Relative validity and reproducibility of a food frequency questionnaire for identifying the dietary patterns of New Zealand toddlers

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Abstract

Analysing dietary patterns is an alternative yet complementary approach to examining intakes of single nutrients, and can provide insight into relationships between the whole diet and risk of disease. Although several food frequency questionnaires have been validated for their ability to identify dietary patterns in adult populations, similar analyses do not appear to have been performed in toddlers. The aim of this thesis was to evaluate the relative validity and reproducibility of a food frequency questionnaire for identifying dietary patterns in toddlers aged 12-24 months, and for ranking toddlers into categories of dietary pattern scores.

We recruited 160 toddlers aged 12-24 months, and administered the food frequency questionnaire on two occasions, approximately five weeks apart. Five days of weighed food records per participant were collected on randomly assigned days over this same period. To identify dietary patterns, principal component analysis was conducted separately on data from the first and second administrations of the food frequency questionnaire, and from the five-day weighed food records. Relative validity was assessed by comparing the dietary patterns derived from the first administration of the food frequency questionnaire to those derived from the weighed food record. Cross-classification and Pearson correlation coefficients were used to evaluate relative validity. Reproducibility was assessed by comparing the dietary patterns derived from the first and second administrations of the food frequency questionnaire, using Pearson and intraclass correlation coefficients.

Three major dietary patterns were characterised from the principal component analysis that were similar across both administrations of the food frequency questionnaire, and the weighed food records. One pattern labelled “sweet foods and hot chips” was associated with high intakes of ‘sweet foods’, ‘hot chips and roast potato and kumara’, ‘spreads’, ‘processed meat’, ‘sweet drinks’, and ‘nutritive drinks’. The second pattern named ‘vegetables and meat’ was associated with high intakes of ‘vegetables’, ‘meat’, ‘eggs and beans’, and ‘fruit’; and a third pattern labelled “milk and fruit” was associated with high intakes of ‘milk and milk products’, and ‘fruit’, and inversely associated with ‘breast milk’ and ‘infant formula and toddler milk’. The first administration of the food frequency questionnaire correctly classified 41.8 - 50.3% of toddlers into the same quartile of pattern score as the weighed food record, for the three patterns. Pearson correlation coefficients between the first food frequency questionnaire and the weighed diet record ranged from 0.56-0.68 for the three patterns. For the reproducibility analysis, Pearson correlation coefficients and intraclass correlation coefficients between the

first and second administrations of the food frequency questionnaire ranged from 0.71-0.72 for all three dietary patterns.

These results indicate that the food frequency questionnaire has acceptable relative validity. It is able to identify dietary patterns in 12-24 month old New Zealand toddlers, and has a good ability to rank toddlers into categories of dietary pattern score. The patterns identified by the first administration of the food frequency questionnaire were highly reproducible.

Key words: food frequency questionnaire, validity, reproducibility, diet, dietary pattern, principal component analysis, toddler, New Zealand.

Preface

This MSc project is part of the Eating Assessment in Toddlers (EAT) Study, a validation study that aimed to test the relative validity and reproducibility of a food frequency questionnaire (FFQ) for determining both nutrient intakes and dietary patterns in a population of toddlers aged 12-24 months, living in New Zealand. The main objective of the FFQ is to rank toddlers according to nutrient intakes and dietary pattern scores. The FFQ was developed by staff at the Department of Human Nutrition (University of Otago, Dunedin) in 2010, prior to the EAT Study. It is intended for use in a population of approximately 800 12-24 month old toddlers in the Prevention of Overweight in Infancy (POI) study (University of Otago, Dunedin).

The EAT Study began in 2011 and was conducted in the Department of Human Nutrition (University of Otago, Dunedin, New Zealand). Dr Anne-Louise Heath, Dr Paula Andrews, and Associate Professor Rachael Taylor designed the validation study, and provided the thesis candidate with supervision. The focus of this thesis was evaluating the relative validity and reproducibility of the FFQ for identifying dietary patterns and ranking diet pattern scores.

As part of this thesis, the MSc candidate:

- Prepared the first draft of the application for ethical approval.
- Wrote the first drafts of the demographic questionnaire, information sheet, consent form, and 'Away from Home' diet recording sheet.
- Completed the nutrient coding for approximately half of the FFQ items.
- Was responsible for developing protocols for study recruitment and the first appointment.
- Was responsible for recruiting approximately 90 study participants in Wellington, including coordinating newspaper and newsletter advertisement bookings, putting up posters, and contacting organisations with networks through which participants could be recruited.
- Was responsible for coordinating approximately 90 study participants, including booking appointment rooms, car parks, making follow-up phone calls, and sending reminder emails and text messages.

- Conducted first appointments with over half of the study participants (n=84). The purpose of these appointments was to complete the first administration of the FFQ, measure the toddlers' weights, lengths and palm volumes, and provide instruction on how to complete the weighed food records.
- Conducted second appointments with over half of the study participants (n=80). The purpose of these appointments was to complete the second administration of the FFQ and collect and check the completed weighed food records.
- Completed data entry of 39 five-day weighed food records.
- Prepared a 'Nutrient Analysis' template to provide parents with information about the their child's diet, and sent nutrient analyses with explanatory letters to over half of the participants (n=80).
- Developed, pre-tested, refined, and managed an online interface for data entry of the FFQs, and prepared the data-entry protocol for the FFQs.
- Completed data entry for some of the FFQs.
- Contributed to the development of a variable naming system, and the set up of a data-dictionary for the EAT Study variables.
- Decided on the 16 food groups to use for the analysis.
- Assigned 91 food items from the FFQ, and 1480 food items from the weighed food records to sixteen food groups.
- Contributed to weekly EAT Study meetings for the first six months of the EAT Study.
- Conducted statistical analysis of the demographic data and the food group intake data, and performed the cross-classification analysis.

Associate Professor Sheila Williams (Department of Preventive and Social Medicine, University of Otago) determined the diet record collection days so that they were randomly distributed over the week, performed the principal component analysis, and calculated Pearson correlation coefficients and intraclass correlation coefficients. The thesis candidate interpreted and reported on the results from the principal component analysis, Pearson correlation, and intraclass correlation, and was responsible for all other statistical analyses presented in this thesis.

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A big thank you must go to all the EAT Study participants and their families, for volunteering their time, expressing so much interest in the study, and diligently keeping weighed food records.

