated. In the fourth week, the FFQ was re-administrated (referred to as FFQ2). Finally, participants were asked whether they had lost weight or changed their diet over the previous 4 weeks.

On completion of each interview, a koha in the form of a \$10 supermarket voucher was presented to the participant to show appreciation and gratitude for their time and commitment. Text, phone and email communications were employed to remind participants of an upcoming interview.

4.3 Data analysis

4.3.1 24-hour dietary recalls

24-hour recalls were analysed using ©Kai-culator, online dietary analysis software developed by the University of Otago with the 2010 NZ food composition tables (Department of Human Nutrition & University of Otago). Mean intakes for dietary fructose, glucose, sucrose and total sugars of the three 24-hour recalls were estimated. Mean sugars intakes were also estimated for non-alcoholic beverages (NAB) and fruit.

4.3.2 Food frequency questionnaire

FFQ1 and FFQ2 were analysed using a specially created spreadsheet. For each item the frequency of intake was multiplied by the average serving size (e.g. chocolate square averaged at 4.7 grams) and transformed into an estimate of average daily consumption.

The ANS08/09 detailed specific food and beverage consumption rates by Māori, and this served as a reference for determining the sugar contents for the FFQ items (University of Otago and Ministry of Health, 2011a). For example, question 11 in our FFQ inquired about usual wine intake in the previous month but does not specify the type of wine. From the ANS08/09, Māori consumed wine in a ratio of approximately 23% red and rosé wines to 77% white wines. Therefore, sugar consumption from wine measured in our FFQ would be calculated from the average sugar content in wines derived from this ratio.

The 2010 Food Composition Tables provided the fructose, glucose, sucrose and total sugar contents for each item. Mean daily intakes of sugars were calculated by totalling sugars from all 33 items. Estimates of mean daily intakes of fructose, glucose, sucrose and total sugars were also calculated for NAB and fruit.

4.4 Statistical analysis

Data were analysed using Stata/IC 11.2 for Mac (StataCorp, 2009). Statistical significance was observed at the level of $p < 0.05$.

4.4.1 Sample size

Cade (2002) recommends at least 50 participants, preferably more, to carry out analyses in validation studies. We aimed to recruit 60-70 participants to ensure our sample contained sufficient numbers of younger and older adults, men and women. This was deemed to be a realistic sample size for two researchers to collect data over a maximum period of 6 months.

4.4.2 Validation

The geometric daily mean intake of sugars (fructose, glucose, sucrose and total sugars) from the two dietary assessment methods was calculated. In addition we calculated the sugars deriving from NAB and fruits separately. We validated the FFQ for accuracy in ranking each participant into intake quartiles of fructose, glucose, sucrose and total sugars by comparison with the means of sugars estimated from their three repeated 24-hour recalls collected over the same time period. Cross-classification agreement with weighted Kappas and Spearman's rank correlation coefficients, paired t-tests, Bland-Altman strengths of agreement analyses comparing sugars intakes from FFQ2 and the repeat 24-hour recalls were estimated as measures of relative validity.

4.4.3 Reliability

Reliability, a measure of the consistency of the sugars intake estimates derived from the FFQ over time, was assessed by administering the FFQ at the first interview (FFQ1) and 4 weeks later at the last interview (FFQ2). Reliability was assessed by comparing estimates derived from FFQ1 and FFQ2 by intraclass correlations, as well as paired t-tests and Wilcoxon sign rank tests.

4.4.4 Cross-classification

Each participant's daily mean intake of fructose, glucose, sucrose and total sugars from the FFQ2 and repeat 24-hour recalls were divided into quartiles of lowest to highest intake. Categories were compared to determine the proportion (%) of participants classified into the same quartile (correct classification), adjacent quartiles (acceptable classification) and into extreme quartiles (grossly misclassified). However, this cross-classification will comprise of a percentage of participants who have been merely classified by chance (W. Willett, 1998). Cohen's (1960) Kappa statistic is a useful test here as it discounts the percentage classified by chance alone. The limitation of the Kappa test is that it inappropriately treats all disagreement as identical, therefore a weighted Kappa (K_w) has been applied to our data to accentuate larger

differences (classification into extreme quartiles) versus smaller differences (classification into adjacent quartiles) (Cohen, 1968). Kappa values greater than 0.80 suggest very good agreement, 0.61 to 0.80 good agreement, 0.41 to 0.60 moderate agreement, 0.21 to 0.40 fair agreement and less than 0.20 poor agreement (Altman, 1991).

4.4.5 Correlation coefficients

Spearman rank correlation coefficients (r_s) assessed the strength of agreement between FFQ2 and repeat 24-hour recalls. This is a non-parametric correlation method which does not require a normally distributed population and is appropriate for small sample sizes (J. Cade et al., 2002; Gauthier, 2001). Correlation coefficient values range from -1 to 1, with 1 representing a perfectly positive relationship, -1 a perfectly negative relationship, and 0 indicating no association between the variables (Pirie, 2004).

Intraclass correlation coefficient (ICC) analysis was used to assess reproducibility of the FFQ by estimating the strength of agreement between the two administrations. ICC are appropriate for assessing FFQ reproducibility, rather than validation (Bland & Altman, 1990). Fleiss (1986) proposes that ICC values below 0.4 signify poor reliability, between 0.4 and 0.75 signify fair to good reliability and values above 0.75 signify excellent reliability.

4.4.6 Mean and mean differences for absolute agreement

The Bland-Altman method assesses the strength of agreement between two methods or measurements (Bland & Altman, 1999). At a population level, perfect agreement between assessment methods is evidenced with a mean percentage agreement of 100, with 100 included in the 95% confidence intervals. The width of the limits of agreement (LoA) denotes the range in which 95% of the differences between two measures are anticipated to lie. Bland Altman analysis was conducted to assess the strength of agreement and relative validity between FFQ2 and the gold standard method of assessment (repeat 24-hour recalls).

4.4.7 Comparison of means

The distribution of the sugars values was skewed to the left and therefore, natural logarithmic transformations were performed on the data to provide a normal distribution. Two-sided paired t-tests were performed to investigate the geometric mean differences between the logged mean intakes from the dietary assessment tools, and the differences were back-transformed. Mean intakes have been expressed in grams of sugar whereas mean differences signify the percentage difference between the methods. Wilcoxon sign rank tests were used to test for differences in sugars estimates between the FFQs for fruit and NAB since the data could not be log transformed to account for the non-normal distribution.

5. Results

A total of 72 participants were recruited in the current study with no loss to follow-up. Four participants did not complete the three repeat 24-hour recalls within a one month period; however we included their results in the current analysis. Although we aimed to take 24-hour recalls on a different day of the week (including at least one weekend day), only three people were able to meet on the weekend and six people had to meet on the same day each week.

