Estimating added sugars intake in New Zealand

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A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Dietetics

At the University of Otago, Dunedin, New Zealand

June 2016

Abstract

Background: Added sugars intake in New Zealand (NZ) cannot be accurately estimated, as the NZ Food Composition Database (NZFCD) does not distinguish between total sugar and added sugars in foods. Added sugars can be defined as sugars that are not intrinsic to fruits, vegetables and milk products and usually refers to sugars added during the processing of foods. High intakes of added sugars, such as those in sugar sweetened beverages (SSBs), have been associated with numerous adverse health outcomes including dental caries, cardiovascular disease (CVD), type two diabetes mellitus (T2DM), weight gain and obesity. Consequently, recent dietary guidelines from the United States Department of Agriculture (USDA) and World Health Organization (WHO) have recommended that added and free sugars provide less than ten percent (%) of total daily energy intake.

Objective: Firstly to develop an added sugars estimate for all food items and recipes in the NZFCD, and secondly to determine added sugars intake of NZ adults using dietary intake data from the NZ Adult Nutrition Survey 2008/09 (ANS 08/09).

Design: A ten-step systematic methodology developed by Louie et al was adapted and applied to FOODfiles, an electronic subset of the NZFCD, to estimate the added sugars content of all food items. Data obtained from the NZ ANS 08/09, a nationwide nutrition survey involving 4,271 participants was then used to estimate added sugars intake of NZ adults. These intakes were used to determine the proportion of the population that was meeting the USDA added sugars and WHO free sugars intake guidelines.

Results: An added sugars estimate was developed for 2,779 unique food items and recipes contained in the FOODfiles database. In total 2,463 (89%) foods had added sugars estimated using objective steps 1-6, and 316 (11%) using subjective steps 7-10. Median usual daily

intake of added sugars for NZ ANS 08/09 participants was 49 grams (g), which contributed 9.5% of total energy (TE) intake. The median total sugar intake of the population was 107g, and added sugars comprised almost half (46%) of total sugar intake. Younger people generally had higher intakes of added sugars than older people, and absolute added sugars intake was greater among men compared with women. By ethnicity, Māori people tended to have higher absolute added sugars intake, (median intake for Māori males 62g and for Māori females 48g) which contributed a greater proportion of total energy intake (10% TE intake for Māori males and 10.6% TE intake for Māori females) compared to NZEO and Pacific people. In comparison with the USDA recommendation for added sugars intake, almost half (46.2%) of the total population had intakes of added sugars that were greater than 10% of TE intake.

Conclusion: The ten-step systematic methodology is currently the best available approach for estimating the added sugars content of foods in NZ, as approximately 90% of foods were estimated using objective measures. When applied to dietary intake data from the NZ ANS 08/09, almost half of the population was not meeting the USDA recommendations for less than 10% TE intake from added sugars. Given that high intakes of added sugars are associated with several negative health outcomes, these findings suggest there may be potential to reduce intakes of added sugars in NZ, particularly amongst young adults who reported the highest intakes.

Preface

This thesis was carried out in Dunedin at the University of Otago under joint supervision from Dr Lisa Te Morenga (primary) from the Department of Human Nutrition and Dr Rachael McLean from the Department of Human Nutrition and the Department of Preventative and Social Medicine.

The added sugars database was developed jointly by Alice Nettleton (candidate) and Rachael Kibblewhite (Master of Dietetics student) who were responsible for:

- Objectively and subjectively developing added sugars estimates for all foods in the NZ FOODfiles (2010) database containing 2,779 food items.
- Development of all assumptions using standardised recipes and ingredient lists from packaged food items.

Liz Fleming from the Department of Human Nutrition was responsible for matching the added sugars estimates for all foods in the FOODfiles database to the NZ ANS 08/09 dietary intake database using Kai-culator dietary assessment software.

Dr Jill Hazard carried out statistical analyses. The Multiple Source Method (MSM) was used to adjust for intra-individual variation in dietary intake, rather than the previously used PC-SIDE method. Additionally, prioritised ethnicity was used instead of total response standard output. This has resulted in small differences in energy, total sugar and sucrose intakes between that reported in the NZ ANS 08/09 and the current thesis.

The candidate was solely responsible for conducting the literature review, interpreting the statistical analyses and writing of all thesis content.

Acknowledgements

There are several people I would like to thank for supporting me to complete this thesis:

- Dr Lisa Te Morenga and Dr Rachael McLean for being such amazing supervisors and always providing me with helpful suggestions and constructive feedback. I feel very fortunate to have been supervised by such experts in the field of nutrition and I have gained so much knowledge from you both about scientific research, writing and nutrition. I have thoroughly enjoyed my time working with you both, and could not have completed this project without your guidance.
- Liz Fleming for her assistance with FOODfiles, Kai-culator and always being available to answer any questions.
- Dr Jill Hazard for her expertise, enthusiasm and prompt statistical analyses of my data.
- Mum and Dad for your never-ending emotional support and financial assistance, I cannot thank you enough. I appreciate this greatly, and could not have achieved what I have without your help.
- Rachael, thanks for being such an awesome person to do this project alongside, I have really enjoyed working with you.
- The University of Otago for funding this project.

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List of Abbreviations

ANS 08/09	Adult Nutrition Survey 2008/2009
CVD	cardiovascular disease
g	grams
kg	kilogram
kJ	kilojoule
MoH	Ministry of Health
MSM	Multiple Source Method
NMES	non-milk extrinsic sugars
NZ	New Zealand
NZEO	New Zealand European and Other
NZFCD	New Zealand Food Composition Database
SSB	sugar-sweetened beverage
TE	total energy
T2DM	type two diabetes mellitus
US	United States
USDA	United States Department of Agriculture
WHO	World Health Organization
%	percentage

1 Introduction

Analytically it is difficult to differentiate total sugar into added sugars and intrinsic sugars, but such information is of importance to nutritionists. Total sugar includes intrinsic sugars found in fruits, vegetables and dairy products, which often come bundled with additional nutrients such as dietary fibre, vitamins, and minerals (1, 2). Alternatively added sugars, which include those sugars added during the processing of foods, provide little additional nutritional benefits, thus contributing empty calories to the diet (3). Furthermore, recent findings have associated high intakes of added sugars, particularly in the form of sugary beverages, with several adverse health outcomes such as CVD (4), dental caries (5), T2DM (6), weight gain (7) and obesity (8).

Currently there are a number of limitations both in NZ and worldwide regarding estimating population intakes of added sugars (3), which has highlighted the need for a simple yet standardised method to estimate the added sugars content in foods. Previous methods used to estimate added sugars in the food supply have been un-standardised, very complicated, or published in insufficient detail to be used by other researchers. The underlying principle of many methodologies to date involves removing the intrinsic sugars from the total sugar content (*added sugars = total sugar – intrinsic sugars*) (3, 9). This poses limitations to both accuracy and repeatability, as it requires in-depth knowledge of food composition. It may also require supplementary information from food manufacturers, which is often difficult to obtain due to frequent reformulation of food products (3). Other methods have used a population-based approach and reviewed food balance sheets (10). However, this option can result in an overestimation of added sugars, as food wastage is frequently underestimated (11).

Estimates of added sugars in the food supply are necessary in order to determine if populations are achieving dietary intake guidelines. The USDA advises that intakes of added sugars provide less than 10% of total calorie intake (12). Furthermore, the WHO recently released a report containing updated recommendations for free sugars intake (13). Free sugars, refers to added sugars with the addition of natural sugars in honey, syrups, fruit juices and fruit juice concentrates (13). Therefore, intakes of added sugars are likely to be comparable and slightly less than free sugars. The WHO now advises that population intakes of free sugars should be reduced throughout the life course, and consist of less than 10% of TE intake (strong recommendation). A further conditional recommendation is also suggested, in which free sugars intake should be restricted to below 5% of TE intake for further health benefits (13). At present, it cannot be determined if the NZ population is meeting these recommendations, as added and free sugars content in the food supply is unknown.

The aim of the current thesis was to derive added sugars estimates for all foods in the NZFCD using an adaption of methods proposed by Louie et al (3). These estimates were then used to determine usual daily intakes of added sugars in NZ adults from the NZ ANS 08/09 by age, sex and ethnicity. This information also allowed for comparisons of current estimated added sugars intake to the most recent USDA and WHO recommendations for added and free sugars intake.

2 Literature Review

2.1 Literature Search Methods

Literature searches were conducted between August 2015 and May 2016 using electronic databases Medline (Ovid), ScienceDirect, Scopus, Google Scholar and Google for articles in English and in human subjects. Searches focused on methodologies for estimating added sugars content in food, health outcomes associated with added sugars intake, classification of sugars, recommendations for sugar intake, and current sugar intake in NZ. In addition, reference lists from articles were searched to acquire more information.

2.2 Introduction

This research focuses on added sugars because a universal approach to estimating added sugars in the food supply has not been used, making it difficult to estimate and compare population intakes in relation to dietary intake guidelines and risk factors for health outcomes (3, 14). A lack of standardisation in defining added sugars has resulted in total sugar intake frequently being reported in nutrition surveys and sucrose is often used as a surrogate for added sugars throughout the literature (15-17). Chemically there are no differences between intrinsic sugars and added sugars; meaning laboratory food analyses cannot differentiate between them (1). Subsequently, different methodologies have been proposed and applied to food composition databases to determine the added sugars content in foods (3). As of yet, this has not been attempted for the NZFCD and thus added sugars intake of the NZ population is unknown.

This review aims to evaluate current literature regarding recommendations for added sugars intake, health outcomes associated with added sugars intake, and investigate different methods used to estimate and monitor added sugars. It will also cover current

sugar intakes in NZ, and investigate why NZ needs added sugars estimates added to the food composition database.

2.3 Why are we interested in added sugars intake?

High dietary sugar intake has been linked with numerous adverse health outcomes including dental caries (5), obesity (7), T2DM (6), and CVD (4). The WHO has identified two health concerns regarding free sugars intake that had sufficient evidence to support a recommendation and will be covered in this review (13). In developing recommendations for free sugars intake the WHO commissioned two systematic reviews regarding free sugars intake, body weight, and dental caries. These reviews concluded that intake of free sugars was an important determinant for both health outcomes (5, 7). Free sugars are added sugars, which also include sugars naturally present in honey, syrups, fruit juice, and fruit juice concentrates, meaning these findings are highly correlated to added sugars (13).

2.3.1 Association between added sugars intake and dental caries

There is a substantial amount of evidence to support the relationship between dietary sugar intake and increased risk of dental caries (5). The cause of dental caries is multifactorial and flow of saliva, fluoride exposure, dietary sugar intake, and teeth cleaning are all factors that can influence risk (18). The proposed mechanism for the association between dietary sugars and dental caries is that dietary sugars provide a substrate for bacteria in the mouth to act upon. Sugars are metabolised to acids by plaque bacteria, resulting in a lower salivary pH, which promotes bacterial growth and tooth demineralisation (19). Studies conducted among children (primary dentition) show that sugar intake is a modifiable risk factor for dental caries (20, 21). In permanent teeth, positive relationships between total sugar intake and dental caries has also been

determined (22, 23). To understand the effect of added sugars (as opposed to total sugar) on dental caries, studies examining SSB intake were also considered, with findings showing a significant increase in dental caries with more SSB consumption per day (21, 24). In terms of intrinsic sugars and dental health, there is evidence that sugar from fruit, when consumed as part of the varied human diet, does not influence the development of dental caries (25). This further suggests that added sugars appear to be more detrimental to oral health than intrinsic sugars (25).

When reviewing this literature there are a number of limitations that must be considered. Many studies have reported the effects of total sugar intake rather than added sugars on dental caries, varying methods have been used to collect dietary information and there appear to be differences in the strength of association between sugars and primary and permanent teeth (21). Better methods for estimating added sugars would provide more definitive evidence and reduce the limitations of these studies. Nevertheless, prevalence of dental caries both in primary and permanent dentition appears to increase as dietary sugar intake increases (5). Although fluoride supplementation has contributed to a reduced risk of dental caries in modern times, reducing dietary sugar intake is still recognised as an important factor in the prevention of dental caries (21). It has also been suggested that very low free sugars intake in line with the WHO conditional recommendation of <5% TE intake is required to reduce the burden of dental caries (26). However, monitoring the extent to which this is achievable by either individuals or populations would require food databases that contain accurate measures of free and added sugars content in the food supply.

2.3.2 Association between added sugars intake and body weight

A considerable number of studies have been carried out investigating the relationship between dietary sugar intake and body weight (7, 27). Although some studies have found no such relationship (28), much of the more recent literature reports a positive association between higher added sugars intake and increased body weight and obesity (7, 8). However, similar to the case with dental caries, the cause of obesity is multifactorial and the exact role that added sugars have in the development of overweight and obesity is uncertain (29). Therefore, it is often concluded that weight gain from added sugars is due to unnecessary extra calories, rather than an independent biological mechanism (6, 7, 30).

A consistent relationship between high intake of SSBs (in which all sugar is added sugars) and increased body weight, particularly in children, has been reported in several studies (8). SSBs are thought to contribute to an increased overall energy intake, as the body does not compensate as well following intake of liquids compared to solid foods (31) and SSBs are not as satiating as solid food (32). In children, higher intakes of SSBs have been associated with increased body weight, body fatness, overweight and obesity compared to those with lower or no SSB intake (33, 34). In adolescents and adults, findings have been similar (6, 35). Some studies have also examined the effect of sugar intake in a solid form on body weight (36, 37). In such studies, there are difficulties distinguishing between types of sugar, as many report total sugar rather than added sugars. However, from the current evidence, which uses surrogate measures such as SSBs for added sugars, it is highly likely these findings would also be true for sugar-sweetened foods.