The hours of recruitment, data collection and data entry for the EAT Study was a team effort, and I would like to thank Emily Watson, my fellow MSc Candidate. There is no way this thesis would have been possible without your help, and it has been lovely working with you over the past year. Thank you also to Ashleigh Barris and Hayley Stevenson for your help with data entry and data checking, and to Liz Fleming for your guidance and assistance with using Kai-culator.

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Last but not least, I would like to thank my fiancée Michael, for the years of support and encouragement you have given me. You have made many sacrifices to enable me to keep studying, and these have not gone unnoticed.

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List of Abbreviations

Abbreviation	Definition
5DWFR	Five-day weighed food record
BMI	Body mass index
Can	Canada
CINAHL	Cumulative Index to Nursing and Allied Health Literature
cm	Centimetre
EAT Study	Eating Assessment in Toddlers Study
EFR	Estimated food record
FFQ	Food frequency questionnaire
FFQ1	Food frequency questionnaire (first administration)
FFQ2	Food frequency questionnaire (second administration)
FR	Food record
g	Grams
ICC	Intraclass correlation coefficient
IQR	Interquartile range
kg	Kilograms
MEDLINE	Medical Literature Analysis and Retrieval System Online
MSc	Master of Science
NZ	New Zealand
PCA	Principal component analysis
QFFQ	Quantitative food frequency questionnaire
RRR	Reduced rank regression
SD	Standard deviation
SQFFQ	Semi-quantitative food frequency questionnaire
UK	United Kingdom
US	United States of America
WFR	Weighed food record

1 Introduction

Higher body weight and rapid growth between birth and two years of age is related to an increased risk of obesity in childhood and adulthood (Baird et al., 2005; Monteiro & Victora, 2005). Obesity leads to an increased risk of cardiovascular disease, type 2 diabetes mellitus and other non-communicable diseases in both children and adults (Brisbois et al., 2012; Cook & Kavey, 2011). Worldwide, the prevalence of obesity has more than doubled over the last thirty years (World Health Organization). Identifying dietary patterns that contribute to weight and rapid growth in infancy, and may be amenable to intervention, is therefore pertinent. Currently, the Prevention of Overweight in Infancy Study (University of Otago, Dunedin) is investigating interventions that may improve dietary quality in a population of New Zealand toddlers, and may result in lower body mass index Z-scores (Taylor et al., 2011). It is paramount that validated dietary assessment tools for infants and toddlers are available for this important area of research.

Weighed diet records are generally considered to be the gold standard method of dietary assessment, but are costly and impractical in large populations (Gibson, 2005). They have high respondent burden, and therefore increase the likelihood of response bias. Assessing the diets of young children presents further challenges: surrogate reporters must be relied on as young children cannot report their own food intake, multiple caregivers may need to be involved, and leftovers and spills need to be accounted for. These challenges highlight the need for simple and accurate dietary assessment tools for research into the food intake of toddlers.

Food frequency questionnaires are a cost effective method useful for the dietary assessment of large population groups (Gibson, 2005; Willett, 1998). However, because food frequency questionnaires are not as accurate as gold standard methods such as weighed food records, their relative validity needs to be tested (Gibson, 2005; Willett & Lenart, 1998). Relative validity refers to how well the food frequency questionnaire measures food or nutrient intake compared to a gold standard method (Gibson, 2005). Many food frequency questionnaires have been validated for use in adult populations, primarily to assess nutrient intake. However, few have been validated for use in young children, particularly the 12-24 month age group. In addition, the focus of food frequency questionnaires that have been validated for young children has been determining nutrient intakes.

Over the past decade, the analysis of dietary patterns has attracted interest as an alternative and complementary approach to the examination of nutrient intakes. Dietary pattern analysis is a way of assessing overall diets rather than single components of dietary intake (such as nutrient intake). This is advantageous as it takes into account interactions between nutrients and food components eaten together that may have a synergistic effect, and allows relationships between dietary patterns and risk of disease to be explored (Hu, 2002; Newby & Tucker, 2004). Several food frequency questionnaires have been validated for their ability to determine dietary patterns in adult populations, but none have been validated for determining dietary patterns in young children.

The Eating Assessment in Toddlers (EAT) Study is a validation study to determine the relative validity and reproducibility of a food frequency questionnaire designed for 12-24 month old children living in New Zealand. The primary aims of the EAT Study are to:

1. Assess the relative validity and reproducibility of the EAT food frequency questionnaire for identifying dietary patterns, and for ranking 12-24 month old children into categories of dietary pattern scores.
2. Assess the relative validity and reproducibility of the EAT food frequency questionnaire for ranking 12-24 month old children into categories of nutrient intake.

This thesis will focus on the first aim of the EAT Study. The second aim of the EAT Study is being evaluated by another candidate.

2 Literature review

This literature review aims to examine the methods for validating food frequency questionnaires (FFQs), with a particular focus on FFQs validated for preschool children, and FFQs validated for their ability to determine dietary patterns.

2.1 Literature search methodology

The article databases MEDLINE, Scopus, CINAHL and Google Scholar were searched, covering a period from 1946 to September 2012. The reference lists of relevant articles and reviews identified from the database searches were also used.

Search terms for section 2.6 were: food frequency questionnaire or FFQ, child or toddler or infant or baby or babies or preschool, validat*, and reproduc*. Search terms for section 2.7 were: diet*, pattern, food group, intake, food frequency questionnaire or FFQ, principal component analysis or PCA, factor analysis, cluster analysis, reduced rank regression, validat*, and reproduc*.

For sections 2.6 and 2.7 of this literature review, studies were restricted to original papers published in peer-reviewed journals since 1990, in English. For section 2.6, studies were included if they were validation or reproducibility studies for FFQs, with a study population that included preschool children. Initially, it was intended to only review studies that validated FFQs for children aged 12-24 months. However, studies in this age range were scarce, so this inclusion criterion was broadened to preschool children. Studies were excluded if the age range only just included the preschool age bracket (for example children aged four to nine years) and the results were analysed as one group so results for preschool children could not be separated from results for older children.

For section 2.7, studies were included if they tested the relative validity or reproducibility of FFQs for their ability to determine dietary patterns using data-driven methods. Because there is little research in this area, all age groups were included. Studies were excluded if they used dietary indices (such as the Healthy Eating Index) to determine dietary patterns, as these methods are not data-driven.