5.1 Participant characteristics

Overall, 72 participants (100% enrolled at baseline) completed all four interviews and were included in the present analysis. Two thirds (67%) were female, and the mean age was 34 years (range, 18 to 65 years), indicating a greater representation of young adults and females in the analyses (Table 5.1). All participants identified as Māori (a predetermined inclusion criterion) although 7% additionally identified as NZ European. The majority of participants (87%) had attained some form of educational qualification at a secondary or tertiary level signifying a fairly well-educated study population. On acceptance into the study, 71% were in either part-time or full-time employment. Furthermore, just under half (47%) of the study population reported at least one co-morbidity, with some participants reporting as many as four separate co-morbidities.

Table 5.1: Characteristics of participants in the wider Māori Kai Study ($n=72$, Gisborne, New Zealand 2013)

Characteristic	n	%
Sex		
Male	24	33
Female	48	67
Age (years)		
18-29	27	38
30-39	17	24
40-49	8	11
50-59	15	21
60+	5	7
Ethnicity ^a		0
Māori	72	100
NZ European	5	7
Highest education qualification		
No secondary school qualification	10	14
Secondary school qualification	32	44
Tertiary qualification – university	19	26
Tertiary qualification - technical/trade school or polytechnic	11	15
Employment status		
Full-time	41	57
Part-time	10	14
Retired	2	3
Student	13	18
Homemaker	4	6
Unemployed	1	1
Other ^b	1	1
Household size (n) ^c		
1-3	30	42
4-6	37	51
7-9	4	6
Co-morbidities ^d		
High blood pressure	18	25
High cholesterol	10	14
Heart disease or angina	4	6
Diabetes	6	8
Cancer	1	1
Gout	1	1
Asthma	16	22
Sleep Apnoea	1	1
None	38	53

n = number of people

^aParticipants were able to identify with more than one ethnicity

^bOther included those who self-identified as an invalid

^cHousehold size: the number of people in the participants household inclusive of the participant

^dParticipants were able to select multiple co-morbidities, given former diagnosis from a medical professional

5.2 Relative validity

5.2.1 Cross-classification

Cross-classification agreement of sugar intake quartiles from FFQ2 and repeat 24-hour recalls is shown in Table 5.2. The majority (95 to 97%) of participants were classified into the same or adjacent quartiles. All categories of sugar intake displayed a small degree of gross misclassification (i.e. classification into an extreme quartile), with fructose showing the greatest (6%) misclassification into extreme quartiles. K_w values for all sugars indicate moderate agreement (0.41-0.60) (Altman, 1991).

Tables 5.3 and 5.4 show the cross-classification of quartiles of mean sugar intakes derived from non-alcoholic beverages and fruits between FFQ2 and the repeat 24hour recalls. Quartiles of sugar intake from non-alcoholic beverages show better cross-classification agreement for all sugar types, in comparison to quartiles of overall mean sugar intakes. Agreement for fructose, sucrose and total sugars from non-alcoholic beverages is also markedly stronger than for those sugars from fruit sources. K_w scores ranged from 0.53-0.60 indicating moderate agreement.

Table 5.2: Cross-classification from FFQ2 and repeat 24-hour recall quartiles of mean sugars intakes by Māori Kai study participants with weighted Kappa values

Sugar	Same quartile (%) ^a	Adjacent quartile (%) ^b	Extreme quartile (%) ^c	K _w ^d
Fructose	53	42	6	0.43
Glucose	51	44	4	0.49
Sucrose	53	44	3	0.51
Total sugars	47	50	3	0.47

FFQ2= food frequency questionnaire version 2; K_w= weighted Kappa score

^aPercentage of participants categorised into the same quartile of sugars intake

^bPercentage of participants categorised into adjacent quartiles of sugars intake

^cPercentage of participants categorised into an extreme quartile

^dWeighted kappa values

Table 5.3: Cross-classification from FFQ2 and repeat 24-hour recall quartiles of mean sugars intakes derived from non-alcoholic beverages with weighted Kappa values

Sugar	Same quartile (%) ^a	Adjacent quartile (%) ^b	Extreme quartile (%) ^c	K _w ^d
Fructose	49	50	1	0.53
Glucose	57	42	1	0.60
Sucrose	58	42	0	0.60
Total sugars	57	42	1	0.60

FFQ2= food frequency questionnaire version 2; K_w= weighted Kappa score

^aPercentage of participants categorised into the same quartile of sugars intake

^bPercentage of participants categorised into adjacent quartiles of sugars intake

^cPercentage of participants categorised into an extreme quartile

^dWeighted kappa values

Table 5.4: Cross-classification from FFQ2 and repeat 24hour recall quartiles of mean sugars intakes derived from fruits with weighted Kappa values

Sugar	Same quartile (%) ^a	Adjacent quartile (%) ^b	Extreme Quartile (%) ^c	K _w ^d
Fructose	50	47	3	0.42
Glucose	44	54	1	0.40
Sucrose	42	57	1	0.42
Total sugars	47	50	3	0.47

FFQ2= food frequency questionnaire version 2; K_w= weighted Kappa score

^aPercentage of participants categorised into the same quartile of sugars intake

^bPercentage of participants categorised into adjacent quartiles of sugars intake

^cPercentage of participants categorised into an extreme quartile

^dWeighted kappa values

5.2.2 Correlation coefficients

There was a positive correlation coefficient between sugars measured from FFQ2 and repeat 24hour recalls (Table 5.5). For overall sugar intake, sucrose showed the strongest measurement agreement between the two tools (0.70) and fructose the weakest (0.59). Correlation for sugars intakes from non-alcoholic beverages was stronger than the overall correlation, with coefficients for each sugar category above 0.75. Conversely, sugars intakes from fruit were comparable with the correlations for sugars from all sources. All measures were statistically significant.

Compared to previous FFQ validation studies, our FFQ showed better overall correlation for glucose and sucrose. Only one study showed better correlation for total sugars (0.77) (Hosseini Esfahani, Asghari, Mirmiran, & Azizi, 2010) and another for fructose (0.66), although this was the only study we found validating for fructose.

5.2.3 Strength of agreement

Good agreement was displayed between FFQ2 and the repeat 24 hour recalls in assessing for mean intakes of fructose, glucose and total sugars (Table 5.6). Conversely, agreement was poor for sucrose, with the FFQ2 overestimating intake by 12% to 51% for most measurements. Sucrose additionally had the widest LoA at 36-473 but all sugars displayed wide LoA, conveying an inability for the tool to show validity at an individual level.