When reviewing this literature similar limitations exist to those in dental caries and dietary sugar intake as reported previously. A lack of analytical methods for estimating the added sugars content of foods often results in the use of total sugar, sucrose or SSBs as surrogate measures for added sugars intake in epidemiological studies (17, 38), which limits our knowledge on the full impact that added sugars have on health outcomes. Nevertheless, there is sufficient evidence from randomised controlled trials from which added sugars intake can be reliably estimated to indicate that high intakes of SSBs and sugar-sweetened foods appear to be an important determinant of body weight (7).

2.4 Defining sugars

The term sugar can be, and is often defined in numerous ways. The following table shows the terms that are most commonly used to describe different forms of sugar throughout the literature (**Table 2.1**). The WHO has most recently defined the term free sugars, which has a very specific set of criteria (13). Other definitions involve those that are older, such as non-milk extrinsic sugars (NMES) or those that are more ambiguous, such as refined sugars, which are less useful, and require a more subjective interpretation.

Table 2.1. Definitions of sugar

Term	Definition
Sugars	Monosaccharides (glucose, fructose and galactose), disaccharides (sucrose, lactose, maltose and trehalose) and polyols or sugar-alcohols (sorbitol, mannitol, lactitol, xylitol, erythritol, isomalt and maltitol) (1).
Intrinsic sugars	Sugars incorporated within the cellular structure of intact fruit and vegetables, and sugar from milk (lactose and galactose) (1).
Extrinsic sugars	Sugars not incorporated within the cellular structure of food (1).
Free sugars	Monosaccharides and disaccharides added to foods and beverages by the cook, manufacturer or consumer as well as sugars intrinsically present in honey, syrups, fruit juices and fruit juice concentrates (13).
Added sugars	Refined sugars added during cooking or manufacturing including: sweeteners such as sugar (granulated sucrose, brown sugar, icing sugar and golden syrup); monosaccharides and disaccharides (e.g., fructose, lactose, maltose, glucose) single-ingredient syrups (light corn, dark corn, high-fructose corn, maple, malt, sorghum); honey and molasses; and maltodextrin. Sugar alcohols are not included under the definition of added sugars as they are not monosaccharides or disaccharides (39).
Refined sugar	No specific definition often refers to sucrose (1).
Sugar-sweetened beverage	Any drink that contains added sugars including non-alcoholic carbonated soft drinks, fruit juices, flavoured milks, sports drinks and energy drinks (40).
Non-milk extrinsic sugars	All extrinsic sugars that are not from milk, excluding lactose. Includes fruit juices, honey and sugars added to foods as a sweetener (1).
Total sugar	All intrinsic and added sugars in foods. Often defined as all monosaccharides and disaccharides that are not polyols (1).
Sucrose	Disaccharide composed of fructose and glucose (1).

2.5 Recommendations for added and free sugars intake

Recently, several notable health institutions and organisations have released recommendations regarding intake of added sugars (**Table 2.2**). The USDA advises that added sugars should provide no more than 10% of total calorie intake (12). This is because once meeting all other food group requirements, there are insufficient calories available to consume higher amounts of added sugars whilst staying within daily calorie needs. This guideline can now be easily monitored by consumers following the recent

addition of added sugars to nutrition information labels of packaged foods in the United States (US) (12). It would be useful to estimate added sugars in NZ foods for comparability with this system in the US and could also lead to quantitative recommendations for the NZ population. The WHO approach to developing recommendations for free sugars differs to that of the USDA, in which the rationale was around adverse health outcomes including dental caries and weight gain, rather than energy intake (13).

Table 2.2. Current recommendations for added and free sugars intake

Institution	Recommendation
Institute of Medicine (2002) (41)	Maximal intake of added sugars should be limited to providing no more than 25% of energy.
WHO (2003) (42)	<10% total energy intake from free sugars.
American Heart Association (2009) (43)	No more than half of discretionary calorie intake from added sugars. 150 calories for males, 100 calories for females per day.
Ministry of Health NZ (2015) (44)	Choose and/or prepare foods and drinks with little or no added sugars.
USDA (2015) (12)	Consume less than 10% of calories per day from added sugars.
WHO (2015) (13)	• Reduce intake of free sugars to <10% total energy intake (strong recommendation). • Further reduce intake of free sugars to <5% total energy intake (conditional recommendation).
Scientific Advisory Committee on Nutrition UK (2015) (45)	Free sugars should account for no more than 5% daily dietary energy intake.

2.6 Current situation in New Zealand

2.6.1 Dietary sugar intake

Due to a lack of information regarding added sugars content of foods in NZ, the ANS 08/09 reported sugar intakes based on individual sugars and total sugar (15). For males, the median usual daily intake of total sugar was 120g, and for females 96g. Fruit (18%),

non-alcoholic beverages (17%), sugar and sweets (15%) and milk (10%) were major contributors to total sugar intake. Sucrose if often used in the literature as a proxy measure for added sugars (17). Therefore, using the reported sucrose intakes from this survey and interpreting them as a surrogate measure for added sugars, the median usual daily intake for males was 55g and 42g for females. Main contributors to sucrose intake included sugars and sweets (23%), non-alcoholic beverages and fruit (both 16%). Currently it is difficult to compare these intakes with added sugars intake recommendations, as total sugar will clearly overestimate added sugars, and the correlation between sucrose and added sugars is not well documented. Hence, population intakes of added sugars and adherence to dietary intake recommendations are yet to be determined in NZ.

2.7 Methodologies for estimating added sugars in foods

Over time a limited number of standardised methods have been developed and published for estimating added sugars in the food supply. Methods proposed have generally been non-specific and involve removing the intrinsic sugars from total sugar in a given food (*e.g. added sugars = total sugar – intrinsic sugars*) (3). Using this method requires an in-depth understanding of food composition and can risk bias (3). Laboratory methods such as high-performance liquid chromatography have also been identified as a possible way to determine sugars in foods and improve the accuracy of these methods (3). However, this is high cost and can only determine individual sugars as opposed to differentiating between added and intrinsic sugars (3, 9). Other methods have involved analysing food balance sheets at a population level such as that by Baghurst et al (10), which looked at refined sugar consumption in Australia. However, this method often underestimates wastage, leading to overestimation in added sugars consumption. Previously, the USDA

developed methods to determine added sugars in foods to add to their food composition database (39). However, it is unlikely these added sugars estimates could be applied to the NZFCD. This is due to differences in formulation of food products between countries, meaning that methods based on food composition data are not reliable (39). For example, a Kit Kat chocolate bar in the NZFCD contains 43.0g of total sugar, whereas the USDA food database has total sugar listed as 48.68g, both have a very similar energy content. This equates to over one teaspoon difference in sugar content for what is supposed to be the exact same product (46, 47). Furthermore, this database for added sugars is no longer available through the USDA website due to difficulties in keeping up-to-date records of added sugars in foods, because manufacturers can change food product formulation (39).

The term non-milk extrinsic sugars (NMES) has previously commonly been used to describe added sugars. There are various reported methods for estimating NMES in foods (48). Earlier methods generally involved deducting sugars in liquid cows milk (lactose) from total sugar, which is likely to overestimate NMES. Subsequent methods accounted for a greater variety of added sugars including honey, syrups, fruit juices, and half of all sugars in processed fruits, vegetables and cereal products (48). However, these methods are limited as they rely on a high level of food composition knowledge, which can risk bias and is unreliable (3). Furthermore, most of these methods were published in insufficient detail, which could result in underestimation of NMES in some food groups (48). The term NMES has now become redundant in favour of the more recently defined term free sugars (45).

In 2011, Roodenburg et al (9) published a method for estimating added sugars as part of the International Choices Programme. This used generic criteria based on nutrient

recommendations, food labels and information from the food industry to develop an average added sugars value as a proportion of the total sugar for individual foods. This resulted in a rather complicated methodology, which contains a total of 59 steps, many of which are specific to a single food item. For example, the added sugars in peanut butter are estimated to be 36% of total sugar. Furthermore, many of the steps involve a blanket estimation approach (i.e. the proportion of total sugar as added sugars) for whole food groups, which can increase the likelihood of over or underestimation of added sugars (3, 9). An advantage is that this methodology has been published in great detail so other researchers can easily adapt and reuse it. For example, it has since been applied to the 2011 Dutch food composition database, which includes 2,556 food items (49). In order to develop added sugars estimates, package information, borrowed estimates from the Danish food composition database, recipes and information from manufacturers websites were used. Limitations were recognised in that food product formulation is constantly changing making it difficult to reliably estimate added sugars based on package information. Therefore, many values were estimated using borrowed data from the Danish food composition database or standardised recipes (49). Considering this method has successfully been applied to another food composition database, it too could be adopted for use in NZ, however, it appears to be rather labour intensive and reliability has not been verified.

More recently a method which uses linear programming to determine added sugars in consumer-packaged goods in the US was published (50), although, it appears the new added sugars labels in the US will rely on food manufacturers information rather than using this approach (51). This method involves using the nutrition information label and nutritional composition and systematically searching the ingredient list for all sources of

added sugars (including all free, monosaccharides, disaccharides and syrups) (50). This option seems to be quite accurate as it involves using the nutrition information label, however, some limitations remain. For example, fruit juice concentrates were not included as added sugars, due to difficulty differentiating between products that contained fruit juice, from fruit juice concentrate. This method also relies heavily on commercial databases and is costly and time consuming for researchers (50). Added sugars for products with many complex ingredients or for foods that come in a multipack also cannot be estimated as there is more than one nutrition label (50).

In 2015, Louie et al (3) proposed a ten-step systematic methodology for estimating added sugars using objective (requires little decision-making) and subjective (does require decision-making) measures. It has previously been applied to the Australian food composition database, whereby 77% of the foods were assigned an added sugars estimate based on objective measures. The method uses a novel approach to objectively estimate added sugars in foods, when the total sugar content of the unsweetened variety is known (step 5). This is in contrast to the traditional regime of deducting intrinsic sugars from total sugar to estimate added sugars. It also appears to be a well-standardised method with good agreement between researchers in which repeatability has previously been tested (3, 52).

In summary, a standardised approach for estimating added sugars in foods worldwide has not been used. Most methods to date have been developed for the purpose of nutrition surveys in which different definitions of sugars and non-standardised methodologies for estimating added sugars have been used. In addition, very few methods have been published in sufficient detail to be interpreted and used by other researchers (3, 48). As a

result, there appears to be few countries effectively monitoring added sugars intake as food databases currently lack reliable estimates of added sugars. Furthermore, food manufacturers can update food formulations making it difficult to provide up-to-date estimates (3, 39).

2.8 Conclusion

Over time added sugars consumption has increased in some countries, linking it as one of the dietary factors contributing to obesity (30). NZ has high rates of obesity, making it of interest to estimate added sugars intake in this population (53). Currently there is no food database in NZ that has information on added sugars content in the food supply, resulting in total sugar and individual sugars being reported in previous national nutrition surveys (15). In order for NZ to accurately monitor added sugars intake of the population and compare these with other countries, along with dietary intake recommendations, a systematic approach for estimating added sugars is required. The current thesis aimed to achieve this through the adaption of a standardised method previously developed for estimating added sugars in the Australian food composition database (3), to estimate added sugars content in the NZ food supply.

3 Objective Statement

Aim: To provide NZ with a food composition database that includes added sugars, in order to estimate intakes of added sugars for the NZ population. Added sugars estimates were developed for all foods and recipes included in the NZ FOODfiles (2010) database, an electronic subset of the NZFCD. These estimates were then used to determine added sugars intake and the extent to which added sugars contribute to total energy intake in NZ ANS 08/09 participants by age, sex and ethnicity. Furthermore, estimates of added sugars allowed for comparisons of current added sugars intake to the most recent USDA recommendation for added sugars intake and WHO recommendations for free sugars intake.

The objectives of this study were as follows:

- To estimate the added sugars content of all foods and recipes in the NZFCD using FOODfiles.
- To estimate added sugars intake of NZ adults from the NZ ANS 08/09 by age, sex and ethnicity.
- To determine to what extent added sugars contributed to total usual daily energy intake.
- To compare added sugars intake with the USDA and WHO recommendations for added and free sugars intake.

4 Subjects and Methods

4.1 Study Design

The current study used a two-tier approach. Firstly, added sugars estimates for all food items and recipes were developed and added to the FOODfiles database using an adaption of methods proposed by Louie et al (3). The next stage involved secondary analysis of the NZ ANS 08/09 to estimate added sugars intake of NZ adults. The NZ Ministry of Health (MoH) has given permission to use the NZ ANS 08/09 data. No additional ethical consent was required.

4.2 Development of added sugars database

The FOODfiles database contains 2,779 unique food records including both single ingredient foods, packaged foods and mixed-dishes (recipes). Information regarding concentration of water, total energy, dietary fibre, polysaccharides, available carbohydrates, fructose, glucose, lactose, maltose, sucrose and total sugar per 100g was extracted for each food record. Two researchers collaboratively developed added sugars estimates for all food items. Researchers met once per week to check for consistency in decision-making processes. Where there were different views, decisions were adjudicated by the study supervisors. Once an added sugars estimate was developed for all foods, these were manually checked by both researchers for calculation errors and discrepancies in added sugars estimations. Following this, a fourth expert reviewed the added sugars estimates before finalising the dataset.

4.3 Definition of added sugars

Throughout this research, added sugars were defined as per the USDA definition (39):

> Added sugars are all sugars added during cooking or manufacturing and include sweeteners such as sugar (granulated sucrose, brown sugar, icing sugar and maple syrup); monosaccharides and disaccharides (e.g. fructose, lactose, maltose, glucose (dextrose)); single-ingredient syrups (light corn, dark corn, high-fructose corn, maple, golden, treacle, malt, sorghum); honey, molasses; and maltodextrin.

4.4 Proposed methodology for estimating added sugars content in foods

There are ten steps involved in this method adapted from Louie et al (3), objective steps being 1-6 and subjective steps being 7-10. Databases and software used throughout this process included FOODfiles and Kai-culator dietary assessment software (version 1.12, Department of Human Nutrition, University of Otago), which uses FOODfiles to capture information relating to cooking and moisture losses (as per step 4).