Abstracts from articles were reviewed against inclusion and exclusion criteria, and a full text copy of each article that met the inclusion criteria was obtained. Twenty studies that tested the validity or reproducibility of FFQs and included preschool children were identified. Three of

these studies were excluded because the age range only just included preschool children and the sample was analysed as one group. Eight studies that validated FFQs for their ability to determine dietary patterns via data-driven methods were identified and included in the review.

2.2 Dietary patterns

2.2.1 Introduction to dietary pattern analysis

Dietary intake data have traditionally been used to establish intakes of single nutrients. However, the single nutrient approach has some limitations: it does not account for interactions or synergy between foods or nutrients eaten together or for collinearity between nutrients, it may be difficult to detect the small effects that single nutrients have on markers of health status (such as blood pressure) (Hu, 2002; Newby & Tucker, 2004), and overall dietary patterns are likely to confound the disease associations established for single nutrients (Hu, 2002). Assessing the whole diet via dietary pattern analysis overcomes these limitations, and allows for relationships between dietary patterns and risk of disease to be explored (Hu, 2002). Relationships between dietary patterns and disease risk have been established, with 'healthy' dietary patterns being associated with decreased weight gain, hypertension, diabetes, risk of myocardial infarction, and risk of early death (DiBello et al.; Michels & Schulze, 2005). Dietary patterns identified in infancy have also been associated with body composition at four years of age (in particular, higher lean mass) (Robinson et al., 2009).

Dietary patterns can be derived a priori, where foods are grouped into patterns based on their known effects on health, or a posteriori, where statistical methods such as factor analysis or principal component analysis are used to sort foods that are commonly consumed together into groups (Newby & Tucker, 2004). A priori dietary pattern analysis involves comparisons to indices based on current dietary guidelines, such as the Healthy Eating Index (Newby & Tucker, 2004). Because the indices are based on dietary guidelines, this approach is limited by current knowledge. In contrast, the a posteriori approach is empirically derived and data-driven; the dietary patterns are derived from the data rather than based on or limited by prior knowledge. As such, this literature review will focus on a priori (data-driven) methods of pattern analysis.

Data-driven methods have been used to characterise dietary patterns in infants previously. Robinson et al (2007) identified two patterns based on FFQ data for children aged 6 months and 12 months from the Southampton Women's Survey. Pattern analysis found two patterns: one pattern ('infant guidelines') associated with high intakes of fruit, vegetables, rice and

pasta, fish, cheese and meat; and another pattern ('adult foods') associated with high intakes of crisps, savoury snacks, processed meat, fruit, squash, chips, roast potatoes and white bread. The patterns were similar for children at 6 and 12 months of age, and were related to quality of maternal diet (Robinson et al., 2007).

Smithers et al (2012) used PCA to identify dietary patterns in children aged 15 months from the Avon Longitudinal Study of Parents and Children (ALSPAC) cohort. Four patterns were identified: one pattern ('herbs, raw fruit and vegetables') high in raw vegetables and fruit, nuts and legumes, fish, and cheese; another ('biscuits, sweets and crisps') high in chocolate, sweets, fizzy drink, crisps, savoury snacks, biscuits, baked beans, condiments, tea and added sugar; another ('ready-prepared baby foods') high in ready prepared infant foods, and the last pattern ('reverse meat, vegetables and desserts') inversely associated with intakes of meat, vegetables and desserts (Smithers et al., 2012).

2.2.2 Data-driven methods of dietary pattern analysis

Data-driven methods for dietary pattern analysis include principal component analysis (PCA), factor analysis, cluster analysis, and reduced rank regression. Principal component analysis reduces the dimensionality of data with a large number of variables, while preserving the original information contained in the data (Joliffe & Morgan, 1992). Food groups or food items are sorted into patterns based on how often they are consumed together (Michels & Schulze, 2005). Reducing the dimensionality of data is an appealing approach for dietary analysis where many variables (such as foods eaten) for large numbers of individuals are examined.

Principal component analysis derives new variables from the original variables. These new derived variables are the 'principal components,' which are linear functions of the original variables (Joliffe & Morgan, 1992). The principal components are uncorrelated with each other, and sequentially explain the maximum amount of variation among all possible linear functions of the original variables (for example the first principal component will explain the most variation) (Joliffe & Morgan, 1992). There can be as many principal components as there are original variables. However, because the principal components are uncorrelated and explain the variation in sequence, usually fewer principal components are required to explain most of the variation in the original variables (Joliffe & Morgan, 1992).

Consumption of food items for the PCA can be measured as frequency, grams, or percentage contribution to total energy (Newby & Tucker, 2004). Food items are often collapsed into

food groups for entry into PCA (Newby & Tucker, 2004; Smithers et al., 2011). This can be necessary based on sample size; experts in factor analysis and PCA recommend that five to ten participants per variable are required to produce stable solutions, and suggest ten participants per variable will maximise stability (Floyd & Widaman, 1995). For example, a stable solution for a sample size of 100 would be obtained by collapsing food items into ten groups.

Food groups (or food items) are then entered into the PCA. Whether food groups or food items should be adjusted for total energy intake is open to question. Experts in nutritional epidemiology suggest that total energy intake should be adjusted for when exploring relationships between nutrients and disease (Willett et al., 1997). This is because total energy intake is often associated with an increased risk of disease, due to its relationship with body mass index (Willett, et al., 1997). Energy intake is correlated with macronutrient intake, so total energy intake may confound relationships between macronutrient intake and disease risk (Willett, et al., 1997). For example, it may appear as though macronutrient intake increases disease risk, when total energy intake is actually the cause (Willett, et al., 1997). This concept could also apply to food group intake and risk of disease. However, studies that have used both energy-adjusted and unadjusted food groups in PCA have found results are comparable, with similar components derived (Balder et al., 2003). Northstone et al (2008) compared PCA results before and after energy-adjustment and concluded energy-adjustment was not necessary as the results were highly comparable. Instead, Northstone et al (2008) argue that energy adjustment is more appropriate after the dietary patterns have been derived from PCA, and when the association between dietary patterns and disease risk is being explored (Northstone et al., 2008).