Table 5.5: Strength of agreement using Spearman's rank correlation coefficients between FFQ2 and repeat 24hour recalls

	r_s			
	Overall	NAB	Fruit	Overall CC from previous studies ^a
Sugar				
Fructose	0.59*	0.75*	0.60*	0.66
Glucose	0.66*	0.79*	0.60*	0.65
Sucrose	0.70*	0.75*	0.61*	-0.04, 0.29 ^c , 0.34 ^c , 0.45 ^b , 0.47 ^b , 0.49, 0.54 ^c , 0.60, 0.60 ^b
Total sugars	0.68*	0.76*	0.66*	0.42, 0.44, 0.49, 0.53, 0.55 0.60, 0.65 ^c , 0.77 ^b ,

FFQ2= food frequency questionnaire version 2; r_s = Spearman's rank coefficient correlation; NAB= non-alcoholic beverage; CC = correlation coefficients

*p<0.05

^aCorrelation coefficients (Spearman or Pearson) from eleven previous FFQ validation studies are listed (Barclay, Flood, Brand-Miller, & Mitchell, 2008; Barrett & Gibson, 2010; Decarli et al., 1996; Hodge, Patterson, Brown, Ireland, & Giles, 2000; Hosseini Esfahani et al., 2010; Johansson et al., 2002; Jønneland et al., 1991; Marks, Hughes, & van der Pols, 2006b; Munger, Folsom, Kushi, Kaye, & Sellers, 1992; Paalanen et al., 2006; W. C. Willett et al., 1985). Where adjusted and deattenuated CC was reported, the crude CC was used for comparison.

^bMale CC only

^cFemale CC only

Table 5.6: Strength of agreement using the Bland-Altman method between sugars intakes derived from FFQ2 and the repeat 24-hour recalls

				Previous studies ^a	
	Mean agreement (%)	95% CI	LoA (%)	Mean agreement (%) (95% CI)	LoA (%)
Fructose	100	86, 116	27-363	1.56	90-271
Glucose	104	90, 120	31-352	1.63	97-276
Sucrose	130	112, 151	36-473	1.25	70-221
Total sugars	110	96, 125	35-341	1.31 (1.25, 1.37)	83-205
				1.17	66-206
				1.37	88-214
				-	47-82

FFQ2= food frequency questionnaire version 2; 95% CI= 95 percent confidence interval; LoA= Limits of Agreement

^aBland-Altman analysis were conducted in four FFQ validation studies added here for comparison (Barclay et al., 2008; Barrett & Gibson, 2010; Hodge et al., 2000; Marks et al., 2006b). One study reported the confidence intervals for mean agreement (%) (Marks et al., 2006b). Another study only reported limits of agreement (Hodge et al., 2000).

5.2.4 Mean sugars intake

Mean daily intake of fructose, glucose, sucrose and total sugars for participants, estimated from FFQ2 and the repeat 24-hour recalls are presented in Table 5.7. Mean sugars intake estimates derived from FFQ2 were higher than estimates obtained from the repeat 24-hour recalls, with the exception of fructose (Table 5.2). For sucrose, this difference was significant ($p=0.001$) with a 1.3 times greater intake estimated from FFQ2.

Tables 5.8 and 5.9 break down the mean daily intakes of sugars contributed from non-alcoholic beverages and fruits in the participant's diets. In our sample, a larger proportion of total sugars and sucrose was contributed from non-alcoholic beverages than fruits.

Table 5.7: Mean (and 95% confidence interval) daily intakes of sugars in participants of the Māori Kai study ($n=72$, Gisborne, New Zealand 2013) and mean daily intakes of sugars in Māori participants from the Adult Nutrition Survey 2008/2009

	FFQ2	Repeat 24hr recalls	Mean difference ^c (ratio) (95% CI)	ANS 08/09 Mean (g) M/F ^d
Sugar	Mean ^a (g) (95% CI)	Mean ^b (g) (95% CI)		
Fructose	25.1 (20.9, 30.2)	25.2 (21.2, 29.9)	1.00 (0.86, 1.16)	21.8/19.0
Glucose	24.3 (20.3, 29.2)	23.4 (19.7, 27.7)	1.04 (0.90, 1.20)	^e
Sucrose	89.8 (73.3, 110.1)	69.1 (57.6, 83.0)	1.30* (1.12, 1.51)	67.4/55.8
Total sugars	156.5 (130.6, 187.5)	142.5 (122.8, 165.3)	1.10 (0.96, 1.25)	131/110

24hr= 24 hour; FFQ2= food frequency questionnaire version 2; CI= confidence intervals; g= grams; ANS08/09= Adult Nutrition Survey 2008/09; M/F = male/female

* $p < 0.05$

^aGeometric mean (grams) from FFQ1

^bGeometric mean (grams) from FFQ2

^cGeometric mean difference (ratio) between FFQ1 and FFQ2

^dMean sugar intakes from the Adult Nutrition Survey 2008/2009 for 1040 Māori men and women (15+ years) (University of Otago and Ministry of Health, 2011a)

^eData for glucose intakes was not available

Table 5.8: Mean (and 95% confidence interval) daily intakes of sugars contributed from non-alcoholic beverages in participants of the Māori Kai study ($n=72$, Gisborne, New Zealand 2013) and Māori participants from the Adult Nutrition Survey 2008/2009

	FFQ2	Repeat 24hr recalls	Mean difference ^c (ratio) (95% CI)
Sugar	Mean ^a (g) (95% CI)	Mean ^b (g) (95% CI)	
Fructose	4.8 (3.3, 7.0)	4.1 (2.6, 6.7)	1.16 (0.79, 1.71)
Glucose	4.7 (3.2, 6.9)	3.9 (2.4, 6.2)	1.21 (0.81, 1.79)
Sucrose	22.7 (15.2, 33.9)	8.8 (5.1, 15.0)	2.59 (1.61, 4.17)
Total sugars	35.9 (24.5, 52.4)	14.4 (8.0, 25.9)	2.49 (1.56, 3.96)

24hr= 24 hour; FFQ2= food frequency questionnaire version 2; CI= confidence intervals; g= grams; ANS08/09= Adult Nutrition Survey 2008/09; M = male; F = female

* $p < 0.05$

^aGeometric mean (grams) from FFQ1

^bGeometric mean (grams) from FFQ2

^cGeometric mean difference (ratio) between FFQ1 and FFQ2

Table 5.9: Mean (and 95% confidence interval) daily intakes of sugars contributed from fruits in participants of the Māori Kai study ($n=72$, Gisborne, New Zealand 2013) and Māori participants from the Adult Nutrition Survey 2008/2009

Sugar	FFQ2	Repeat24hr recalls	Mean difference ^c (ratio) (95% CI)
	Mean ^a (g) (95% CI)	Mean ^b (g) (95% CI)	
Fructose	6.4 (4.8, 8.5)	3.9 (2.8, 5.3)	1.65 (1.22, 2.24)
Glucose	5.5 (4.1, 7.4)	3.2 (2.3, 4.4)	1.73 (1.28, 2.33)
Sucrose	7.3 (5.5, 9.6)	3.6 (2.5, 5.2)	2.01 (1.44, 2.79)
Total sugars	18.7 (13.9, 25.2)	9.3 (6.4, 13.5)	2.02 (1.48, 2.77)