Step 1: Foods that have no total sugar, were assigned 0g of added sugars.

Step 2: Foods that met the following criteria or were in these food groups were assumed to have 0g of added sugars due to minimal processing:

- Fresh fruit, vegetables, fish, meat, seafood, and tofu
- Fruit canned in 100% fruit juice
- Dried fruits with no added sugars
- 100% fruit and vegetable juice with no added sugars
- Juice or cordial sweetened with artificial sweeteners, and fruit juice concentrates diluted with water
- Plain cereals including pastas, rice and flours
- Plain pastries, which do not have fillings containing chocolate, fruit, dried fruit and nuts

- Breads (plain) including English muffins, pizza bases, naan bread, pita bread, bagels, white loaf bread and multigrain/wholemeal loaf bread. Does not included gluten free breads*
- Oats, including porridge with no added sugar
- Legumes, dried, fresh and canned (not-including sweetened varieties, or those containing other ingredients e.g. baked beans canned in tomato sauce)
- Eggs and egg products (excluding egg-based desserts)
- Meat dishes, e.g. meat casserole (subject to recipes containing no added sugars)
- All herbs, spices, fats and oils
- All nuts and seeds (does not include sweetened varieties or nut bars)
- Fresh or dried coconut and coconut products e.g. coconut milk
- Milk and dairy products, except for sweetened varieties e.g. flavoured milks.
- Plain Greek yoghurt and yoghurt sweetened with artificial sweetener only
- Non-sugar-sweetened tea and coffee
- Alcoholic beverages (excludes liqueurs and mixers)

*Gluten free breads were not included in step two as they are often yeast free, meaning any sugar added to the product acts as a sweetener as opposed to a processing aid.

Step 3: Foods listed below were assumed to have minimal intrinsic sugars and therefore sugar in them will be 100% added sugars:

- Undiluted fruit juice concentrates and syrups
- Beverage bases (including coffee) with no milk solids, dry or prepared
- Standard soft drinks, sports drinks, energy drinks and flavoured water
- Soy products including milk, beverages and yoghurts, not containing fruit
- Sugar and syrup
- Stock powder
- All processed meats, including meat pies and pastries that do not contain dairy products e.g. cheese
- Meat and seafood that has been crumbed or battered
- Breakfast cereals and snack/cereal bars with no fruit, dried fruit, chocolate, dairy or milk solids
- Crackers, sweet biscuits, cakes, donuts and other batter-based products without fruit, dried fruit, chocolate, milk solids or dairy products
- Sugary confectionary/lollies (does not include chocolate or toffee)
- All potato crisps and other chip varieties e.g. corn chips
- Sauces and dressings except those containing fruit, vegetables, dairy or milk solids
- Gluten-free breads
- All liqueurs that are not cream-based

Step 4: Added sugars were estimated using a standard recipe from FOODfiles whereby the added sugars content of all ingredients in the recipe was determined from steps 1-4. Added sugars estimates were based on the recipe and ingredients using the following equation:

$$\mathbf{AS_{100g}} = \frac{\sum_{i=1}^{j} \boldsymbol{W_i} \times \boldsymbol{AS_i}}{(\sum_{i=1}^{j}) \times (\mathbf{100}\% + \%\boldsymbol{W_{\Delta}})}$$

In this calculation, the weight (W*i*) of each ingredient in the recipe is multiplied by the added sugars content per 100g (AS*i*). All ingredients and their added sugars content are then summed. The $\%W_{\Delta}$ is the change in weight upon cooking, which is provided from moisture factors for recipes within Kai-culator. This equation was then entered into Microsoft Excel to calculate estimated added sugars for all recipes.

Example recipe: A103, Biscuit oaty fruit, low fat. Moisture retention 85%, therefore percentage weight change 15%.

Ingredients	Weight (%)	Added sugars/100g
G1008: Egg, whole, raw	8.5	0
J1005: Margarine, Poly, 70% fat	10.8	0
W19: Sugar, Brown	10.8	95.1
W25: Syrup, Golden	3.5	76.6
E108: Flour, wheat, white, standard	23.8	0
E24: Oats, wholegrain, raw	28.6	0
L173: Sultanas	13.3	0
P1: Baking powder	0.6	0

AS_{100g} = [(0.085 x 0) + (0.108 x 0) + (0.108 x 95.1) + (0.035 x 76.6) + (0.238 x 0) + (0.286 x 0)] / [(8.5+10.8+10.8+3.5+23.8+28.6+13.3+0.6) x (100%+15%)] = 14.9g

Step 5: Added sugars were estimated based on comparison with total sugar from the unsweetened variety of the food using the following equation:

$$\mathbf{AS_{100g}} = \frac{\mathbf{100} \times (\boldsymbol{S_{us}} - \boldsymbol{S_{total}})}{\boldsymbol{S_{us}} - \mathbf{100}}$$

S_{us} is the total sugar per 100g of the unsweetened variety, and S_{total} is the total sugar content per 100g of the sweetened variety of the product.

Example food: C11, Juice, grapefruit, sweetened
Total sugar per 100g = 9.7g
C12 Juice, grapefruit, unsweetened, is a comparable unsweetened variety with 7.9g of total sugar per 100g.
AS_{100g} = [100 x (7.9-9.7)] / (7.9-100) = 1.95g

Step 6: Added sugars estimation based on analytical data. This step was used when a food contained dairy products or milk solids and information regarding lactose content of the food was available. Added sugars were calculated as: total sugar minus lactose. Lactose was deducted from all foods except for potato crisps, other chip varieties and sugary confectionery/lollies (excludes chocolate and toffee). In this instance lactose was determined to be a sweetener rather than an intrinsic sugar, since such foods are considered to be discretionary.

Step 7: Added sugars estimation based on borrowed values from overseas databases or similar foods in which added sugars have been calculated using steps 1-6. Once a suitable food match had been found, added sugars were calculated as: total sugar multiplied by the percentage added sugars content (from the borrowed food). The proportion of added sugars was calculated from the borrowed food by doing a simple percentage calculation. All borrowed values were obtained from recipes within the FOODfiles database, or from the Australian food composition database (AUSNUT 2007).

Example Food: H212, Spring roll, traditional, with meat, commercial, deep-fried
Total sugar per 100g = 2.35g
Borrowed value from recipe H130 (Spring roll, deep-fried) estimates 10% of the total sugar is added sugars.
AS_{100g} = 2.35 x 0.1 = 0.235g

Step 8: Subjective estimation of added sugars based on ingredient lists, recipes or assumptions. This step involved searching the ingredient lists of packaged foods and recipes for sources of added sugars. If no sources of added sugars were stated in the recipe or ingredient list, then the food was assumed to have no added sugars. If percentages of each ingredient on the ingredient list were available, then these were used to estimate added sugars. The percentage of intrinsic sugar was then multiplied by the total sugar content of that intrinsic sugar (e.g. dried fruit), which was then deducted from the total sugar content (see example food below). Step 8 was also used in the development of assumptions, whereby multiple ingredient lists of identical or similar food products were searched, and a suitable estimate for added sugars was developed (**Table 4.1**).

Example food: A70, Biscuit, Fruit, Digestive
Total sugar per 100g = 22.95g
Lactose per 100g = 0.25g
The ingredient label states that these biscuits contain milk solids and currants (8%), which are both sources of intrinsic sugars. Therefore, added sugars are calculated as follows:
AS_{100g} = [Total sugar per 100g – (% currants x total sugar per 100g in currants)] – lactose
= [22.95 – (0.08 x 64.93)] – 0.2 = 18.8g

4.5 Assumptions

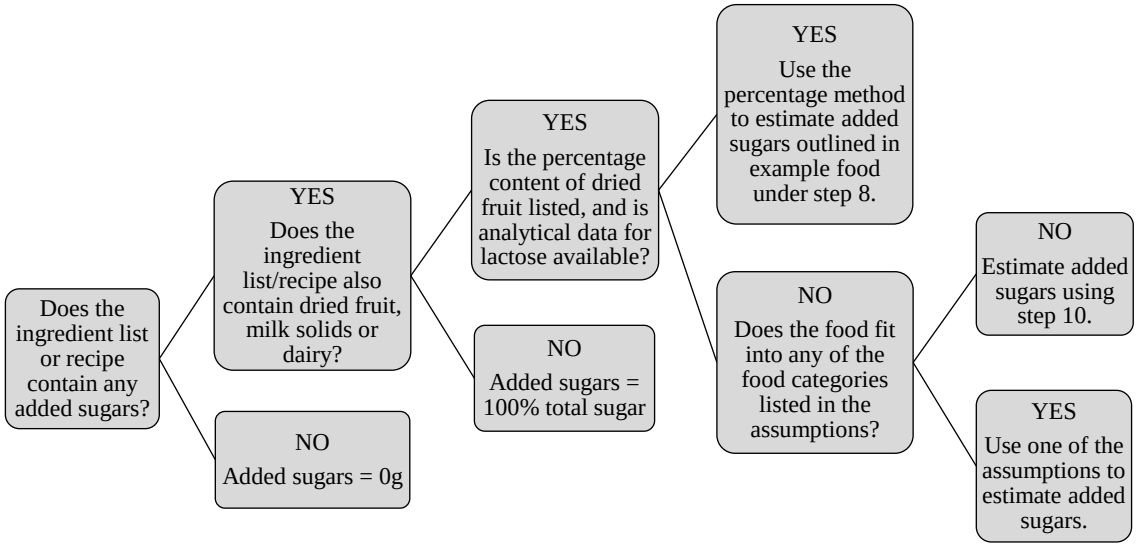
A small number of food items that are now discontinued were included in the NZ ANS 08/09, thus added sugars estimates were required for these and were derived from the added sugars content of similar food products currently available in NZ. All assumptions are listed below in **Table 4.1**.

Table 4.1. Assumptions developed for estimating added sugars

Food	Assumption	Step	Rule	Example
Fruit breads/buns	When a standardised percentage (20%) of dried fruit was removed from the total sugar, the remaining sugar content was similar to that of regular bread, suggesting no added sugars.	8	No added sugars.	N/A
Breakfast cereals containing dried fruit	Added sugars were determined using the ingredient list and percentage fruit content.	8	All dried fruits that were not available on FOODfiles (2010) e.g. dried tropical fruits and freeze-dried berries, were matched to one of four dried fruits: sultanas, raisins, dried apricots and dried cranberries. If the percentage of fruit was stated and there was more than one type, then it was assumed to have equal proportions of each fruit.	**D23, Fruitful Breakfast, Hubbards** Ingredient label states fruit (25%) consisting of papaya, pineapple, sultanas, coconut and apple. Apricot fruit pieces (1.8%), tropical fruit pieces (0.4%). Total sugar per 100g = 22.12g Lactose per 100g = 0.5g Assumed 12.5% (half of 25%) intrinsic fruit sugars from sultanas and 14.7% (half of 25% plus 2.2% from apricot fruit pieces and tropical fruit puree) from dried apricots. Total sugar per 100g in sultanas = 73.2g Total sugar per 100g in dried apricots = 44.9g AS_{100g} = [22.1 – (0.125 x 73.2) – (0.147 x 44.9) – 0.5] = 5.85g
Muesli bars with fruit pieces	When an exact product match could not be found, muesli bars were split into three main categories, which were assigned a percentage dried fruit content based on other similar products. The percentage of intrinsic fruit sugars was then deducted from the total sugar content.	8	Muesli bars with fruit pieces: 20% dried fruit using total sugar in dried apricots.	**U20, Muesli bar, mixed fruit (muesli bar with fruit pieces)** Total sugar per 100g = 20.2g Lactose per 100g = 0.4g Assumed 20% dried apricots Total sugar per 100g in dried apricots = 44.9g AS_{100g} = 20.2 – (0.2 x 44.9) – 0.4 = 10.82g
Fruit filled muesli bars		8	Fruit filled muesli bars: 30% fruit using total sugar in dried apricots or stewed apples without added sugar.	
Fruit and nut bars		8	Fruit and nut bars: 20% dried fruit using total sugar in dried apricots.	

Food	Assumption	Step	Rule	Example
Yogurt containing fruit pieces	These were split into two categories and assigned a generic percentage fruit content based on ingredient lists of similar products. Intrinsic sugars from the fruit content were deducted from the total sugar content first, followed by lactose. Most yoghurt was assumed to be apricot flavoured, unless the type of fruit was specified in the product name e.g. Fruit corner, yoghurt and berry fruit. In this case, fresh or stewed berries without sugar would be used.	8	Yogurt containing fruit pieces: 7% fresh fruit.	**F83, Yoghurt, assorted fruits and flavours, sweetened (fruit yoghurt containing fruit pieces)** Total sugar per 100g = 13.25g Lactose per 100g = 4.85g Assume 7% fresh apricots Total sugar per 100g in fresh apricots = 9.0g AS_{100g} = 13.35 – (0.07 x 9.0) – 4.85 = 7.7g
Yoghurt containing fruit puree		8	Yoghurt containing fruit puree: 10% stewed fruit without added sugar.	
Soups 1	This category is for soups in which there were homemade recipes to estimate added sugars from.	7	Use step 7, with the same proportion of added sugars as the homemade version.	
Soups 2	Tomato soups: After searching many ingredient lists, it was decided that most commercial tomato soups contained a minimum of 90% tomatoes. Condensed tomato soups had a greater amount of added sugars due to the increased concentration.	8	Regular tomato soups = 10% added sugars. Condensed tomato soups = 20% added sugars.	**V1007, Soup, pumpkin, from paste, ready to eat, Watties (soups 1)** Total sugar per 100g = 1.9g Using step 7, a similar product is V34 (soup, pumpkin, homemade) in which 7% of the total sugar is added sugars. AS_{100g} for V1007 = 1.9 x 0.07 = 0.13g
Soups 3	If lactose was the only source of total sugar, added sugars = 0g.	6	No added sugars.	
Soups 4	For all other soups, added sugars were estimated using step 10.	10	Added sugars = 50% of total sugar.	
Canned fruit (syrup not drained)	The percentage fruit content was determined from searching the ingredient lists of multiple different brands (Watties, Oak, Pams, Golden Circle, Dole and Budget) to estimate the average fruit content.	8	Added sugars = Total sugar – (%fruit content x total sugar in fresh unsweetened variety of the fruit).	**L125, Peaches, canned, syrup not drained** Total sugar per 100g = 22.2g Total sugar per 100g of fresh peach = 7.3g. AS_{100g} = 22.2 – (0.6 x 7.3) = 17.82g
Canned fruit (syrup drained)	Assumed to contain some residual added sugars from the syrup.	5	Use step 5, with fresh fruit as the unsweetened variety.	