Once the principal component analysis is complete, investigators decide which pattern solutions or principal components to retain. Eigenvalues and scree plots can be used to make this decision (Floyd & Widaman, 1995; Michels & Schulze, 2005; Newby & Tucker, 2004; Smithers, et al., 2011). Eigenvalues greater than one are commonly used to decide which principal components to retain (Michels & Schulze, 2005; Newby & Tucker, 2004). Eigenvalues represent how much variation is accounted for by each principal component (Michels & Schulze, 2005), and an eigenvalue above one means a principal component accounts for more variance than one of the original variables entered into the PCA (Michels & Schulze, 2005). Eigenvalues should also be plotted onto a scree plot to separate principal components into those with large eigenvalues and those with small eigenvalues (Michels & Schulze, 2005). A break point will occur in the scree plot, dividing the eigenvalues into two

groups. The principal components with the larger eigenvalues before the break point are interpreted as being meaningful (Michels & Schulze, 2005). According to Michels and Schulze (2005) the percentage variation explained by each principal component is not a suitable decision criterion, as it will vary based on the number of variables included in the solution.

Once the components to retain have been identified, it is common practice to rotate the components orthogonally to achieve a simpler structure. After rotation, factor loadings on the components should either be high or close to zero, and food items or groups should have high factor loadings on one component only, making the PCA easier to interpret (Michels & Schulze, 2005; Newby & Tucker, 2004). The factor loadings indicate how correlated each food group is with each component. Finally, the patterns in the solution are named, either quantitatively or qualitatively (Newby & Tucker, 2004). Quantitatively named patterns are either named based on the variable with the highest factor loading, or by describing the pattern by dietary composition, such as 'high-fat' or 'high-energy' (Newby & Tucker, 2004). Qualitatively named patterns describe patterns by healthfulness, geographic location, or nutritional characteristics, for example 'Healthy,' 'Western' and 'Refined' respectively (Newby & Tucker, 2004). Foods that load highly on these patterns differ between studies, for example Newby and Tucker (2004) report that vegetables, fish, whole grains and low-fat dairy loaded highly on the 'Healthy' pattern in one study, whereas brown bread, low-fat spreads, low-fat milk, fruit and alcohol loaded highly on the 'Healthy' pattern in another study. Foods that load highly on 'Western' patterns tend to be red meat, high fat dairy products, butter, eggs, sweets, desserts and refined grains (Michels & Schulze, 2005). 'Refined' patterns have loaded highly on foods such as French fries, sugary drinks and white bread (van Dam et al., 2003).

Several authors have published reviews on dietary pattern analysis and PCA and agree there are steps where arbitrary or subjective decisions are made (Hu, 2002; Kant, 2004; Michels & Schulze, 2005; Newby & Tucker, 2004; Smithers, et al., 2011) These are:

1. Collapsing food items into food groups prior to PCA
2. Selecting the method of rotation
3. Selecting the number of patterns to extract or retain in the PCA solution
4. Naming the patterns that have been identified in the solution

To minimise subjectivity, it is essential that researchers clearly document the decisions made at each of these steps.

Two reviews focus on the methods of dietary pattern analysis and summarise commonly used approaches when deriving dietary patterns using PCA (Newby & Tucker, 2004; Smithers, et al., 2011). The reviews identified that most researchers use frequency data (the average number of servings per day), food items tend to be collapsed into food groups, orthogonal rotation is used to improve interpretability, and eigenvalues above one are used to determine the principal components to retain in the solution (Newby & Tucker, 2004; Smithers, et al., 2011). In the majority of studies, patterns derived by PCA were named qualitatively, often by healthfulness, such as 'Prudent' or 'Healthful' (Newby & Tucker, 2004; Smithers, et al., 2011). Another common approach was to choose names that describe the foods in the pattern, for example 'Refined' (Newby & Tucker, 2004). Common issues with reporting PCA methods were identified; often authors did not report how foods were collapsed into food groups, the eigenvalue cut points used, the criteria to decide on the solution, method of rotation, or the percentage of variation explained by the dietary patterns (Newby & Tucker, 2004; Smithers, et al., 2011).

Factor analysis is data-driven like PCA and involves similar steps. Food items are often collapsed into groups, eigenvalues and scree plots are used to identify factors to retain, factors can be orthogonally rotated, and patterns need to be named (Michels & Schulze, 2005; Newby & Tucker, 2004). This means subjectivity affects factor analysis in the same way it affects PCA. Authors often treat PCA as a sub-type of factor analysis, although this is not the case (Joliffe & Morgan, 1992). Factor analysis differs from PCA; instead of deriving new variables from the original variables, it assumes there are unobservable variables behind the original variables that are linear combinations of the factors and an error term for each variable (Joliffe & Morgan, 1992). Although PCA and factor analysis are different approaches, the results from each method are sometimes identical (Joliffe & Morgan, 1992).

Cluster analysis is another data-driven approach. Cluster analysis groups together participants who have similar diets, rather than grouping together foods that are commonly consumed together (Michels & Schulze, 2005). Reduced rank regression (RRR) employs data-driven methods similar to factor analysis or PCA, and combines this with prior information on response variables for disease risk (such as lipid profiles and cardiovascular disease) (Michels & Schulze, 2005). The purpose is to identify dietary patterns that explain differences in the response variables (Michels & Schulze, 2005). Michels and Schulze (2005) report that patterns identified using RRR tend to have stronger associations with disease end points compared to patterns identified with factor analysis. This is advantageous for establishing what effects dietary patterns have on disease risk. However, RRR can only be used when

information on biomarkers is available from the study population. In addition, similar to a priori methods, RRR is limited by current knowledge (Michels & Schulze, 2005).

2.3 Dietary assessment methods in 12-24 month old children

Challenges in assessing the food intake of toddlers

There is limited research about methods for assessing the diets of 12-24 month old children, so this section will focus on methods that have been used in adult and preschool populations, and the challenges that may arise when using these methods for toddlers.

Twenty-four hour recalls, food records, diet histories and FFQs are typically used for adults, and can be used for toddlers (Serdula et al., 2001). This poses additional challenges. The diets of infants and toddlers change rapidly (Serdula, et al., 2001), especially when introducing complementary foods and weaning from breastmilk. This means assessing dietary intake over a long period (such as a year) may not be meaningful. Also, toddlers cannot report their own food intake, so surrogate reporters such as the child's parent must be used. Ideally the surrogate reporter should be the caregiver who prepares most of the child's food (Samet & Alberg, 1998). However, toddlers may have multiple caregivers or spend time in early childhood centres, decreasing the main caregiver's ability to account for everything their child eats (Serdula, et al., 2001). Respondent burden may also be higher when assessing the food intake of toddlers, as spilled foods and refused foods will need to be accounted for.