24hr= 24 hour; FFQ2= food frequency questionnaire version 2; CI= confidence intervals; g= grams; ANS08/09= Adult Nutrition Survey 2008/09; M = male; F = female

* $p < 0.05$

^aGeometric mean (grams) from FFQ1

^bGeometric mean (grams) from FFQ2

^cGeometric mean difference (ratio) between FFQ1 and FFQ2

5.3 Test-retest reliability

5.3.1 Correlation coefficients

ICC, shown in Table 5.10, were analysed between the two administrations (FFQ1 and FFQ2) of the short-FFQ. Reproducibility was excellent for sucrose and total sugars and good for fructose and glucose. ICC for sugars intakes from non-alcoholic beverages were all above 0.84, indicating excellent reproducibility for assessing sugar contribution from this food group. Sugar intakes from fruit showed lower reproducibility in comparison to the overall study and separate analysis for non-alcoholic beverages but still good.

5.3.2 Mean sugars intake

Table 5.11 compares mean sugar intakes from FFQ1 and FFQ2 when tested on the same participants under matched conditions. A consistent pattern of under-estimation of sugar intakes by FFQ2 is displayed. This trend is statistically significant for fructose [1.31, 95% CI (1.11-1.53)], glucose [1.27, 95% CI (1.09-1.49)] and total sugars [1.16, 95% CI (1.01-1.32)]. There were no significant differences in any sugars estimates for NAB between administrations, however sugars estimates from fruit were significantly lower in FFQ2 than FFQ1 (data not shown).

Table 5.10: Strength of agreement using intraclass correlation coefficients between mean daily sugars intakes derived from FFQ1 and FFQ2

Sugar	ICC					
	Overall ^a	95% CI	NAB ^b	95% CI	Fruit ^c	95% CI
Fructose	0.71	0.51, 0.82	0.84	0.75, 0.90	0.70	0.51, 0.82
Glucose	0.73	0.55, 0.83	0.85	0.76, 0.91	0.69	0.50, 0.81
Sucrose	0.86	0.78, 0.91	0.87	0.79, 0.92	0.66	0.46, 0.79
Total sugars	0.83	0.72, 0.89	0.86	0.78, 0.91	0.70	0.51, 0.81

FFQ1= food frequency questionnaire version 1; FFQ2= food frequency questionnaire version 2; ICC= intraclass correlation coefficient; 95% CI= 95 percent confidence interval; NAB= non-alcoholic beverages

^aICC for sugar intakes from the main validation study between FFQ1 and FFQ2

^bICC for sugar intakes contributed from non-alcoholic beverages between FFQ1 and FFQ2

^cICC for sugar intakes contributed from fruit between FFQ1 and FFQ2

Table 5.11: Mean (and 95% confidence interval) daily intakes of sugars from FFQ1 and FFQ2 with mean differences

Sugar	FFQ1		FFQ2		Mean ^c difference	
	Mean ^a (g)	95% CI	Mean ^b (g)	95% CI	(ratio)	95% CI
Fructose	32.7	27.8, 38.6	25.1	20.9, 30.2	1.31*	1.11, 1.53
Glucose	31.0	26.1, 36.7	24.3	20.3, 29.2	1.27*	1.09, 1.49
Sucrose	96.4	79.0, 117.6	89.8	73.3, 110.1	1.07	0.93, 1.24
Total sugars	181.1	152.7, 214.8	156.5	130.6, 187.5	1.16*	1.01, 1.32

FFQ1= food frequency questionnaire version 1; FFQ2= food frequency questionnaire version 2; CI= confidence intervals; g= grams

*p<0.05

^aGeometric mean (grams) from FFQ1

^bGeometric mean (grams) from FFQ2

^cGeometric mean difference (ratio) between FFQ1 and FFQ2

6. Discussion

The Māori Kai food frequency questionnaire (FFQ) was developed as a culturally appropriate dietary assessment tool with the purpose of measuring sugars intakes in a Māori population. This study focused on evaluating the relative validity and reliability of the instrument in a sample of 72 Māori adults. Our instrument showed an excellent ability to rank individuals into categories of sugar intake, as well as good estimation of group mean sugar intakes when assessed against repeat 24-hour recalls. When retested, the FFQ demonstrated good reproducibility. Overall, the FFQ performed as good as or better than previous FFQs validated for assessing sugar intakes.

6.1 Validity

In contrast to previous validation studies, the Māori Kai FFQ demonstrated a superior ability to correctly classify individuals into the same or adjacent quartile of sugars intake (Barclay et al., 2008; Decarli et al., 1996; Hosseini Esfahani et al., 2010; Kroke et al., 1999; Marks et al., 2006b). Notably, three of these studies each used a combined 12 days of weighed food records as their dietary reference standard and therefore should have gathered more accurate intakes than our repeat 24-hour recalls (Barclay et al., 2008; Decarli et al., 1996; Marks et al., 2006b). However, as they demonstrated worse cross-classification, it may indicate that our FFQ classified better with our 24-hour recalls because of carrying similar measurement error. Only one study used quartiles to categorise sugar intakes, with the rest favouring quintiles and tertiles. This would affect overall cross-classification as, for example, fewer categories would increase the likelihood that an individual's intake is correctly classified. Therefore, our FFQ may be performing even better against previously validated FFQs.

Conversely, weighted kappa scores from cross-classification of the FFQ were indicative of only a moderate agreement between the FFQ and the repeat 24-hour recalls. Our weighted kappa score for total sugars was better than another study (0.47 versus 0.41),

although both still showed moderate agreement (Barclay et al., 2008). As previously mentioned, Kappa values greater than 0.80 suggest very good agreement, 0.61 to 0.80 good agreement, 0.41 to 0.60 moderate agreement, 0.21 to 0.40 fair agreement and less than 0.20 poor agreement (Altman, 1991). However, it is proposed that this scale of agreement acceptability might not be appropriate, as weighted kappa values have been observed to produce consistently lower values than Spearman and Pearson correlation coefficients (Masson et al., 2003).

A strong positive association between the FFQ and repeat 24-hour recalls was also observed with high Spearman correlation coefficients for all sugars. Specifically, the sucrose correlation was much higher than previous validation studies (Barrett & Gibson, 2010; Johansson et al., 2002; Jønneland et al., 1991; Munger et al., 1992; Paalanen et al., 2006; W. C. Willett et al., 1985). Although these results indicated good agreement, the strong correlations could be due to our reference standard having similar error to our FFQ.