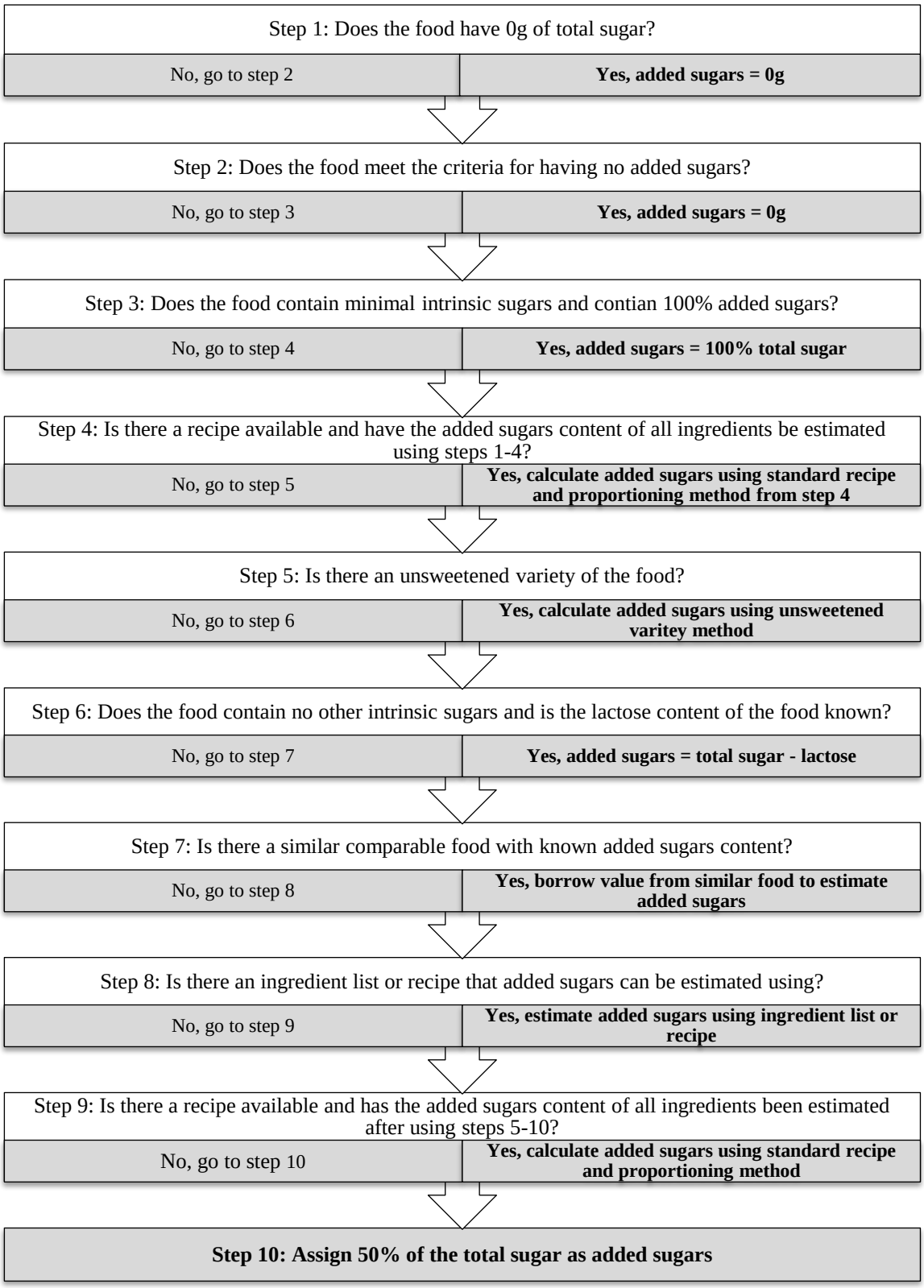
Figure 4.1. Decision making process for using Step 8 to estimate added sugars



Step 9: Once the added sugars content of more foods had been estimated, step 4 was repeated. Added sugars were estimated from recipes that had ingredients with added sugars estimated from steps 5-10. For example, recipes that contained jams were estimated using this step, as the added sugars content of jam was estimated using step ten.

Step 10: When added sugars could not be estimated using steps 1-9, 50% of the total sugar was estimated to be added sugars. This occurred due to a lack of specific product information or no other suitable comparable foods. This step was used for takeaway foods such as McDonald's and pizzas, as well as some soups, sauces and jams.

Figure 4.2. Decision making process for ten-step systematic methodology adapted from Louie et al (3)



4.6 Estimation of added sugars intake in the NZ population from the ANS 08/09

This research involved secondary analysis of the NZ ANS 08/09 survey data. A summary of the methods used for this survey has been provided, however, a full report can be accessed on the MoH Website (54).

4.6.1 Participants

The NZ ANS 08/09 was a nationwide nutrition survey in which the target population was residents aged 15 years and over living in permanent private dwellings in NZ. This survey used a multi-stage, stratified, probability-proportional-to-size sample design. Increased sampling targeted populations of Māori and Pacific ethnic groups, younger age groups (under 19 years old) and older age groups (over 70 years old) using screened sampling.

4.6.2 24-hour diet recall

A 24-hour diet recall was carried out with 4,721 respondents. This involved asking participants to recall all foods and beverages they had consumed at and away from home during the previous 24-hours (from midnight to midnight). All 24-hour diet recalls were carried out during the face-to-face interviews in the participant's homes. To estimate day-to-day intra-individual variation in dietary intake, a random sub-sample of 25% of participants completed a second 24-hour diet recall within a month of their first interview. Data from the second 24-hour diet recall was used to adjust nutrient intakes from the first diet recall to reflect usual intakes of the population.

4.6.3 Matching foods to nutrient data

Food and beverage intakes obtained from the 24-hour diet recalls were matched using FOODfiles to provide nutrient intakes. In total, 11,850 food item descriptors were reported, which were then matched to their nutrient line in FOODfiles. If a direct match was not available, then an appropriate overseas food database such as NUTTAB 2006 (Australia) or USDA (US) was used. If a suitable substitute could not be found on an overseas database and the particular food was consumed in high enough frequency, then this food was analysed and added to the NZFCD.

Figure 4.3. Process for combining added sugars estimates with the NZ ANS 08/09 dietary intake database

1. Added sugars estimates were developed for 2,779 foods contained in FOODfiles.
2. The added sugars estimates were uploaded as a CSV. file and analysed using Kai-culator dietary assessment software (version 1.12, Department of Human Nutrition, University of Otago).
3. Added sugars estimates were re-calculated for NZ ANS 08/09 recipes.
4. All dietary intakes from the NZ ANS 08/09 were analysed.
5. A list of food items with missing added sugars estimates was sent to researchers, who calculated added sugars estimates for these foods.
6. Steps 3-5 were repeated, due to difficulties with Kai-culator dietary assessment software.
7. Usual daily dietary intakes including estimated added sugars intake for all NZ ANS 08/09 participants, by food item and nutrient, were outputted.

4.7 Statistical Methods

For the statistical analysis of the current study, data from the NZ ANS 08/09 were categorised by age, sex and ethnicity. Age was split into five categories: 15-18, 19-30, 31-50, 51-70, and 71+ years old. Sex was separated into male or female and prioritised ethnicity was used categorised into Māori, Pacific and New Zealand European and other (NZEO). Stata Statistical Analysis Software (version 13.1, Stata Corporation, Texas) was used for all analyses. Data from each participant were weighted so that estimates of added sugars intake can be interpreted as representative of the entire NZ population aged 15 years and over (54). The Stata survey command was used to estimate means, medians, percentiles and proportions for this population. A nutrient intake line for each participant in the NZ ANS 08/09 was generated from the 24-hour diet recalls, of which (25%) had two 24-hour diet recalls. Estimates of usual intake for total sugar, sucrose and added sugars were estimated using MSM (55), which predicts habitual consumption based on a short-term measurement of dietary intake and accounts for intra-individual variation without adjustment for age, sex or ethnicity. Usual daily intakes of total sugar, sucrose and added sugars were then reported in grams and %TE intake for the whole population by mean, 10^{th}, 50^{th} and 90^{th} centiles. Age, ethnicity and sex-specific intakes were also determined. Following this, the percentage of the participants from the NZ ANS 08/09 (by age, sex and ethnicity) meeting the USDA and WHO recommendations for added and free sugars intake were reported. Previously reported intake data from the NZ ANS 08/09 were adjusted for intra-individual variation using the PC-SIDE method (56) and total response standard output ethnicity was used rather than prioritised ethnicity. This has resulted in small differences in reported energy, total sugar and sucrose intakes.

5 Results

5.1 Estimation of added sugars for all foods in the FOODfiles database

In total, 2,779 foods contained in the FOODfiles database were allocated an added sugars estimate. Objective steps 1-6 were used to estimate added sugars for 2,463 (89%) foods and 316 (11%) were estimated using subjective steps 7-10. Over half of the foods (n=2,080) were classified using steps 1-3. The number of foods allocated by each step is shown in **Table 5.1**. A subsample of foods from the FOODfiles database and their added sugars estimates has also been provided in **Table 5.2**.

5.2 Sample characteristics of NZ ANS 08/09 participants

The target population for the NZ ANS 08/09 consisted of 3.2 million adults aged 15 years and over, who were living in NZ. The final weighted response rate for the survey was 61%, with refusal and non-contact rates being 31% and 8% respectively. Overall, 4,721 24-hour diet recalls were completed with respondents. A repeat 24-hour diet recall was collected in 25% of participants, which was used to adjust for usual dietary intake. The median energy intake for this population was 8,630 kilojoules (kJ), with males consuming 9,900kJ and females 7,740kJ per day. The median total sugar intake of the population was 107g and added sugars comprised slightly under half (46%) of total sugar intake (**Appendix B**).

Table 5.1. Step allocation for added sugars estimates

Step number	Step type	Number of foods
1	Objective	657
2	Objective	1088
3	Objective	335
4	Objective	161
5	Objective	43
6	Objective	179
7	Subjective	55
8	Subjective	129
9	Subjective	49
10	Subjective	83
Total		2,779

Table 5.2. Estimated added sugars content for selected food items within the FOODfiles database.

Food ID and name	Total sugar content (g /100g)	Added sugars content (g /100g)
A154 Bread, soy and linseed, South Island, prepackaged, U.N.I	3.8	0
A137 Cracker, Snax, Griffins	2.3	2.3
A61 Biscuit, cookie, chocolate chip	39.8	38.6
B14 Liqueur, Advocaat	27.1	27.1
C104 Juice, Nature’s Blend, Citrus Tree	10.6	3.1
C84 Powerade, liquid	8.8	8.8
D43 Sultana Bran, Kellogg's	32.2	13.1
E1001 Spaghetti, in tomato sauce, canned, Watties	5.1	2.7
F116 Yoghurt, Yoplait Lite assorted fruit, low fat, sweetened	12.8	6.3
H1023 Butter Chicken	5.0	4.2
H1043 Sausage roll, individual size, microwaved	2.8	2.8
H11 Burger, Quarter Pounder, McDonald's	3.9	2.0
H189 Pizza, meat, large, baked, commercial, thick crust	3.5	1.7
L135 Pears, canned, with syrup	19.7	12.7
R101 Pudding, bread and butter, baked	11.0	4.3
R27 Casserole, chicken with vegetables	2.0	0
R363 Nachos, with beans, cheese & sour cream	4.3	1.1
R62 Omelette, cheese	0.4	0
S32 Dressing, Italian, Lite, Eta	5.0	5.0
U6 Potato crisps, flavoured	1.2	1.2
U24 Muesli bar, yoghurt coated, assorted	31.0	17.5
V66 Soup, mushroom, dried, prepared with water	0.1	0.1
W38 Chocolate bar, with peanuts	34.2	27.7
W8 Fruit gums	56.2	56.2

5.3 Differences in added sugars intake by age group, sex and ethnicity for NZ ANS 08/09 participants

Median usual intake of added sugars for the total population was 49g (**Table 9.1**), which contributed 9.5% of total energy intake (**Table 9.2**). Males had higher absolute added sugars intake than females (**Figure 5.1**), however, added sugars contributed the same proportion to total energy intake, both 9.5% (**Table 9.2**). Younger age groups generally had significantly higher intakes of added sugars than older age groups (**Table 9.1**). By ethnicity, Māori people tended to have higher absolute added sugars intake, (median intake for Māori males 62g and for Māori females 48g) which contributed a greater proportion of total energy intake (10% TE intake for Māori males and 10.6% TE intake for Māori females) compared to NZEO and Pacific people. Lowest median intake of added sugars (25g) was among Pacific females aged 51 years and over, in this group added sugars also contributed the least to total energy intake (6.4%). Conversely, Pacific males aged 19-30 years were the highest absolute consumers of added sugars with a median usual intake of 82g. Regarding energy intake, added sugars contributed the greatest proportion of total energy (14.5%) among Māori females aged 15-18 years. By total population, added sugars and sucrose contributed a similar proportion to total energy intake (**Figure 5.4**), however, once stratified by age group sucrose intake differed to added sugars intake (**Figure 5.5**). This difference was statistically significant in the 15-18 years of age category, who had the highest added sugars intake (**Figure 5.5**).