Methods for assessing toddlers' diets

A 24-hour recall involves a trained interviewer asking a surrogate reporter what their child has had to eat and drink in the past 24 hours. If the researchers are investigating habitual dietary intake, then multiple recalls on non-consecutive days will be needed to account for the day-to-day variation in an individual's food intake (within-subject variation) (Gibson, 2005). Advantages of the 24-hour recall are that it is 'open-ended' so respondents are not limited by a specific food list, it has low respondent burden, and respondents do not need to be literate (Buzzard, 1998). In addition, 24-hour recalls are less likely to cause respondents to change their toddler's eating pattern than other dietary assessment methods, because recalls take place after the child has already eaten (Buzzard, 1998; Gibson, 2005). Limitations of 24-hour recalls are that they rely on memory and the ability of respondents to describe portion size (Bingham, 2007). Interviewers also need to be skilled in probing for information, and training interviewers to do this can be costly. Both under-reporting and over-reporting have been documented for 24-hour recalls in preschool populations, with snacks and desserts less likely

to be reported than main meals (Serdula, et al., 2001). For toddlers, investigators may need to contact multiple carers to determine what the child ate over 24 hours, adding time and complexity to the 24-hour recall method.

A diet history is an in-depth interview with a surrogate reporter about the toddler's eating patterns, food and fluid intake, and portion sizes. Diet histories are costly, labour-intensive and require highly skilled interviewers so are better suited for clinical use rather than research (Bingham, 2007). Limitations are similar to 24-hour recalls: reliance on respondent memory and ability to estimate portion size, and reliance on a skilled interviewer to elicit accurate information. Usually only one caregiver would participate in the diet history interview, so obtaining information on the child's food intake while cared for by others may be difficult.

Food diaries or food records require surrogate reporters to record everything their toddler eats and drinks at the time of consumption, over one or more days (Buzzard, 1998; Gibson, 2005). Portion sizes can be estimated with household measures, or weighed. Weighed food records are the most precise (Gibson, 2005), and research suggests they provide better estimates of energy intake for children aged 6 months to 4.5 years than other dietary assessment methods, when compared with energy expenditure measured by the doubly labelled water method (Burrows et al., 2010). To assess habitual intake and account for day-to-day variation, multiple non-consecutive days should be recorded (Gibson, 2005). Also, food patterns vary on different days of the week, so weekdays and weekend days should be represented proportionately (Gibson, 2005). Strengths of food records are that they do not rely on memory, and portion size is measured (Buzzard, 1998). Also, food records are 'open ended' allowing for any food to be reported, to any level of detail (Buzzard, 1998). High respondent burden is a disadvantage, requiring motivated, literate and numerate respondents (Buzzard, 1998). Low energy reporting is also common (Gibson, 2005; Serdula, et al., 2001). For toddlers, foods that are spilled need to be accounted for, there may be more leftovers to measure, and several carers may need to be involved with keeping the record, potentially increasing respondent burden.

Food frequency questionnaires list foods and drinks alongside a section to indicate how frequently they are consumed (Gibson, 2005). Food frequency questionnaires measure habitual food intake over a long time (for example a month or a year) (Buzzard, 1998), and are useful for ranking individuals within a population, rather than for assessing absolute food or nutrient intakes (Cade et al., 2002; Gibson, 2005). They can be self-administered, or administered by an interviewer. Interviewer-administered FFQs have demonstrated higher relative validity and reproducibility for some nutrients (Cade, et al., 2002), possibly because

interviewers can minimise missing data. Food frequency questionnaires can also be semi-quantitative; where portion size information is collected as well as frequency data (Gibson, 2005).

Food frequency questionnaires are well suited for research in populations, as they have low respondent burden, are designed to assess habitual food intake, and are more cost-effective than other dietary assessment methods due to simpler administration, data-entry and analysis (Buzzard, 1998; Gibson, 2005). Experts also note that FFQs are advantageous as they rely on 'generic' rather than 'episodic' memory, and it is easier for respondents to explain habitual food intake than recall a specific meal in detail (Buzzard, 1998). Limitations of FFQs are that they rely on memory and the ability of respondents to describe portion size (Gibson, 2005). For toddlers, surrogate reporters need the ability to describe the amount eaten rather than offered, and portion sizes may vary highly for young children from day-to-day, making it difficult to estimate average intake. In addition, FFQs are not open ended; foods that can be reported are limited to those on the list (Gibson, 2005). Like all dietary assessment methods, under reporting also occurs (Bingham, 2007) and it may be difficult to assess foods the child eats outside of the surrogate reporter's care.

2.4 Methods of food frequency questionnaire validation

2.4.1 Study design

Several experts and international expert groups have published guidance on the gold standard methods for validating FFQs (Cade, et al., 2002; Gibson, 2005; Willett & Lenart, 1998). This section of the literature review focuses on these expert recommendations.

It is essential to test the relative validity of dietary assessment tools before using them in research to establish the tool's performance in the research population, whether it measures what it was intended to measure, and if it can determine dietary differences among participants (Willett & Lenart, 1998). A dietary assessment tool that performs poorly can lead to inaccurate research results and incorrect conclusions about the relationships between diet and health (Cade, et al., 2002). The absolute validity of a dietary assessment tool is difficult to determine, as there is almost no way to truly assess what people eat (aside from surreptitious observation, which is impractical) (Gibson, 2005). As such, it is routine to measure relative validity: how well the tool compares to a more accurate reference method (Gibson, 2005).

Experts agree that sources of error in the reference method should be independent to sources of error in the test method (Cade, et al., 2002; Gibson, 2005; Willett & Lenart, 1998). As such, weighed food records are the preferred reference when validating FFQs (Cade, et al., 2002; Willett & Lenart, 1998). Sources of error in FFQs include: a limited list of foods to choose from, reliance on the participant's ability to estimate portion size, and reliance on memory (Willett, 1998). In contrast, weighed diet records are open-ended so participants can choose any food, portion sizes are measured, and foods are recorded at the time they are eaten (Willett & Lenart, 1998). Multiple 24-hour recalls have been used as reference methods in FFQ validation studies, but are not ideal as they rely on memory and estimation of portion size, so sources of error are not independent. Experts agree that because the errors that affect FFQs and weighed diet records are independent, validity is more likely to be underestimated than overestimated when validating against diet records (Cade, et al., 2002; Willett & Lenart, 1998).