Several factors may be influencing the Māori Kai FFQ's ability to show better cross-classification and correlation than FFQs previously validated for sugar intakes. Firstly, our FFQ was designed to specifically target sugary foods and drinks, whereas other validated FFQs assessed whole diets. This means that, although other FFQs had a wider range of items, we likely had more detailed sources of sugary foods and beverages. Compared to other FFQs that contained between 61 and 297 items, our FFQ was considerably shorter with 33 items. This is advantageous as it reduces the likelihood of fatigue associated with longer questionnaires, keeping participants engaged to answer more accurately. Moreover, our FFQ was designed for use in Māori adults, and food and beverage items were unique to our population's diet. Participants will therefore relate better to the dietary intake questions and answer more confidently versus the more generalised food and beverage questions included in wider population studies. Unlike previous studies that typically spanned over a year, we conducted three 24-hour recalls within the one month period prior to the second

administration of the FFQ. This shorter timeframe is likely to improve memory recall in the FFQ, but also reduce the likelihood of changes to sugar intakes due to seasonality, i.e. sugars from fruit consumption.

Bland-Altman agreement for mean sugars intake between the FFQ and the repeat-24 hour recalls was considerably better in our study than previous research, although our LoA were noticeably wider (Barclay et al., 2008; Barrett & Gibson, 2010; Hodge et al., 2000; Marks, Hughes, & van der Pols, 2006a). The wide LoA are unlikely to be due to having a smaller sample size ($n=72$) as other studies sample sizes were similar, ranging from 63 to 96 participants. A more plausible explanation for these wide limits is that 41% participants reported at least one day of dietary recall represented a “non-typical” day of eating and drinking for them. Therefore, a participant recalling at least one day of vastly different sugar intake will have a large influence on the Bland Altman test, resulting in a wider LoA and reduced confidence in the tool’s reliability to assess sugar intakes at an individual level. Bland (1999) suggests not to remove these outliers from the analyses, however, a temporary exclusion could show their effect on overall LoA. Although the tool was not intended to measure actual individual intake, we were interested in seeing how well it performed at this. Overall the short-FFQ was still accurate at reporting mean sugar intakes of a group.

Mean sugar intakes in the Māori Kai FFQ tended to overestimate mean sugars intake against the repeat 24-hour recalls. This finding was paralleled in other validation studies but to a greater degree, with the estimation of sugars approximately 20% higher in the FFQs compared to the reference dietary assessment methods (Barclay et al., 2008; Decarli et al., 1996; Hodge et al., 2000). The 24-hour recalls are likely to have experienced a degree of underestimation despite using the USDA 5-step method as reporting sugar intakes is socially undesirable (Lafay et al., 2000).

6.2 Reliability

ICC for our tool demonstrated close to excellent reproducibility for assessing mean daily sugar intakes. In particular, ICC for mean sucrose intakes assessed between FFQ1 and FFQ2 was substantially better than previous validation studies (Johansson et al., 2002; Munger et al., 1992; W. C. Willett et al., 1985). Considering most of these studies administered their FFQ at a six month to one year interval, this finding may be attributed to the shorter timeframe of one month in which our tool was re-administered. Alternatively, this shorter re-administration period could have improved memory recall for our participants.

Excellent reproducibility was displayed for the tool in assessing sugars contributed from NAB, whereas only fair to good reproducibility was shown for sugars derived from fruits. It is possible that the ICC for sugars contributed from fruit showed slightly poorer reproducibility as fruit intake alters with seasonality while NAB intake, in general, does not. In the first phase of validation, the season was transitioning from autumn to winter, and in the second phase, transitioning from winter to spring. Over a one month period this may have affected the accessibility of fruits to our sample and changed their consumption as a consequence. In this instance, the FFQ would be accurately recording intakes, but the intakes would truly be different at the two different administrations.

Conversely, paired t-tests demonstrated that FFQ1, in comparison to FFQ2, significantly overestimated mean fructose, glucose and total sugars intake by 31%, 27% and 16% respectively. One explanation for these results is that involvement in our study influenced participants to alter their diets through the course of interviews. 57% reported at least one dietary change that would have affected sugar intakes including eating less sugar, drinking less fruit juice, drinking fewer sugary drinks and drinking less alcohol. An additional 26% of participants reported weight loss over the one month interval. A personal observation we had supporting this, was that participants reported increased awareness around eating and drinking. For example, one person expressed guilt and embarrassment with reporting their

alcohol intake, and consequently chose to sober drive for the remainder of the study duration. This reflection on diet therefore seemed to induce an ‘intervention effect’ towards consuming a healthier diet.

6.3 Strengths

A major strength of the short-FFQ was that it was developed and pretested in the population intended for its use, i.e. Māori adults. The FFQ included a limited number of food items, reflecting important sources of dietary sugars, that were typical of the foods and drinks consumed by Maori participants, as recommended by Cade et al. (J. Cade et al., 2002). In addition to this, the inclusion of examples and coloured food photographs attached to food items (e.g. Ribena as an example for ‘Fruit Drink’) was designed to aid participants with lower literacy to answer as accurately as possible. The FFQ was limited to estimating usual intakes within the previous one month period as participants are far more likely to recall intakes in one month than, for example, over the previous year. Since sugars intakes are relatively stable over time (Goldbohm et al., 1995) it was felt that this would be appropriate and improve recall accuracy.

Our sample was relatively representative of the Māori adult’s age class distribution ranging from 18 to 65 years of age, with a higher weighting on younger adults. This, in conjunction with the overall validation sample, supports the use of the FFQ across the general Māori adult population although not in age subgroups. Since our participants were also relatively well-educated, we have confidence in the accuracy of our gold-standard dietary recall method because of increased understanding of dietary assessment. Additionally, given our recruited population had higher literacy rates, it could have been possible to use weighed diet records.

As a reference dietary assessment method, 24-hour recalls provided a feasible method of accurately assessing food and fluid intakes without the high response burden associated with weighed food records. We consider that our use of the USDA 5-step method for 24-hour

recalls, rather than the 4 step protocol used in the ANS08/09 (University of Otago and Ministry of Health, 2011b) was a strength of our study as it includes a step inquiring about commonly forgotten foods. Forgotten foods that we included tended to have higher sugar contents, for example soft drink, chocolate, lollies and fruit. As nearly all participants gave positive responses with this method, a more accurate and detailed recall of intake was able to be obtained. This factor is likely to contribute to the good overall validity of the short-FFQ.

6.4 Limitations

Although a wide-ranging age group was procured for this validation study, the sample size remains too small to investigate associations with intakes in age-class and gender subgroups. For example, there was only one male in the ‘60 years plus’ age group. Further validation has the ability to expand this by increasing overall sample size and thus, produce results that can be extrapolated for these subgroups.