Figure 5.1. Median usual daily added sugars intake (g) by age group and sex, for NZ ANS 08/09 participants

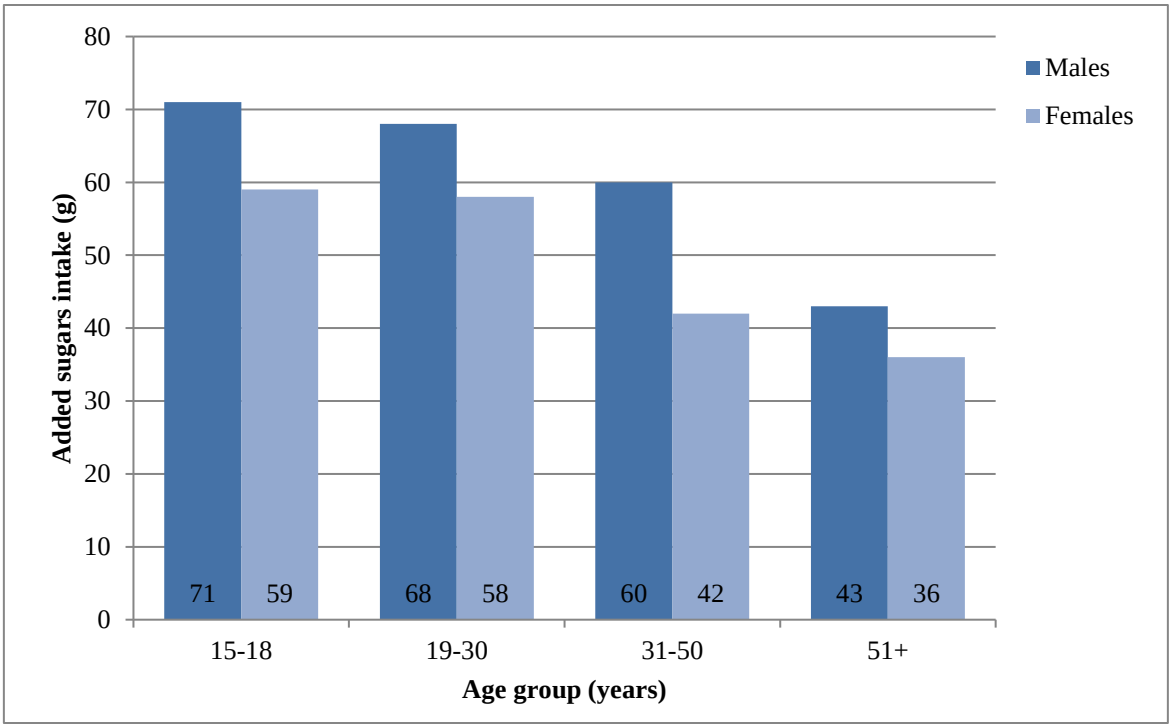


Figure 5.2. Median percent total energy intake from added sugars by age group and sex, for NZ ANS 08/09 participants

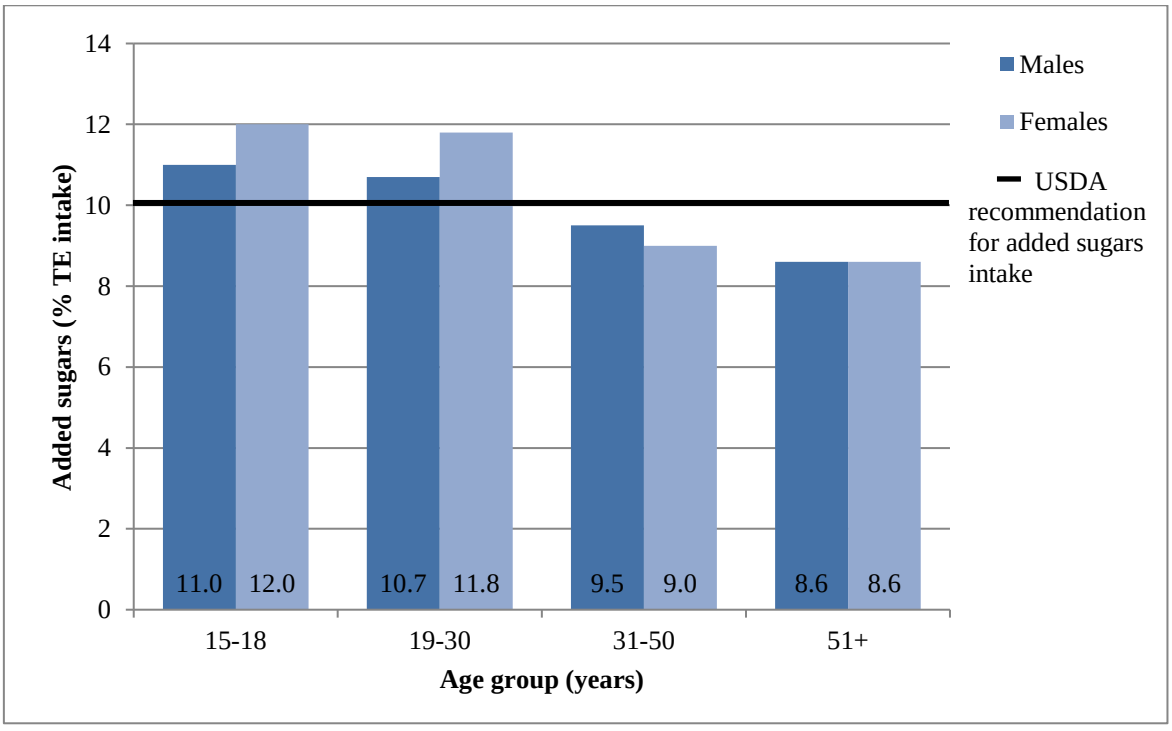


Figure 5.3. Median usual daily intake (g) of total sugar, sucrose, free and added sugars, for NZ ANS 08/09 participants, by sex

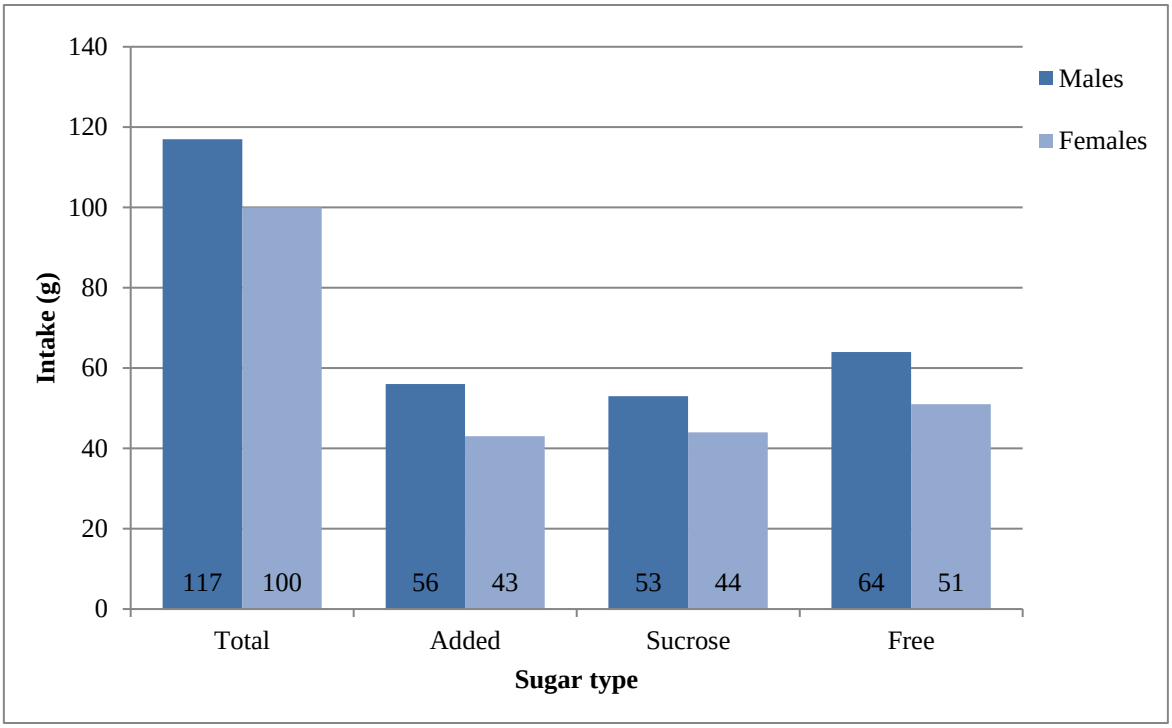


Figure 5.4. Median percent total energy intake from total sugar, sucrose, free and added sugars, for NZ ANS 08/09 participants, by sex

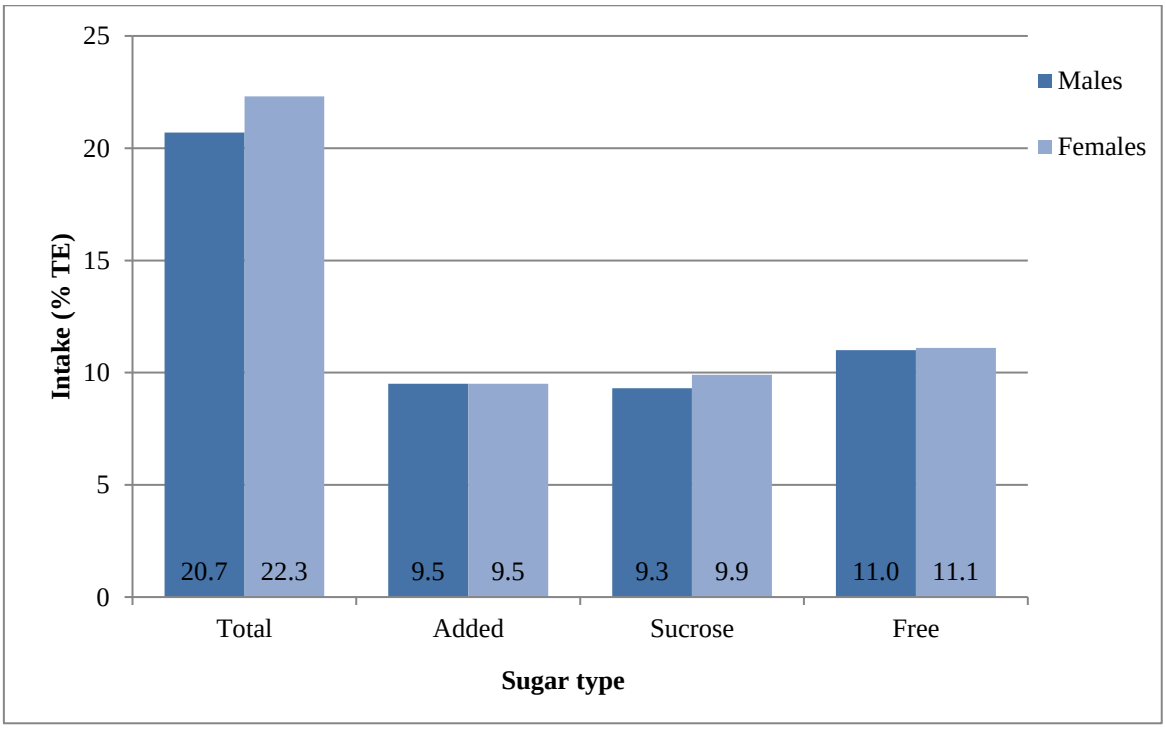
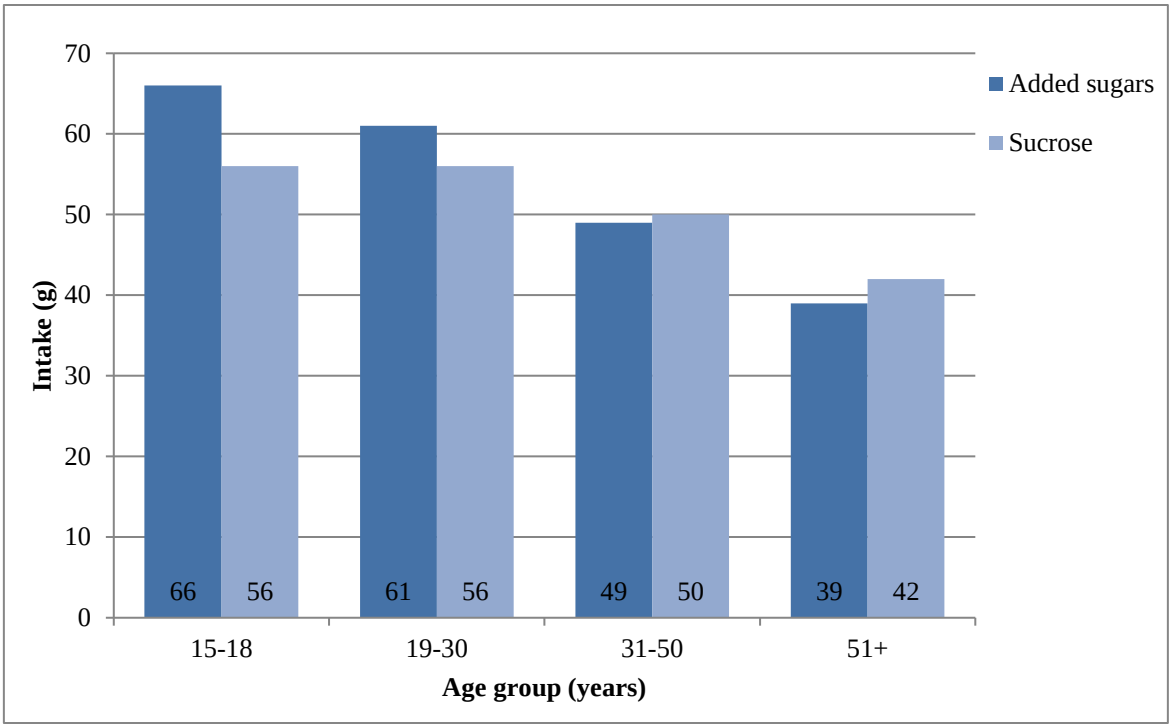


Figure 5.5. Median usual daily added sugars and sucrose intake (g) for NZ ANS 08/09 participants, by age group



5.4 Percentage of participants from the NZ ANS 08/09 meeting USDA added sugars and WHO free sugars intake guidelines

Within the adult NZ population, highest adherence was to the <10% TE intake from added sugars guideline with over half of the population (53.8%) achieving this recommendation. The percentage of the population meeting the WHO conditional recommendation of <5% TE from added sugars was substantially lower at 14.9% (**Table 5.3**). In general, a greater proportion of males in all age categories were meeting these recommendations when compared with females. Older age groups were also more likely to meet these guidelines than younger people (**Figure 5.6**). Greatest adherence (69.3%) was found among Māori males ages 51 years and over to the <10% TE intake from added sugars recommendation. Across all age categories, Pacific people were more likely to meet these recommendations when compared to Māori and NZEO ethnicities.