The FFQ should be administered before the reference method as completing the reference method may increase participants' awareness of their food intake, leading to overestimation of the FFQ's validity (Cade, et al., 2002; Gibson, 2005; Willett & Lenart, 1998). However, only administering the FFQ before the reference method may underestimate validity, as the FFQ is assessing a period prior to the reference method (Willett & Lenart, 1998). Experts suggest it is useful to administer the FFQ both before and after the reference method to provide both 'maximal' and 'minimal' estimates of validity (Gibson, 2005; Willett & Lenart, 1998).

The reference method should cover the same objective and timeframe as the test method. If an FFQ aims to collect data on usual intake over one year, the reference method should aim to do the same (Gibson, 2005; Willett & Lenart, 1998). Willett and Lenart (1998) suggest that the reference method should be conducted over a long time (such as one year) to get a reflection of true habitual intake. This may be suitable for adults, but young children's diets change rapidly making shorter time frames (such as a few weeks) appropriate. The reference method should be recorded for multiple, non-consecutive days to give an idea of average intake and reduce the effect of within-subject variation (Cade, et al., 2002; Willett & Lenart, 1998). Ideally, data should be collected for each day of the week as food intake can vary by day of the week (also known as day-of-the-week effects) (Gibson, 2005). However, seven-day food records may be impractical, and experts suggest four to five days per participant should be adequate for a validation study (Stram et al., 1995). When collecting fewer than seven days

of records, the days of the week should be randomly allocated to account for day-of-the-week effects (Stram, et al., 1995).

Groups with different characteristics in different locations are likely to have different diets, so it is essential that the FFQ is validated in the target population, or in a population as similar as possible in age, sex, health status, geographical location, ethnicity and socioeconomic status, as these factors can affect responses to dietary assessment (Cade, et al., 2002; Gibson, 2005). Ideally the population should be a random sample to avoid selection bias (Gibson, 2005; Willett & Lenart, 1998), however this may not be possible due to time and financial constraints. Sample size depends on the statistical methods that will be used to analyse the data, and should be decided in consultation with a statistician (Cade, et al., 2002). Cade et al (2002) suggest a sample of at least 100 is preferable when using the Bland-Altman method, and Willett and Lenart (1998) suggest a sample size of 100 to 200 participants is "adequate for a range of likely degrees of validity."

2.4.2 Statistical methods for FFQ validation

Several statistical methods can be used to compare the results from FFQs and diet records; cross-classification, correlation coefficients, comparison of means, and the mean and standard deviation of the difference. These methods all have strengths and weaknesses as outlined below. Experts recommend using several different statistical methods to compare the FFQ and reference method (Cade, et al., 2002; Gibson, 2005). Willett and Lenart (1998) recommend that correlation coefficients and the means and standard deviations from the FFQ and the reference method should be used at the very least.

Cross-classification

In cross-classification, participants are separated into categories of intake from the FFQ and the reference method (for example tertiles or quartiles) (Cade, et al., 2002; Gibson, 2005; Willett & Lenart, 1998). The proportion of participants classified into the same category, same or adjacent categories, or grossly misclassified into opposite categories can then be calculated, giving an idea of the FFQ's validity. A limitation of cross-classification is that some participants will be classified into the same category by chance (Gibson, 2005). However, experts suggest a strength of cross-classification is that it provides quantitative information on true differences in intake based on the FFQ and reference method (Cade, et al., 2002; Willett & Lenart, 1998). Masson et al (2003) have suggested that when dividing participants into tertiles, over 50% correctly classified and less than 10% incorrectly classified

is indicative of validity for nutrients. However, the interpretation of the proportion classified will vary based on the number of categories participants are classified into, for example if 50% classified into correct tertiles indicates good relative validity, then 50% classified into correct quartiles is likely to indicate better relative validity, as the categories are narrower and there is a smaller degree of chance that participants have been correctly classified (25% for quartiles versus 33% for tertiles).

Correlation coefficients

Correlation coefficients measure the strength of the linear relationship between data from the FFQ and reference method, but do not represent how well the FFQ and reference data agree (Bland & Altman, 1986; Cade, et al., 2002; Gibson, 2005). For example, if you used two different methods to measure dietary intake, and the results from one method were consistently twice as high as the other, the correlation between the two methods would be 100%, even though the results did not agree. This is a strong criticism of correlation and experts agree it is inappropriate to only use correlation to assess validity.

Correlation is usually used to see if there is a relationship between two different variables that are not expected to be correlated (Gibson, 2005). However, the FFQ and reference method are measuring the same variable (food intake of the same participants), so correlation is expected. This can lead to inflated correlation coefficients that need to be interpreted cautiously, and Gibson (2005) recommends that significance calculations in this situation should be discarded. Similarly, Bland and Altman (1986) point out that when two methods measure the same variable, it would be surprising if the results did not have a linear relationship. Correlation coefficients are also affected by between-person variation (Gibson, 2005; Willett & Lenart, 1998). As between-person variation increases, so will the correlation coefficients due to the wider range of results for each method (Gibson, 2005). Experts agree that other statistical methods should be used in addition to correlation analysis, such as the mean and standard deviation of the difference (Cade, et al., 2002; Gibson, 2005).

Either Pearson or Spearman correlation coefficients can be used in correlation analysis (for normally distributed or non-normal data respectively) (Masson et al., 2003). Both methods are subject to the limitations described above. Nevertheless, correlation analysis is commonly used in validation studies (Cade, et al., 2002). Experts have noted that correlations of 0.5-0.7 are reasonably high for food frequency questionnaire validation studies, and are comparable to the validity for other measurements in free-living populations, such as physical activity (Willett & Lenart, 1998). Correlations greater than 0.70 for FFQ validation studies are rare

(Willett, 2001), and it has been suggested that there is a ceiling of validity for FFQs around 0.6-0.7, likely to be because a questionnaire cannot entirely capture the complex nature of dietary intake (Willett, 2001).

Comparison of means

Paired t-tests can be used to test if there is a statistical difference between mean group results from the FFQ and reference method, provided the data are normally distributed (Cade, et al., 2002; Gibson, 2005). If data cannot be normalised via transformation, medians and percentiles can be compared, and the Wilcoxon's signed rank test can be used instead (Cade, et al., 2002; Gibson, 2005).