Taking into account that our participants were volunteers, they may not represent the overall demographic of Māori adults to which this research is aimed at. A positive response to recruitment could be indicative of those who are more motivated about their health and consume less sugary drinks and foods as a side-effect of higher socio-economic status and higher education. Moreover, as we have previously mentioned, our study population was fairly well educated. We are therefore likely to be missing Māori adults who have lower literacy and may find our FFQ less comprehensible. This response bias could therefore show the overall validity and reliability of the FFQ to be better than it truly is. Further, Māori adults who have high sugar diets are less likely to be health-conscious and participate in our research, attenuating the effect that higher intakes of sugar have in later validation research with biomarkers. One way of overcoming this would be to include additional questions to demographic information in reference to socioeconomic status, ascertaining if people from diverse circumstances are represented. For example, adding in quantitative and qualitative questions pertaining to health beliefs, incomes/household salaries and food security. Results

could therefore be adjusted by the outcomes to these variables and show if FFQ validity varies with certain subgroups of Māori adults.

A further limitation of our study is the lack of anthropometric and biochemical indices to aid validation. Anthropometry provides another element to analyse data with, by accounting for any differences in validity with participant body mass index (BMI). Underreporting in our study was witnessed in several participants who consumed far less energy than estimated daily requirements. In particular, an estimated 5.2MJ is required for basal metabolic rate in short (1.5m), small (49.5kg) females and we had at least three participants who consumed less than this on a day of dietary recall (National Health and Medical Research Council & Ministry of Health, 2006). By taking at minimum a BMI measure, underreporting could be identified and extreme cases excluded from the analyses. Nevertheless both the FFQ and 24-hour recalls are likely to capture this bias, thus minimising the effect of measurement error on our validation study.

Dietary intakes are difficult to assess accurately due to widespread under-reporting or memory biases. There is therefore increasing interest in the use of blood, urine or tissue biomarkers to more accurately estimate dietary intakes. In large population studies it may not, however, be feasible to collect and analyse tissue samples from all participants. One approach is to collect tissue biomarkers from a sub-sample of participants and use this information to quantify the measurement error derived from dietary assessment alone (Bingham, 2002). Bingham (2002) acknowledges biomarkers by suggesting they become a routine of any nutrition research assessing dietary intake. This utility of using blood and urine biomarkers of intake to more accurately assess sugars intake estimates will be examined in future research.

For a small section of participants (n=4), we were not able to complete all four interviews within a one month period. In each case this was due to their travel to the Waikato for the Māori King Koroneihana (coronation) celebrations in August. This added an additional two weeks to the four week period projected to complete all four interviews within. In this

instance, the first two 24-hour recalls would not correspond with intake over the one-month period that the FFQ specified. Therefore, there is a small possibility that using these recalls may have reduced the overall agreement for relative validity of the tool.

Three days of dietary recall may have been insufficient to show variation in some of the participants' diets, especially those who were unable to meet on alternative days of the week. Barriers to this included car access, work and personal commitments, involvement in marae activities and events, and being too 'hung-over' from the previous night. Hangovers were a common theme for rescheduling interviews in those who had higher intakes of alcohol recorded with the short-FFQ. These participants tended to report lower sugars intakes in the 24hr recalls as the sugar contribution from alcohol is likely to be underrepresented. A solution to this could have been to increase the number of dietary recall days or exclude the participants who could not adhere to meeting on different days of the week/weekend. Realistically, this limitation is not easily overcome without biasing the sample population to being a group who is more motivated for their health and more flexible in their commitment to the research.

A limitation of the approach to interviewing, by meeting with participants at their convenience, was that in situations where other household members were responsible for the food shopping, preparation and cooking and did not accompany the participant to the interview, we were unable to verify information about brands and recipes. These participants also tended to be less confident in estimating portion sizes, even when food models and photographs were used. Consequently, it can be recommended that future research aim to actively encourage whanau involvement, where appropriate, to recall details of recipes, cooking methods, and product brands. This will, however, prove challenging where family experience competing priorities to aiding the research.

A final limitation is that as our FFQ was only a partial estimate of an individual's diet, we could not estimate total energy intake and are thus unable to adjust our estimates of sugars intakes for energy intake.

6.5 Conclusion

Worldwide, the rising prevalence of NCD has become a key contributor to socio-economic burden in both developed and developing countries. To counteract this, it is fundamental that we challenge this trend with up-to-date health recommendations based on the latest research.

The robust evidence that is emerging on the causal link of dietary sugar to disease cannot be ignored (R. J. Johnson et al., 2009; Malik et al., 2013; Te Morenga et al., 2013). Exploring this association in populations groups at increased risk of NCDs could provide new insights into factors explaining health inequities. The Māori Kai food frequency questionnaire was developed with the purpose of measuring sugar intakes, for use in prospective sugar-disease research. In this validation and reliability study we have shown the tool to be effective in identifying mean sugar intakes at the population level. Moreover, the short-FFQ can correctly classify individuals into categories of sugar consumption and successfully reproduce this upon re-administration. We see merits in its low response burden, ease of administration, relevance of food and fluid items and cost-effectiveness, and are confident for its use in New Zealand-wide studies.

Further validation through anthropometric and biochemical markers is warranted before the diet-disease relationship can be investigated. This will be conducted in the follow-on phase of the study. Additionally, it is essential to test the tool in Māori across NZ, to see if it is applicable within different socio-economic, environmental and iwi subgroups. Future research could also investigate the lifestyle pattern associated with different levels of sugar intake by examining activity levels, dietary behaviour and other components of the diet.

Outcomes of this research could determine if sugar intakes affect Māori differentially, depending on other lifestyle factors.

7. Application to Practice

The recent development and validation of the Māori Kai food frequency questionnaire will enable researchers to employ a valid and reliable dietary assessment tool for measuring sugar intakes in Māori. This is instrumental to the investigation of sugars association to metabolic disease such as obesity, type two diabetes mellitus, cardiovascular disease and gout. It will additionally aid government and health agencies to set national health recommendations around sugar to Māori that are meaningful in the prevention of these diseases.

Knowledge of this relationship will empower dietitians and health professionals in the public health sector to form new health policy. Subsequent health promotion activities can give appropriate attention to addressing sugar intakes for the prevention and management of NCD. On an individual basis, health professionals working with Māori will be better equipped to provide evidenced-based advice on safe levels of sugar intake. Dietitians will also play a key role in working alongside Māori health providers to initiate strategies for focusing on sugar intakes.

It should be noted that although this FFQ was demonstrated to have good validation in a Māori population, it cannot be used to compare sugar intakes with other populations for which it has not been validated. However, the method in which this tool has been developed, pretested and validated can be beneficial to those seeking to design a culturally-appropriate FFQ for measuring nutrients in another population.

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9. Appendices

9.1 Final open-ended FFQ

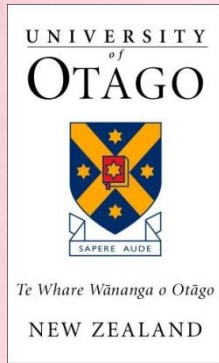
9.2 Participant information and consent form

9.3 Participant contact details form

9.4 Participant demographic questionnaire

9.5 24-hour dietary recall collection sheet

9.1 Final open-ended FFQ



Māori Kai Study

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

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

How can you help?