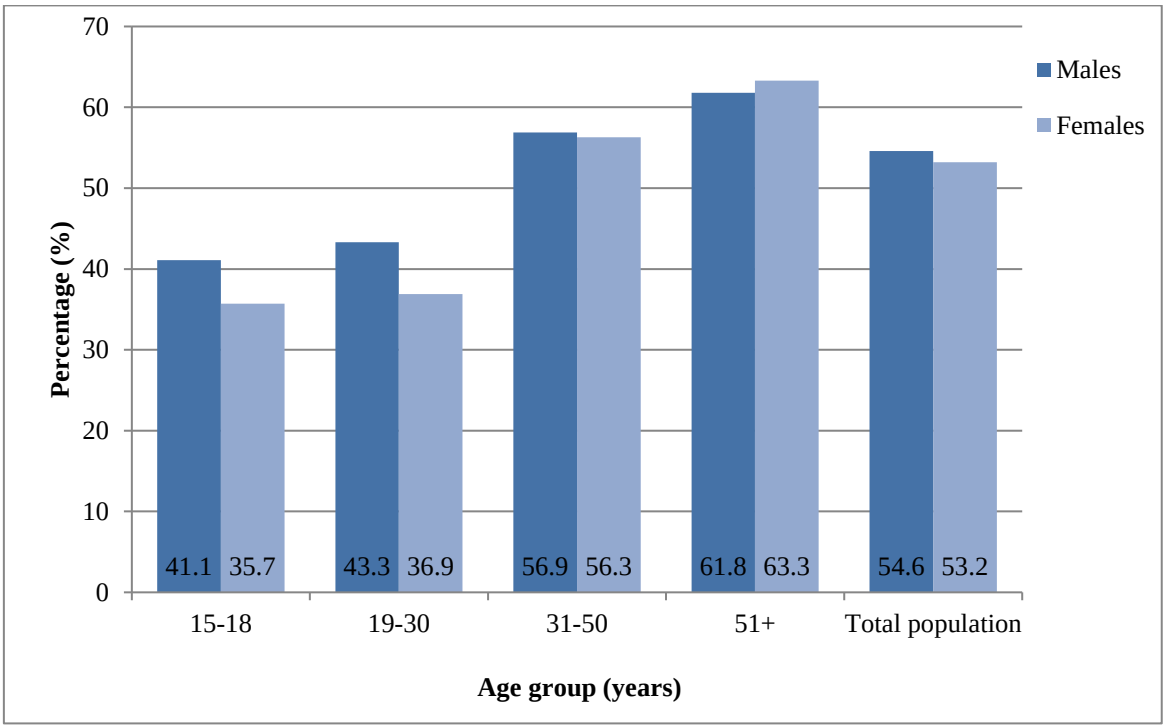
Table 5.3. Percentage of participants from the NZ ANS 08/09 meeting USDA added sugars and WHO free sugars intake recommendations

		Population meeting USDA added sugars and WHO free sugars intake recommendations (%)	
		Added sugars <10% TE intake	**Added sugars <5% TE intake (conditional recommendation)[1]**
Total population		53.8	14.9
By age group (years)			
Males	15-18	41.1	9.2
	19-30	43.3	14.8
	31-50	56.9	15.1
	51+	61.8	17.4
	Total	54.6	15.1
Females	15-18	35.7	8.0
	19-30	36.9	8.8
	31-50	56.3	14.2
	51+	63.3	19.9
	Total	53.2	14.8
Māori			
Males	15-18	36.7	6.1
	19-30	40.4	14.9
	31-50	52.2	15.5
	51+	69.3	26.7
	Total	51.9	17.0
Females	15-18	32.3	8.1
	19-30	33.9	8.5
	31-50	48.0	13.2
	51+	65.1	24.7
	Total	46.5	14.0
Pacific			
Males	15-18	57.7	19.2
	19-30	45.7	14.3
	31-50	66.7	18.9
	51+	65.2	29.0
	Total	61.1	20.1
Females	15-18	36.8	15.8
	19-30	42.1	12.2
	31-50	61.8	12.7
	51+	76.0	34.7
	Total	56.5	17.2
NZEO			
Males	15-18	40.2	8.8
	19-30	44.2	15.0
	31-50	54.0	12.6
	51+	60.3	14.8

		Population meeting USDA added sugars and WHO free sugars intake recommendations (%)	
		Added sugars <10% TE intake	**Added sugars <5% TE intake (conditional recommendation)[1]**
	Total	53.8	14.6
Females	15-18	36.3	7.0
	19-30	36.7	6.7
	31-50	59.9	15.6
	51+	62.0	17.8
	Total	55.0	13.2

1 Conditional recommendation is for free sugars intake, although population adherence is reported as added sugars intake.

Figure 5.6. Percentage of participants from the NZ ANS 08/09, by age group and sex, meeting the USDA <10% TE intake from added sugars recommendation



6 Discussion and Conclusions

The purpose of the current study was to develop an added sugars database to estimate intakes of added sugars among NZ adults using data from the NZ ANS 08/09. A modified version of the ten-step systematic methodology proposed by Louie et al (3) was applied to the NZFCD using FOODfiles. In total, 2,779 foods were assigned an added sugars estimate using objective and subjective steps. Within this population of NZ adults, added sugars comprised 9.5% of total energy intake (median intake 49g), which made up almost half (46%) of total sugar intake. As expected, higher intakes of added sugars were found among younger age groups compared to older people and men had higher absolute intakes than women, although added sugars contributed the same proportion to total energy intake (median intake 9.5% TE). Compared with dietary intake guidelines, almost half of the population (46.2%) was not meeting the USDA recommendation for added sugars intake (<10% TE intake). Furthermore, adherence to the conditional WHO recommendation was substantially lower, with just 14.9% of the population achieving intakes of added sugars <5% of TE intake. Although these intakes are reported as added sugars, population adherence to the conditional WHO recommendation would likely be similar and slightly lower for free sugars intake.

The added sugars estimates developed for the NZFCD can be interpreted as the best currently available data, as a standardised methodology was used (3). The majority of added sugars were estimated using objective steps (89%, n=2,463) as opposed to subjective steps (11%, n=316). This increases the reliability of these estimates and significantly reduces the likelihood of bias, as the subjective steps have little overall impact (3). These results are comparable to Louie et al (3), who recently applied this method to the Australian food

composition database. Although more foods are included in the Australian database, 72% had added sugars estimated using objective steps and 28% through subjective estimation. A greater number of subjective estimates compared to our findings may be a result of a larger database, which is likely to contain a higher number of packaged food items requiring subjective estimation. Considering chemical analysis cannot differentiate added sugars from intrinsic sugars (3), the estimates proposed from the current study provide a reliable starting point for NZ.

It is difficult to accurately compare estimates of added sugars intake in NZ with population intakes in other countries due to differences in methods of dietary assessment, definitions of added sugars and methods used to estimate added sugars. Nevertheless, some comparable studies have been identified. Recent intake data from 3,817 Dutch men and women aged 7-69 years reported a median added sugars intake of 64g/day, contributing 12.2% to TE intake and 55% of total sugar intake (49). These intakes are notably higher than that of the NZ population, considering a similar added sugars definition and the same method of dietary assessment was used. However, this study did use a different method (International Choices Program) for estimating added sugars in the food supply, which may account for some differences (49). The International Choices Programme is a somewhat complicated 59-step method, using generic criteria based on food labels and information from food manufacturers to develop added sugars values as a proportion of total sugar for packaged foods (9). Another study of 4,140 Australian children aged 2-16 years estimated mean added sugars intake using the same approach our method is based on. The mean reported intake of added sugars was 58.9g/day (11.9% TE intake), which comprised 46.9% of total sugar intake (57). In the Australian population aged 2-71 years and older, the mean intake of added sugars was 60.3g,

which was 10.8% of TE intake (58). Although these two Australian studies also included children, our findings are highly comparable as added sugars were estimated using the same method (3) and dietary intake was also assessed via a 24-hour diet recall. Although the proportion of total sugar as added sugars is very similar, it appears absolute intakes of added sugars in Australia are somewhat higher than in NZ. One explanation for these differences could be that these studies presented intakes as means rather than medians, which tend to be skewed towards higher values for dietary intake. For example, in the present study mean intakes of added sugars are noticeably higher than median intakes. In addition, under-reporting of dietary intake from participants in the NZ ANS 08/09 could also be a another important factor contributing to lower estimated added sugars intake in NZ compared to other similar countries (59). Using information from a study that estimated the level of under-reporting in the NZ ANS 08/09, it could be conservatively assumed that all intakes were underestimated by approximately 20% (59). This would suggest median added sugars intake for the current study are closer to 59g, similar to that in Australia, and potentially contributing a greater proportion to total energy intake. Therefore, a cautious approach should be taken when interpreting these results in relation to other findings, particularly as these are estimated intakes.

Previously, some studies have estimated added sugars intake via sucrose, as it is thought this is a suitable surrogate measure (17). Although this assumption may be true at a population level, our findings suggest that the use of surrogate measures, such as sucrose, underestimates added sugars intake among under 30 year olds. This was particularly evident in 15-18 year olds, whereby sucrose intake was significantly lower (18% difference) than added sugars intake. In those over 30 years of age, sucrose slightly underestimates added

sugars intake, due to fruit contributing more to sucrose intake in older people compared with younger people (15). Sucrose is widely found not only in many processed foods, but also in foods such as fruit and vegetables, which do not contribute to added sugars (1). Furthermore, the use of sucrose does not account for several other forms of added sugars, which are encompassed under the USDA definition of added sugars (39). Therefore, in future nutrition surveys it is recommended that the added sugars estimates developed from the current study be used, as sucrose may over or underestimate added sugars intake, while capturing intrinsic sugars in fruit and vegetables.

Few other studies have reported population adherence to added sugars intake guidelines and those that have, suggest some recommendations are too ambitious for populations to achieve (2). In the Dutch study mentioned previously, 71% of the population were not achieving the <10% of TE from added sugars guideline (49). Analysis of National Health and Nutrition Examination Survey (NHANES III) data also shows a similar proportion (71.4%) of US adults have added sugars intake >10% of TE intake (4). This is substantially more than reported by NZ adults in the NZ ANS 08/09, in which slightly under half (46.2%) of the population were not meeting this recommendation and substantially fewer were achieving the conditional WHO recommendation. Recently, Erickson and Slavin (2) claimed that the conditional recommendation set by the WHO was not realistic for the general public to achieve, unless they were prepared to use food products that were artificially sweetened and suggested the <10% TE guideline is more practical. Our findings also imply that the conditional recommendation (<5% TE intake from free sugars) would be challenging for many of the NZ population to meet, particularly those in the younger age groups. From a public health perspective, it is important that these recommendations are achievable for

populations, in order to make changes that will have a significant and lasting impact and not result in wasted resources. In the future, structural changes to the food supply including sugar taxes, healthy food policies in schools and food industry adopting the use of non-caloric sweeteners in foods and drinks could all be possible methods to make this conditional recommendation more realistic (2, 40). Currently, the <10% TE intake from added sugars guideline could be a more achievable goal for NZ people, particularly on a population basis.

6.1 Strengths and Limitations

This study was the first of its kind to develop added sugars estimates for the NZFCD in order to determine added sugars intake in NZ adults. There are a number of strengths in the ten-step systematic methodology used to develop added sugars estimates for the present study. This method only contains ten detailed, yet easy to follow steps, in which inter-rater repeatability has been tested showing good reliability (52). Simplicity of use, particularly regarding the objective steps meant a high level of detailed knowledge on food composition was not required, reducing the possibility of bias (3). Furthermore, the added sugars estimates that were developed are reasonably credible as the majority (89%) of foods were estimated using objective steps. Since laboratory-based analytical methods cannot differentiate between added and intrinsic sugars, this method offers a simple approach to estimate added sugars in NZ (3). This will also provide a way to distinguish between those who have high sugar intakes from fruit, such as older people, compared to high intakes from discretionary foods among the NZ population (15).

Another strength of this study is that intake data for added sugars was obtained from the NZ ANS 08/09, which contains a sizable representative sample of NZ adults (15). As the sample

size of this survey was large, it provided a wide range of added sugars intake, allowing for comparisons to be made. Furthermore, the use of two non-consecutive 24-hour diet recalls in 25% of participants helped account for intra-individual variation in dietary intake, providing an indication of usual added sugars intake (55). Although it is challenging to obtain reliable and accurate measures of dietary intake, the use of individual intake data such as that from the NZ ANS 08/09 is preferred to food availability data. This is often due to food balance sheets not accounting for wastage, resulting in overestimations of consumption (11). For example, Food and Agriculture Organization data shows that NZ consumed 54.6 kilograms (kg) per capita of sugar in 2008, suggesting an estimated average daily intake of 150g (60). This is compared to our analysis of the NZ ANS 08/09 data, which indicates a median intake of 107g of total sugar, of which 49g is added sugars. Hence, the development of added sugars estimates for the NZFCD and linkage to individual dietary intake data signifies a key strength of this study.