Mean and standard deviation of the difference (Bland-Altman method)

As an alternative to correlation, Bland and Altman (1986) recommend using the mean and standard deviation of the difference between results to compare the absolute agreement between two measurement methods. Results from the FFQ and reference method can be plotted against each other and a line of equality drawn (Gibson, 2005). If the FFQ data are consistently above or below the line, the FFQ is biased and is over or underestimating intakes respectively (Cade, et al., 2002; Gibson, 2005). Another plot can be created of the mean results for each variable (for example nutrient or food group) from the FFQ and reference method. This is plotted against the mean difference between each pair of variables, and if the methods are close to one another, the differences should ideally plot along the zero line, and the mean difference should be close to zero (Bland & Altman, 1986; Gibson, 2005).

Strengths of the mean and standard deviation of the difference approach are that it can show how well the FFQ and reference method agree across a range of intakes, for example whether the FFQ performs better at high or low intakes (Cade, et al., 2002; Gibson, 2005). Also, between-person variation does not affect the standard deviation of the difference like it affects correlation coefficients (Willett & Lenart, 1998). According to Willett and Lenart (1998), a limitation of this method is that it is difficult to use when assessing multiple variables such as nutrients. Willett and Lenart (1986) state an in depth knowledge of usual absolute nutrient intakes and between-person variation for each nutrient is needed when interpreting the mean and standard deviation of the difference. Therefore, only those with an excellent knowledge of many different nutrients can confidently interpret the results (Willett & Lenart, 1998). Cade et al (2002) note that few FFQ validation studies have used this method.

The Bland and Altman method is useful for looking at absolute differences between methods. However, FFQs are designed to rank individuals into categories of food or nutrient intake, rather than to determine absolute intakes (Masson, et al., 2003). This means that comparing differences in absolute intakes via the Bland-Altman method is not always appropriate for FFQs that have been designed to rank individuals within a population. When assessing the ability of an FFQ to rank individuals into categories, it has been suggested that cross-classification and Pearson or Spearman correlation coefficients are preferable (Masson, et al., 2003).

2.5 How to assess reproducibility

Reproducibility is a measure of how consistent results from an FFQ are when administered at two different time points for the same participants (Willett & Lenart, 1998). The reproducibility of an FFQ should ideally be tested at the same time as validity. Similar to validation studies, reproducibility should be tested in populations as close as possible to the target population (Gibson, 2005; Willett & Lenart, 1998). Experts suggest low reproducibility indicates an FFQ does not work well (Willett & Lenart, 1998). However, high reproducibility does not guarantee FFQ validity, as it is possible for the FFQ results to have correlated errors (Willett & Lenart, 1998).

The results from two administrations of an FFQ at different time points can be compared using the same statistical methods used for validity: correlation coefficients, mean and standard deviation of the difference, and paired t-tests. Intraclass correlation coefficients can also be used to measure reproducibility (Bland & Altman, 1990). According to Lee (1980), intraclass correlation has an advantage over other types of correlation (for example Pearson's) because it assesses how well two measurement methods (or two administrations of the same method) agree, and corrects for the component of this agreement that is due to chance (Lee, 1980). Intraclass correlations above 0.4 show good agreement (Gibson, 2005). Some authors suggest intraclass correlation can be used for validity also (Gibson, 2005; Lee, 1980; Muller & Buttner, 1994). However, Bland and Altman (1990) disagree because intraclass correlation was designed to measure the relationship between variables where there is no clear x and y variable. Bland and Altman (1990) give the example of comparing blood pressure in sets of identical twins: it is not clear which twin in each set should be the x variable and which the y variable, and how they are assigned will affect the results. This is not the case when comparing two measurement methods, as the methods will be assigned as x or y variables

consistently based on whether they are the test or reference method. Also, the model assumes the two different methods have the same measurement error, which is unlikely to be true (Bland & Altman, 1990).

When testing reproducibility, the interval between the two administrations is critical. The interval should be long enough for participants to have forgotten their answers to the first administration, but short enough that dietary habits have not genuinely changed (Cade, et al., 2002; Gibson, 2005; Willett & Lenart, 1998). Changes in season also need to be considered when choosing the interval (Gibson, 2005). Some experts recommend 4-8 weeks as an adequate interval (Gibson, 2005), but others suggest this may be short enough for participants to remember their previous responses (Willett & Lenart, 1998). Gibson (2005) notes that the time interval should be chosen based on the study population and the timeframe the tool assesses. The diets of very young children change quickly, so an interval of a few weeks is likely to be appropriate. Even then, true changes to dietary intake are possible.

Reproducibility will also be affected by true sources of variability, such as within-subject variation and between-subject variation (Gibson, 2005). Within-subject variation occurs because the food intake of individuals varies from day-to-day. Between-subject variation occurs because individuals have differences in food intake between one another. Both sources of variation will decrease the reproducibility of the FFQ. This is because it is less likely that food consumption will be similar at two different time points, if individuals eat a large number of different foods on different days, and if the individuals in a population consume very different foods to one another. In this case, lower reproducibility could be due to true variation rather than poor performance of the FFQ. Gibson (2005) notes that it is difficult to separate the effects of between and within-subject variation from measurement error. Between and within-subject variation cannot be calculated for FFQs, as this requires at least two days of dietary data per person. This makes separation of true variation and measurement error even more difficult for FFQs.

2.6 Food frequency questionnaires validated for preschool children

Eighteen studies that validate or test the reproducibility of FFQs for children less than five years of age were identified. In two cases, two of the studies used the same FFQ in the same population, but validated for different nutrients (Marshall et al., 2003; Rankin et al., 2011) (Huybrechts et al., 2009; Huybrechts et al., 2006). Thirteen of the studies included children two years of age or under (Andersen et al., 2004; Andersen et al., 2003; Blum et al.; D'Ambrosio et al., 2012; Iannotti et al., 1994; Klohe et al., 2005; Marriott et al., 2007;

Marriott et al., 2008; Marshall, et al., 2003; Metcalf et al., 2003; Parrish et al., 2003; Rankin, et al., 2011; Williams & Innis, 2005), whereas three of the studies specifically examined children in the 12 to 24 month age range (Andersen, et al., 2004; Andersen, et al., 2003; Marriott, et al., 2008). The design features of the FFQs used in these studies are summarised in **Table 2.1**.