- Answer each question as best as you can.
- Please tell us about **YOU**
- Tick or fill in **ONE answer** for **EACH question**.
(Erase or scribble out mistakes.)

This is an example of how to answer the questions

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



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

For this question:

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

Ryan writes:

4 times

☒ a day

☐ a week

☐ a month

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

1 cup OR

 ml OR

 litre

PLEASE NOTE: Each item has 2 questions:

- “how often”
- “how much”

These photos may help you estimate **how much** you usually drink each time:

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



= 1 cup = 250mls

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

☐ never (go to next question)

____ times ☐ a day
☐ a week
☐ a month



1 L



3 L

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

____ cup (photo on page 3) OR

____ ml (photos on page 3) OR

____ litre

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

☐ never (go to next question)

____ times ☐ a day
☐ a week
☐ a month



3 L



1 L

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

____ cup (photo on page 3)

____ ml (photos on page 3)

____ litre

3. Over the last month, on average, **how often** did you drink regular **cordial**? (eg. Raro, Refresh, Vitafresh)

☐ never (go to next question)

____ times ☐ a day
☐ a week
☐ a month



How do you **prepare** the cordial?

- ☐ strong (less water added)
☐ following packet instructions (1 packet = 1 litre)
☐ weak (more water added)

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

____ cup (photo on page 3)

____ ml OR

____ litre

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

☐ never (go to next question)

____ times ☐ a day
☐ a week
☐ a month



How much do you usually drink each time?

____ cup (photo on page 3)

____ ml

____ litre

5. Over the last month, on average, **how often** did you drink **low-calorie/diet soft drink**? (eg. Coke Zero, Diet lemonade) Or sugar-free energy drink (ie. Sugar-free V or sugar-free Red Bull)

☐ never (go to next question)

_____ times ☐ a day

☐ a week

☐ a month



355mls

600mls

How much do you usually drink each time?

_____ cup (photo on page 3) OR

_____ ml (more photos on page 3)

_____ litre

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

☐ never (go to next question)

_____ times ☐ a day

☐ a week

☐ a month



1.5L



2.25L

or

2250mls

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

_____ ml (more photos on page 3)

_____ litre

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

☐ never (go to next question)

_____ times ☐ a day

☐ a week

☐ a month



250ml



375ml



500ml

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

_____ small can (250 ml)

_____ medium can or bottle (375 ml)

_____ large can (500 ml)

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

☐ never (go to next question)

____ times

☐ a day

☐ a week

☐ a month



600ml



750mls

How much do you usually drink each time?

____ cup (photo on page 3)

____ ml

____ litre

9. Over the last month, on average, **how often** did you drink **flavoured milk** (eg. Primo, Calci Yum)?

☐ never (go to next question)

____ times

☐ a day

☐ a week

☐ a month



250mls



300mls



600mls

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

____ cup OR

____ ml OR

____ litre



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

PLEASE NOTE: For the following questions:

This photo may help you estimate **how much** you usually drink each time:



10. Over the last month, on average, **how often** did you drink **beer, lager or cider**?

☐ never (go to next question)

_____ times ☐ a day

☐ a week

☐ a month

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

_____ bottle (330ml)

_____ can (355 ml)

_____ large bottle (745 ml)

_____ pint or handle (400 ml)

_____ jug (1000 ml) = 1 litre

_____ ml (photos above)

.....
11. Over the last month, on average, **how often** do you drink **wine**?

☐ never (go to next question)

_____ times ☐ a day

☐ a week

☐ a month

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

_____ wine glass (photo above) (150ml)

_____ wine bottle (750ml)

_____ ml

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

☐ never (go to next question)

_____ times ☐ a day
 ☐ a week
 ☐ a month

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

_____ wine glass (150ml) -photo page 7

_____ ml

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

☐ never (go to next question)

_____ times ☐ a day
 ☐ a week
 ☐ a month

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

_____ spirit glass (150ml) with 1 nip

_____ spirit glass (150ml) with 2 nips

_____ tall glass (200ml) with 1 nip

_____ tall glass (200ml) with 2 nips

_____ small bottle/can (330ml)

.....

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

☐ never (go to next question)

_____ times ☐ a day

☐ a week

☐ a month

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

_____ nip (30ml)

_____ double nip (60ml)

_____ ml

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

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

☐ never (go to next question)

_____ times

☐ a day

☐ a week

☐ a month



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

_____ teaspoon

_____ tablespoon

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



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

☐ never (go to next question)

_____ times

☐ a day

☐ a week

☐ a month



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

_____ teaspoon

_____ tablespoon

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



17. Over the last month, on average, **how often** did you add Milo, powdered drinking chocolate or other milk mix to your drink?

☐ never (go to next question)

____ times ☐ a day
☐ a week
☐ a month



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

____ teaspoon

____ tablespoon

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



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

☐ never (go to next question)

____ times ☐ a day
☐ a week
☐ a month

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

How much do you usually add **each time**? (Please circle) Photo A



Photo B

Photo C

19. Over the last month, on average, **how often** did you add **tomato sauce**, BBQ or sweet chilli sauce to **your foods**?

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month



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

_____ teaspoon

_____ tablespoon

_____ mls

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



.....

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

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

☐ never (go to next question)

____ times ☐ a day
☐ a week
☐ a month



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

____ level handful



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

☐ never (go to next question)

____ times ☐ a day
☐ a week
☐ a month



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

____ cans (425grams)

22. Over the last month, on average, **how often** did you eat **fresh raw fruit?** (eg. apple, banana, orange, pear, grapes)

☐ never (go to next question)

_____ times ☐ a day
 ☐ a week
 ☐ a month



How much do you usually eat **each time?** _____ whole piece(s) of fruit

_____ handfuls

_____ cup

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

☐ never (go to next question)

_____ times ☐ a day
 ☐ a week
 ☐ a month



Yoghurt pottles

125 grams

How much do you usually eat **each time?** _____ pottle(s)

_____ cup

24. Over the last month, on average, **how often** do you eat **ice cream, ice blocks, jelly** or frozen yoghurt?

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month

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

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



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

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month

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

☐ Weetbix ☐ 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



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

☐ never (go to next question)

_____ times ☐ a day
 ☐ a week
 ☐ a month

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

_____ tablespoon

_____ mls

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

☐ never (go to next question)

_____ times ☐ a day
 ☐ a week
 ☐ a month



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

_____ grams

28. Over the last month, on average, **how often** did you eat **chocolate biscuits** (eg. Tim Tam, Toffee Pop) or **cream-filled sweet biscuits (e.g. cameo cream)**

☐ never (go to next question)