The methodology used for this study is one of the more standardised available, however, some limitations still exist. One of the most notable of these, as with other methods, is that food manufacturers are constantly updating food formulations making it difficult to keep up-to-date (3). This research used data from FOODfiles 2010 meaning a small number of food items were either outdated, or had been reformulated and the sugar content along with other nutrients had changed. Assumptions regarding the added sugars content of these food groups were developed to simplify the process, which may have compromised the accuracy of a small number of these estimates. During this process, it was also noted that many discretionary foods and snack products used other forms of sweeteners, which fell outside of the added sugars definition (39). These included fruit juices, fruit purees and dried fruits

added as a sweetener, however, these were not included as added sugars (13). In light of the recent addition of added sugars to nutrition information labels in the US, the use of these forms of sweeteners could pose a limitation, as all added sugars may not be accounted for in labeling. This may create an opportunity for food manufacturers to use these alternative sweeteners without compromising the added sugars content listed on the nutrition label (51). In the current study, the use of fruit-derived sugars as a sweetener may have resulted in some underestimation of the true extent of added sugars in foods, particularly those requiring subjective estimation.

A final limitation of this research is the validity of the estimated added sugars intake, as mentioned previously there is potential for underestimation (59). Some studies have shown that underreporting, particularly of discretionary food items, which are likely to contain greater amounts of added sugars, is a common issue (61, 62). Recent research regarding the NZ ANS 08/09 found 21% of men and 25% of women potentially under-reported on dietary intake. Furthermore, this problem appeared to be more pronounced among people who were overweight or obese, as well as Pacific people compared to Māori and NZEO (59). These findings should be recognised as a possible limitation of this research. Therefore, estimated intakes of added sugars for NZ adults could potentially be greater, thus overestimating the proportion of the population who are meeting the USDA and WHO recommendations for added and free sugars intake.

6.2 Conclusions and Recommendations

A modified version of the ten-step systematic methodology for estimating added sugars in the food supply was successfully applied to the NZFCD and estimates of added sugars intake in

the NZ population were determined. Estimated intakes of added sugars in NZ are slightly lower than other comparable countries, however, the possibility of under-reporting on dietary intake must be taken into account when interpreting the findings (59). Furthermore, almost half of the population was not adhering to the USDA recommendation for added sugars intake. This is concerning, given the likelihood of under-reporting, as intakes above this recommendation have been linked to higher risk of dental caries (5), CVD (4) and obesity (7). These findings indicate there may be benefits in reducing added sugars consumption in NZ, particularly among young adults who reported the highest intakes. While total population results indicate sucrose may be a good surrogate measure for added sugars, further analysis shows using sucrose can over or underestimate added sugars intake. Therefore, it is recommended that this database be regularly updated to measure and monitor added sugars intake in the NZ population in relation to dietary intake guidelines and health outcomes.

7 Application of Research to Dietetic Practice

The results of this research indicate that almost half of the NZ adult population aged 15 years and over have high intakes of added sugars, that is added sugars >10% of TE intake (12). This is concerning to dietitians and public health experts as high intakes of added sugars have been related to increased body weight and obesity (7). Results from the latest NZ Health Survey indicate almost one third of all NZ adults are classified as obese, with a further 35% of adults overweight (53). Therefore, the reduction of added sugars intake in NZ could be an important component for dietitians, public health experts and other health professionals to consider in the battle against obesity.

Evidence-based dietary guidelines are important for population health and underpin dietetic practice, however, they are not useful unless population level intakes can be measured and monitored. Previously, it was very difficult to monitor added sugars intake in NZ in relation to nutrition guidelines, as national survey data only reported individual and total sugar intake (15). Now that the NZ food supply contains estimates of added sugars, it is possible to compare intakes of added sugars to dietary intake recommendations. The results of this research may also be useful for future MoH guidelines regarding added sugars intake, potentially allowing for the adoption of more quantitative recommendations similar to that of the USDA and WHO (12, 13). Dietitians and other health professionals could then apply these evidence-based quantitative guidelines with increased confidence to contribute to the health and wellbeing of the NZ population.

From the current study, we know that young adults are the highest consumers of added sugars. In addition, the ANS 08/09 data for total sugar and sucrose intake (15), shows the food groups that are likely to contribute to high added sugars intakes. However, these added sugars estimates now provide an opportunity for future research to more accurately determine key food groups contributing to added sugars in the NZ diet. Subsequently, this would provide direction for nutrition interventions at both an individual and population level, which could direct public health initiatives to have a positive impact and reduce added sugars intake in NZ.

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9 Appendices

Appendix A

Appendix B

Appendix C

Appendix D

Appendix A

Table 9.1. Added sugars intake (g) and percentage total energy intake from added sugars, by age group, sex and ethnicity for NZ ANS 08/09 participants

		Added sugars intake (g)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Total population		58	16	49 (47-51)	108
By age group (years)					
Males	15-18	79	21	71 (64-78)	132
	19-30	81	23	68 (59-76)	156
	31-50	67	21	60 (56-64)	124
	51+	51	14	43 (39-47)	93
	Total	65	19	56 (53-59)	120
Females	15-18	70	21	59 (54-65)	133
	19-30	68	21	58 (52-63)	131
	31-50	50	16	42 (38-46)	98
	51+	41	14	36 (33-39)	72
	Total	52	16	43 (41-46)	98
Māori					
Males	15-18	83	33	80 (61-100)	132
	19-30	90	23	81 (59-103)	154
	31-50	69	22	62 (50-73)	140
	51+	44	9	38 (29-46)	88
	Total	71	18	62 (54-71)	134
Females	15-18	74	21	65 (49-81)	133
	19-30	74	19	65 (52-78)	141
	31-50	56	18	47 (39-56)	109
	51+	39	11	31 (26-36)	80
	Total	60	16	48 (42-55)	116
Pacific					
Males	15-18	62	16	53 (35-70)	143
	19-30	88	27	82 (55-109)	151
	31-50	56	21	42 (36-48)	112
	51+	59	11	42 (35-49)	129
	Total	67	17	51 (43-59)	143
Females	15-18	67	18	59 (40-79)	112
	19-30	67	18	53 (41-66)	117
	31-50	53	19	43 (37-49)	98
	51+	35	8	25 (20-29)	63
	Total	55	15	42 (36-48)	103
NZEO					

		Added sugars intake (g)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Males	15-18	79	20	71 (63-79)	131
	19-30	79	23	63 (55-72)	156
	31-50	67	20	60 (55-65)	124
	51+	51	14	44 (40-48)	93
	Total	64	19	55 (52-59)	118
Females	15-18	69	21	58 (52-65)	133
	19-30	67	24	57 (51-62)	121
	31-50	49	16	42 (38-45)	96
	51+	42	14	37 (33-40)	72
	Total	50	16	43 (41-45)	94

1 Usual daily intake. These data were adjusted for intra-individual variation using MSM.
2 Percentiles.

Table 9.2. Percentage total energy intake from added sugars by age group, sex and ethnicity for NZ ANS 08/09 participants

		Added sugars (% TE intake)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Total population		10.3	4.0	9.5 (9.3-9.8)	17.1
By age group (years)					
Males	15-18	12.0	4.8	11.0 (10.0-12.0)	19.1
	19-30	12.0	4.2	10.7 (9.7-11.8)	21.7
	31-50	10.1	4.3	9.5 (8.8-10.1)	16.0
	51+	9.2	3.3	8.6 (7.9-9.2)	15.1
	Total	10.3	4.0	9.5 (9.1-9.9)	17.2
Females	15-18	13.3	5.6	12.0 (11.0-13.0)	22.5
	19-30	12.3	5.0	11.8 (10.8-12.8)	19.9
	31-50	9.8	4.1	9.0 (8.3-9.7)	16.5
	51+	9.1	3.8	8.6 (8.1-9.0)	15.3
	Total	10.3	4.0	9.5 (9.2-9.8)	17.1
Māori					
Males	15-18	12.6	5.8	13.0 (9.9-16.1)	19.0
	19-30	12.3	4.5	11.7 (9.3-14.0)	20.7
	31-50	10.3	4.8	9.5 (8.5-10.4)	17.4
	51+	8.8	2.5	7.2 (6.1-8.2)	15.1
	Total	10.8	4.1	10.0 (8.9-11.2)	18.5
Females	15-18	14.5	6.2	14.5 (11.2-18.0)	23.7
	19-30	12.7	4.7	12.2 (10.8-13.7)	20.8
	31-50	10.7	4.9	10.7 (9.3-12.0)	18.0
	51+	8.7	2.8	8.1 (6.9-9.3)	16.3
	Total	11.2	4.1	10.6 (9.7-11.4)	19.4
Pacific					
Males	15-18	9.6	4.0	7.9 (6.0-9.9)	15.4
	19-30	13.0	4.9	11.4 (9.4-13.4)	24.5
	31-50	8.8	3.7	7.7 (6.7-8.7)	15.8
	51+	9.7	3.4	8.5 (7.1-9.9)	17.0
	Total	10.3	4.0	8.9 (7.9-9.9)	18.3
Females	15-18	13.0	4.9	11.0 (7.7-14.3)	24.4
	19-30	11.4	4.1	10.7 (9.3-12.0)	21.1
	31-50	9.5	4.9	8.9 (8.2-9.6)	14.7
	51+	7.5	2.4	6.4 (5.2-7.6)	13.7
	Total	10.0	3.7	9.0 (8.3-9.7)	16.7
NZEO					
Males	15-18	12.1	4.8	11.2 (10.0-12.3)	20.2
	19-30	11.9	4.2	10.5 (9.3-11.8)	21.7
	31-50	10.1	4.3	9.6 (8.8-10.5)	15.9
	51+	9.2	3.5	8.6 (7.9-9.3)	14.9
	Total	10.2	4.0	9.5 (9.1-9.9)	17.0

		Added sugars (% TE intake)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Females	15-18	13.0	5.9	11.9 (11.1-12.6)	21.7
	19-30	12.3	5.4	11.8 (10.5-13.0)	19.1
	31-50	9.7	3.8	8.9 (8.1-9.7)	16.4
	51+	9.1	3.8	8.6 (8.1-9.1)	15.3
	Total	10.2	4.0	9.4 (9.0-9.8)	16.8

1 Usual daily intake. These data were adjusted for intra-individual variation using MSM.
2 Percentiles.

Appendix B

Table 9.3. Total sugar intake (g) and percentage total energy intake from total sugar, by age group, sex and ethnicity for NZ ANS 08/09 participants

		Total sugar intake (g)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Total population		114	61	107 (105-109)	175
By age group (years)					
Males	15-18	132	60	126 (118-134)	214
	19-30	137	73	126 (117-135)	215
	31-50	128	67	122 (115-130)	194
	51+	110	62	106 (102-110)	164
	Total	124	66	117 (113-121)	188
Females	15-18	117	60	109 (104-115)	179
	19-30	121	63	112 (104-121)	184
	31-50	104	58	99 (95-103)	156
	51+	98	55	95 (92-98)	143
	Total	106	58	100 (97-102)	157
Māori					
Males	15-18	134	73	128 (109-146)	217
	19-30	144	63	136 (111-162)	229
	31-50	120	64	112 (101-123)	203
	51+	96	50	92 (74-109)	147
	Total	123	61	112 (103-121)	202
Females	15-18	112	50	108 (88-129)	172
	19-30	126	61	114 (105-124)	206
	31-50	109	50	103 (98-108)	170
	51+	88	45	82 (73-90)	139
	Total	110	51	102 (96-108)	176
Pacific					
Males	15-18	118	67	89 (63-116)	210
	19-30	139	58	129 (103-154)	221
	31-50	107	45	99 (84-113)	181
	51+	107	47	88 (65-112)	180
	Total	117	51	109 (97-120)	203
Females	15-18	111	59	105 (90-120)	169
	19-30	117	49	106 (93-119)	189
	31-50	106	53	96 (89-102)	169
	51+	82	36	70 (57-83)	134
	Total	104	46	94 (90-99)	168
NZEO					

		Total sugar intake (g)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Males	15-18	133	57	128 (120-136)	214
	19-30	136	73	124 (113-134)	215
	31-50	130	69	126 (118-134)	194
	51+	111	63	108 (103-113)	165
	Total	124	67	118 (114-122)	186
Females	15-18	119	60	111 (104-118)	182
	19-30	120	63	112 (101-124)	179
	31-50	103	60	98 (94-103)	154
	51+	99	57	96 (92-100)	143
	Total	105	59	99 (96-103)	155

1 Usual daily intake. These data were adjusted for intra-individual variation using MSM.
2 Percentiles.

Table 9.4. Percentage total energy intake from total sugar by age group, sex and ethnicity for NZ ANS 08/09 participants