_____ times ☐ a day
 ☐ a week
 ☐ a month

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

_____ packet (200grams)

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

☐ never (go to next question)

_____ times ☐ a day

☐ a week

☐ a month

How much do you usually eat **each time**? _____ small biscuit (eg. wine)

_____ large biscuit (eg. Cookie Time)

_____ packet (200 gm)

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

☐ never (go to next question)

_____ times ☐ a day

☐ a week

☐ a month

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

_____ bun

_____ sweet pastry

31. Over the last month, on average, **how often** did you eat **cake, sponge, muffins or baked pudding**?

☐ never (go to next question)

_____ times ☐ a day

☐ a week

☐ a month



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

Photo A

Photo B

Photo C

OR _____ g

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

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

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month

How much did you usually eat each time? _____ lollies

_____ family packet (200grams)

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

☐ never (go to next question)

_____ times ☐ a day
☐ a week
☐ a month

45g



50g



How much do you usually eat each time? _____ squares

_____ gs



100 gm



200 gm



350 gm

34. Have you **changed your diet** in the past year?

☐ No (go to next question)

☐ Yes

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

☐ I eat *less* food.

☐ I eat *more* food.

☐ I eat *less* sugar.

☐ I eat *more* sugar.

☐ I eat *less* fat.

☐ I eat *more* fat.

☐ I eat *less* fruit.

☐ I eat *more* fruit.

☐ I drink *less* fruit juice.

☐ I drink *more* fruit juice.

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

☐ I drink *less* alcohol.

☐ I drink *more* alcohol.

☐ Other: _____

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

☐ No

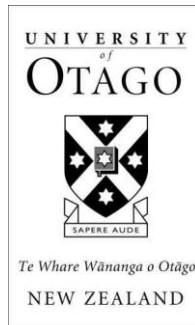
☐ Yes

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

Tēnā rawa atu koe for helping me with this important project!

9.2 Participant information and consent form

1 July 2013



Validation of a sugar screener for Māori populations INFORMATION SHEET FOR PARTICIPANTS

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

What is the Aim of the Project?

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

What Type of Participants are being sought?

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

What will Participants be Asked to Do?

Should you agree to take part in this project, you will be asked to participate in 4 interviews with the student dietitian over a one month period. These interviews will take place in your own home or, if you prefer, we will arrange a meeting place somewhere else suitable in Gisborne (such as a local health clinic). At the first interview, after mihimihi, you will be asked to answer a questionnaire asking about how often you eat different sorts of foods and drinks. Following this the student will collect information about everything you ate and drank the day before. You will be asked questions about what foods you ate and at what time, what was the size of your food servings, what brands of products you used, and how you cooked your food. The total amount of time you spend with the student at each interview session could be up to 1.5 hours. If it is okay with you the student may ask to record the interview. You will receive a \$10 supermarket voucher at the completion of each interview.

Please be aware that you may decide not to take part in the project without any disadvantage to yourself of any kind. At the second and third interviews the student dietitian will again record information about everything you ate and drank the day before. At the last interview the student will just ask you to fill in the simple questionnaire again.

What Data or Information will be Collected and What Use will be Made of it?

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

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

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

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

Can Participants Change their Mind and Withdraw from the Project?

You may withdraw from participating in the project at any time and without any disadvantage to yourself in any way.

What if Participants have any Questions?

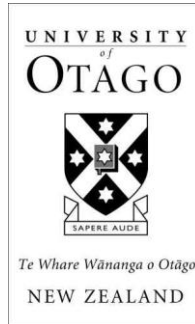
If you have any questions about our project, either now or in the future, please feel free to contact either:-

Elain Furter
Department of Human Nutrition
021 188 3200
furel613@student.otago.ac.nz

and/or

Dr. Lisa Te Morenga
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.



Validation of a sugar screener for Maori populations

CONSENT FORM FOR PARTICIPANTS

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

I know that:-

1. My participation in the project is entirely voluntary;
2. I am free to withdraw from the project at any time without any disadvantage;
3. Personal identifying information including audio recordings will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for at least five years;
4. This project involves an open-questioning technique. The general line of questioning includes your opinions on the sugar questionnaire, and questions relating to what you ate and drank during the previous day including the types, amounts and brands of foods, portion sizes, sauces and condiments added to foods, and how you cooked your food. The precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops.
7. The results of the project may be published and available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity.

I agree to take part in this project.

.....
(Signature of participant)

.....
(Date)

9.3 Participant contact details form

Contact Details Form

Name: _____

Gender (please circle): male / female

Date of Birth: _____

Address: _____

Contact Number: _____ (home)
_____ (mobile)
_____ (work)

Email address: _____

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

How would you prefer to be contacted (please circle):

Email / Text / Phone call

(For study staff use only)

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

Date: _____ (weekday/weekend) Time: _____

Voucher given: yes / no

Notes:

Appointment 2 (2nd 24hr recall):

Date: _____ (weekday/weekend) Time: _____

Voucher given: yes / no

Notes:

Appointment 3 (3rd 24hr recall):

Date: _____ (weekday/weekend) Time: _____

Voucher given: yes / no

Notes:

Appointment 4 (2nd FFQ):

Date: _____ (weekday/weekend) Time: _____

Voucher given: yes / no

Notes:

9.4 Participant demographic questionnaire

A few questions about yourself

1. Are you?
☐ Male ☐ Female
2. Your present age: _____ years
3. Which ethnic group(s) do you belong to? (*Mark the circles that apply to you*)
☐ New Zealand European
☐ Māori (specify Iwi: _____)
☐ Pukapuka Islander
☐ Cook Island Māori
☐ Samoan
☐ Tongan
☐ Niuean
☐ Chinese
☐ Indian
☐ Other (such as Dutch, Japanese, Tokelauan). Please State: _____
4. What is your highest educational qualification? (mark ONE only)
☐ No high school (secondary school) qualification
☐ School Certificate or Sixth Form Certificate (National Certificate Level 1 or 2)
☐ University Entrance/Bursary or Higher School Certificate (completed 7th form)
☐ Technical/trade school or polytechnic diploma (at least 3 months of full-time study)
☐ University degree/diploma
5. What is your *usual* occupation? (If retired, state occupation before retirement.)

6. What is your current employment situation? (mark ONE only)

☐ Employed, full time	☐ Student
☐ Employed, part time	☐ Homemaker
☐ Self-employed	☐ Unemployed
☐ Retired	☐ Other: (<i>please specify</i>) _____
7. How many adults do you live with? _____
8. How many children 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!

9.5 24-hour dietary recall collection sheet

Participant ID: _____

Date (dd/mm/yy): _____ Interviewer: _____

Day of the week (*circle*): MON TUES WEDS THUR FRI SAT SUN

Is this a typical day? (*circle*): YES/NO

If no describe why not

typical: _____

[illegible]