		Total sugar (% TE intake)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Total population		21.9	14.2	21.5 (21.2-21.8)	29.7
By age group (years)					
Males	15-18	21.7	13.2	21.0 (19.9-21.1)	29.7
	19-30	21.8	14.3	20.8 (19.7-22.0)	31.1
	31-50	20.5	13.1	20.4 (19.5-21.3)	28.0
	51+	21.0	13.0	20.8 (20.1-21.4)	28.4
	Total	21.0	13.2	20.7 (20.2-21.2)	28.8
Females	15-18	24.1	15.7	23.9 (23.0-24.8)	33.1
	19-30	23.7	16.9	23.9 (22.7-25.0)	31.8
	31-50	21.8	14.4	21.5 (20.7-22.2)	29.7
	51+	22.7	15.2	22.2 (21.7-22.8)	30.3
	Total	22.7	15.1	22.3 (21.9-22.7)	30.7
Māori					
Males	15-18	21.5	13.2	20.7 (16.1-25.3)	27.6
	19-30	21.2	12.4	20.3 (17.6-23.1)	29.7
	31-50	19.1	12.3	17.8 (16.5-19.2)	26.8
	51+	19.7	11.7	17.3 (16.1-18.5)	28.0
	Total	20.1	12.4	18.8 (17.8-19.7)	28.0
Females	15-18	23.7	13.8	23.8 (20.7-27.0)	34.2
	19-30	23.4	14.6	23.9 (22.1-25.7)	32.4
	31-50	23.0	13.3	23.0 (21.2-24.8)	32.8
	51+	21.2	13.3	20.4 (18.9-21.8)	29.5
	Total	22.8	13.7	22.8 (21.7-23.9)	32.1
Pacific					
Males	15-18	19.9	12.8	17.5 (14.0-21.3)	28.5
	19-30	21.7	12.6	19.8 (17.5-22.1)	36.3
	31-50	18.0	10.7	17.9 (15.5-20.4)	26.2
	51+	19.8	12.5	18.5 (16.1-20.9)	29.6
	Total	19.6	11.8	18.8 (17.6-20.1)	29.3
Females	15-18	23.9	12.4	23.6 (21.0-26.1)	33.2
	19-30	22.5	13.1	21.7 (20.3-23.1)	31.6
	31-50	20.8	14.2	21.1 (19.7-22.5)	27.9
	51+	44.4	11.2	18.3 (16.2-20.4)	27.2
	Total	21.2	13.0	21.0 (20.2-21.9)	29.3
NZEO					
Males	15-18	21.9	13.2	21.5 (20.4-22.6)	30.4
	19-30	21.9	14.7	21.2 (19.6-22.8)	31.1
	31-50	20.8	14.1	20.7 (19.9-21.5)	28.0
	51+	21.1	13.3	20.9 (20.1-21.8)	28.4
	Total	21.2	13.5	21.0 (20.5-21.5)	28.8

		Total sugar (% TE intake)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Females	15-18	24.2	16.3	24.1 (22.9-25.2)	33.1
	19-30	23.9	17.3	23.9 (22.7-25.0)	31.7
	31-50	21.7	14.6	21.3 (20.5-22.2)	29.3
	51+	22.9	15.5	22.4 (21.7-23.0)	30.3
	Total	22.7	15.4	22.3 (21.8-22.8)	30.4

1 Usual daily intake. These data were adjusted for intra-individual variation using MSM.
2 Percentiles.

Appendix C

Table 9.5. Sucrose intake (g) and percentage total energy intake from total sugar, by age group, sex and ethnicity for NZ ANS 08/09 participants

		Sucrose intake (g)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Total population		54	22	48 (46-50)	89
By age group (years)					
Males	15-18	65	26	59 (55-64)	110
	19-30	68	29	60 (55-66)	123
	31-50	61	23	56 (53-60)	98
	51+	50	22	45 (42-47)	80
	Total	59	23	53 (51-55)	97
Females	15-18	60	24	54 (50-57)	101
	19-30	61	28	54 (50-58)	100
	31-50	49	21	44 (42-46)	81
	51+	43	19	40 (38-41)	69
	Total	50	22	44 (42-46)	82
Māori					
Males	15-18	68	30	64 (56-73)	108
	19-30	73	26	66 (57-74)	121
	31-50	60	22	53 (47-59)	107
	51+	44	13	39 (31-48)	75
	Total	61	22	54 (49-59)	107
Females	15-18	61	18	53 (38-67)	113
	19-30	65	25	56 (47-65)	120
	31-50	54	21	50 (43-57)	91
	51+	41	17	36 (30-41)	76
	Total	55	20	47 (42-52)	96
Pacific					
Males	15-18	54	21	46 (29-63)	131
	19-30	71	29	68 (53-83)	113
	31-50	53	19	48 (41-56)	95
	51+	62	15	46 (35-57)	110
	Total	60	21	51 (45-57)	110
Females	15-18	58	19	51 (43-60)	97
	19-30	60	19	52 (44-60)	100
	31-50	53	23	48 (44-51)	92
	51+	42	13	35 (28-41)	67
	Total	53	18	46 (42-49)	92
NZEO					
Males	15-18	66	26	59 (55-64)	110
	19-30	66	30	59 (53-65)	123
	31-50	62	23	58 (54-61)	98
	51+	50	22	45 (42-48)	80

		Sucrose intake (g)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
	Total	58	24	53 (51-55)	95
Females	15-18	60	26	54 (50-58)	98
	19-30	60	28	54 (50-59)	95
	31-50	48	21	44 (41-46)	79
	51+	43	20	40 (38-42)	68
	Total	49	22	44 (42-46)	80

1 Usual daily intake. These data were adjusted for intra-individual variation using MSM.
2 Percentiles.

Table 9.6. Percentage total energy intake from sucrose by age group sex and ethnicity for NZ ANS 08/09 participants

		Sucrose (% TE intake)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Total population		10.0	5.4	9.6 (9.4-9.8)	15.1
By age group (years)					
Males	15-18	10.5	5.5	9.9 (9.1-10.6)	16.4
	19-30	10.5	5.3	9.7 (9.1-10.3)	16.5
	31-50	9.6	5.0	9.2 (8.6-9.8)	14.1
	51+	9.3	4.7	8.9 (8.4-9.4)	14.1
	Total	9.7	5.1	9.3 (9.0-9.5)	14.8
Females	15-18	12.0	6.2	11.4 (10.6-12.1)	18.0
	19-30	11.5	6.7	10.9 (10.1-11.6)	17.2
	31-50	10.0	5.3	9.6 (9.1-10.0)	15.0
	51+	9.7	5.4	9.3 (8.9-9.7)	14.6
	Total	10.3	5.6	9.9 (9.7-10.1)	15.4
Māori					
Males	15-18	10.7	5.8	10.6 (8.3-13.0)	15.1
	19-30	10.5	5.1	10.3 (8.9-11.7)	16.2
	31-50	9.4	4.7	9.0 (8.0-10.0)	13.9
	51+	9.0	3.4	8.1 (6.7-9.5)	13.6
	Total	9.8	4.7	9.3 (8.7-10.0)	14.8
Females	15-18	12.5	6.1	11.4 (9.0-13.7)	21.4
	19-30	11.5	6.3	11.8 (10.5-13.0)	17.2
	31-50	10.9	5.3	11.2 (10.1-12.2)	16.2
	51+	9.5	5.2	9.2 (8.3-10.1])	14.8
	Total	11.0	5.4	10.5 (9.9-11.1)	17.1
Pacific					
Males	15-18	8.8	4.7	7.9 (6.1-9.8)	15.7
	19-30	10.8	5.6	10.3 (8.5-12.1)	16.5
	31-50	8.7	4.3	8.4 (7.5-9.4)	13.5
	51+	10.6	4.7	9.3 (7.6-10.9)	18.5
	Total	9.7	4.7	9.0 (8.2-9.9)	16.0
Females	15-18	12.1	5.0	11.4 (9.4-13.5)	17.0
	19-30	11.0	5.5	10.3 (9.1-11.5)	17.1
	31-50	10.1	5.9	9.7 (8.8-10.6)	14.5
	51+	9.1	4.0	8.3 (6.8-9.8)	15.8
	Total	10.3	5.1	10.0 (9.3-10.6)	15.7
NZEO					
Males	15-18	10.6	5.5	9.9 (9.1-10.7)	17.0
	19-30	10.5	5.3	9.6 (8.9-10.3)	16.4
	31-50	9.7	5.1	9.3 (8.5-10.0)	14.2
	51+	9.3	4.9	8.9 (8.4-9.4)	14.1
	Total	9.7	5.1	9.3 (9.0-9.6)	14.8

		Sucrose (% TE intake)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Females	15-18	11.8	6.8	11.4 (10.6-12.1)	17.2
	19-30	11.6	6.9	10.8 (10.0-11.6)	17.2
	31-50	9.8	5.3	9.5 (8.9-10.0)	14.9
	51+	9.8	5.5	9.3 (8.9-9.7)	14.6
	Total	10.2	5.7	9.9 (9.6-10.1)	15.1

1 Usual daily intake. These data were adjusted for intra-individual variation using MSM.
2 Percentiles.

Appendix D

Table 9.7. Free sugars intake (g) and percentage total energy intake from total sugar, by age group, sex and ethnicity for NZ ANS 08/09 participants

		Free sugars intake (g)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Total population		66	20	57 (55-59)	121
By age group (years)					
Males	15-18	89	27	84 (76-91)	150
	19-30	91	31	75 (67-83)	167
	31-50	76	26	68 (62-73)	134
	51+	58	16	51 (48-54)	104
	Total	73	22	64 (60-68)	134
Females	15-18	80	26	71 (66-76)	137
	19-30	78	25	65 (58-72)	143
	31-50	57	21	50 (46-53)	104
	51+	48	17	42 (39-46)	83
	Total	59	19	51 (48-54)	110
Māori					
Males	15-18	92	34	88 (70-106)	150
	19-30	99	26	85 (66-105)	172
	31-50	78	27	64 (51-78)	153
	51+	48	11	42 (33-51)	93
	Total	79	20	71 (62-79)	150
Females	15-18	82	22	75 (56-93)	136
	19-30	81	24	69 (58-80)	146
	31-50	64	21	57 (49-66)	112
	51+	45	12	36 (29-43)	87
	Total	67	20	57 (51-64)	132
Pacific					
Males	15-18	74	17	62 (47-77)	156
	19-30	96	38	91 (63-119)	155
	31-50	64	21	53 (44-63)	130
	51+	65	14	52 (44-61)	132
	Total	75	21	61 (53-68)	154
Females	15-18	75	26	66 (48-83)	116
	19-30	77	23	62 (49-76)	129
	31-50	59	22	52 (46-58)	111
	51+	44	10	28 (23-33)	88
	Total	63	19	51 (46-56)	114
NZEO					

		Free sugars intake (g)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Males	15-18	60	25	86 (80-93)	145
	19-30	90	31	72 (63-82)	167
	31-50	76	27	69 (63-75)	133
	51+	58	17	52 (49-55)	105
	Total	73	22	63 (60-67)	128
Females	15-18	80	27	71 (64-78)	141
	19-30	77	26	64 (56-73)	143
	31-50	55	21	49 (45-53)	101
	51+	48	17	43 (40-47)	82
	Total	58	20	50 (47-53)	105

Table 9.8. Percentage total energy intake from free sugars by age group, sex and ethnicity for NZ ANS 08/09 participants

		Free sugars (% TE intake)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Total population		11.8	5.0	11.1 (10.7-11.4)	19.4
By age group (years)					
Males	15-18	13.8	5.7	13.0 (11.9-14.1)	21.7
	19-30	13.7	6.1	12.1 (10.9-13.3)	23.2
	31-50	11.5	5.0	10.9 (10.2-11.7)	18.2
	51+	10.5	4.0	10.1 (9.5-10.7)	16.7
	Total	11.8	4.9	11.0 (10.5-11.4)	19.1
Females	15-18	15.6	7.1	14.7 (13.6-15.8)	24.9
	19-30	14.2	6.7	13.7 (12.7-14.7)	22.1
	31-50	11.3	5.1	10.6 (9.8-11.5)	18.7
	51+	10.5	4.4	9.7 (9.2-10.2)	17.3
	Total	11.9	5.1	11.1 (10.7-11.5)	19.6
Māori					
Males	15-18	14.1	6.7	13.8 (10.8-16.7)	20.2
	19-30	13.7	5.2	13.3 (12.2-14.5)	21.8
	31-50	11.7	5.4	10.6 (9.3-11.9)	19.8
	51+	9.7	3.0	8.4 (6.9-9.9)	16.6
	Total	12.1	4.9	11.6 (10.8-12.5)	20.2
Females	15-18	16.5	7.1	17.3 (13.7-20.9)	25.4
	19-30	14.1	5.2	13.7 (12.1-15.3)	22.6
	31-50	12.5	6.0	12.2 (10.7-13.7)	21.4
	51+	9.9	3.2	8.9 (7.5-10.4)	17.7
	Total	12.9	5.3	12.1 (11.2-13.0)	21.4
Pacific					
Males	15-18	11.7	4.4	9.1 (5.6-12.6)	20.5
	19-30	14.3	6.4	13.0 (10.5-15.6)	25.4
	31-50	10.3	4.3	9.1 (7.6-10.5)	16.9
	51+	11.0	4.0	10.2 (8.6-10.8)	17.6
	Total	11.7	4.8	10.6 (975-11.6)	20.1
Females	15-18	15.3	5.5	14.7 (12.1-17.4)	26.4
	19-30	13.4	5.5	12.8 (11.6-14.1)	27.6
	31-50	11.0	5.5	10.3 (9.2-11.4)	17.0
	51+	9.4	3.0	7.9 (6.4-9.3)	18.5
	Total	11.8	4.6	10.8 (10.0-11.7)	20.5
NZEO					
Males	15-18	13.9	5.5	13.1 (12.0-14.3)	22.2
	19-30	13.6	6.1	11.8 (10.5-13.2)	22.4
	31-50	11.5	5.1	11.1 (10.2-12.0)	17.9
	51+	10.6	4.4	10.2 (9.6-10.8)	16.7
	Total	11.7	4.9	10.9 (10.5-11.4)	18.9

		Free sugars (% TE intake)[1]			
		Mean	10th[2]	Median (50th)[2], (95% CI)	90th[2]
Females	15-18	15.3	7.4	14.1 (13.0-15.3)	23.6
	19-30	14.3	6.9	14.3 (13.2-15.4)	22.0
	31-50	11.2	5.0	10.6 (9.5-11.7)	18.3
	51+	10.6	4.6	9.8 (9.2-10.4)	17.1
	Total	11.8	5.1	11.0 (10.6-11.5)	19.2

1 Usual daily intake. These data were adjusted for intra-individual variation using MSM.
2 Percentiles.