The FFQs ranged in length from 16 (Marshall, et al., 2003) to 191 items (Marshall, et al., 2003; Williams & Innis, 2005). Eleven of the FFQs assessed nutrient intake (Blum et al., 1999; D'Ambrosio, et al., 2012; Huybrechts, et al., 2006; Iannotti, et al., 1994; Marriott, et al., 2007; Marriott, et al., 2008; Parrish, et al., 2003; Rankin, et al., 2011; Stein et al., 1992; Taylor & Goulding, 1998; Treiber et al., 1990), three assessed food intake (Huybrechts, et al., 2009; Klohe et al.; Metcalf, et al., 2003), and four assessed both food and nutrient intake (Andersen, et al., 2004; Andersen, et al., 2003; Marshall, et al., 2003; Williams & Innis, 2005).

The FFQs assessed timeframes ranging from the previous week to the previous year. Most of the studies were designed to assess food intake over shorter timeframes of one to four weeks (Andersen, et al., 2004; Andersen, et al., 2003; Blum, et al., 1999; D'Ambrosio, et al., 2012; Iannotti, et al., 1994; Marriott, et al., 2007; Marriott, et al., 2008; Marshall, et al., 2003; Metcalf, et al., 2003; Rankin, et al., 2011; Williams & Innis, 2005), appropriate for young children. However, FFQs in four studies assessed food intake over 12 months (Huybrechts, et al., 2009; Huybrechts, et al., 2006; Parrish, et al., 2003; Taylor & Goulding, 1998). It is likely that the food preferences and portion sizes of children will have changed significantly over the course of 12 months, making it difficult for parents to accurately estimate the average usual intake for the entire 12-month period. Parents may be more likely to report their child's recent food intake, possibly resulting in lower validity for questionnaires that assess long timeframes.

Ten of the FFQs were self-administered (completed by the parent or caregiver) (Andersen, et al., 2004; Andersen, et al., 2003; Blum, et al.; Huybrechts, et al., 2009; Huybrechts, et al., 2006; Klohe, et al., 2005; Marshall, et al., 2003; Metcalf, et al., 2003; Parrish, et al., 2003; Rankin, et al., 2011; Taylor & Goulding, 1998) and seven were interviewer-administered (D'Ambrosio, et al., 2012; Iannotti, et al., 1994; Marriott, et al., 2007; Marriott, et al., 2008; Stein, et al., 1992; Treiber, et al., 1990; Williams & Innis, 2005). Interviewer-administered FFQs have an advantage as interviewers can minimise missing data by ensuring every question is answered, and can assist respondents with comprehension of the questionnaire. As such, interviewer-administered FFQs may validate more highly than self-administered FFQs.

Ten of the FFQs were newly developed for the target population (Andersen, et al., 2004; Andersen, et al., 2003; D'Ambrosio, et al., 2012; Huybrechts, et al., 2009; Huybrechts, et al., 2006; Marriott, et al., 2007; Marriott, et al., 2008; Metcalf, et al., 2003; Rankin, et al., 2011; Williams & Innis, 2005), four were modified for children from existing FFQs (Blum, et al., 1999; Klohe, et al., 2005; Stein, et al., 1992; Treiber, et al., 1990), and three were existing FFQs for adults that had not been modified for preschool children (Iannotti, et al., 1994; Parrish, et al., 2003; Taylor & Goulding, 1998). The Willett 111-item FFQ was used in four of the studies (Iannotti, et al., 1994; Parrish, et al., 2003; Stein, et al., 1992; Treiber, et al., 1990), but was modified to suit the preschool population in just two of these studies (Stein, et al., 1992; Treiber, et al., 1990). Food frequency questionnaires designed or modified for preschool children are likely to perform better in preschool populations than FFQs designed for adults, and as such may have higher validity. Children have different portion sizes to adults, and different food preferences (for example breast milk or infant cereal would be inappropriate in an adult FFQ). Responding to an adult questionnaire for a young child may also be more difficult; as participants may need to convert adult portion sizes to portion sizes their child usually eats.

Table 2.2 summarises key aspects of the methods used to validate FFQs in preschool populations. Seventeen studies have validated FFQs for preschool children. Sample sizes ranged from 17 (Iannotti, et al., 1994) to 1579 (Huybrechts, et al., 2006). Six studies used the gold standard of weighed food records as the reference method (Andersen, et al., 2004; Andersen, et al., 2003; Iannotti, et al., 1994; Marriott, et al., 2007; Marriott, et al., 2008; Williams & Innis, 2005), with food records ranging in length from three to seven days. These studies are likely to have the most accurate reference data with independent sources of error to the FFQ, and as such the validity of these FFQs may be underestimated. Five studies used estimated food records (Huybrechts, et al., 2009; Huybrechts, et al., 2006; Marshall, et al., 2003; Rankin, et al., 2011; Taylor & Goulding, 1998), and five used 24-hour recalls as the reference method (Blum, et al., 1999; D'Ambrosio, et al., 2012; Parrish, et al., 2003; Stein, et al., 1992; Treiber, et al., 1990). One study used a combination of one 24-hour recall and a 2-day food record as the reference method (Klohe, et al., 2005).

In general, response rates were reasonable and ranged from 46.7% to 100%. The 46.7% response rate appears low, however it occurred in a study that followed-up participants five years after recruitment (Marshall, et al., 2003).

Trieber (1990) and Stein (1992) took an alternative approach and administered the FFQs and reference methods simultaneously. For example, in the study by Stein et al (1992) the FFQ

was administered twice in 12 months, and four 24-hour recalls were completed over the same 12 months. A strength of this approach is that the test and reference method measure food intake from the same period of time, as well as the same length of time. Three studies administered the FFQs after the reference method when participants were likely to be sensitised to the dietary intake of their children (Iannotti, et al., 1994; Parrish, et al., 2003; Williams & Innis, 2005). Consequently, the validity of these FFQs may be over-estimated. Two studies did not report the sequence of administration for the test and reference methods (Klohe, et al., 2005; Taylor & Goulding, 1998).

Diet varies on different days of the week (particularly between weekdays and weekend days) and this should be considered when collecting reference data (Gibson, 2005). Ten out of seventeen studies reported on the days of the week that were assessed by the reference method. Eight studies reported including weekend days (Andersen, et al., 2004; Andersen, et al., 2003; Blum, et al., 1999; Klohe, et al., 2005; Marshall, et al., 2003; Parrish, et al., 2003; Rankin, et al., 2011; Williams & Innis, 2005). However, Stein et al (1992) reported that their 24-hour recalls were not systematised by day of the week, and Treiber et al (1990) reported only collecting 24-hour recalls on weekdays. Although this may have collected food intake data on Sundays, it would not have included Saturdays. The reference data in these studies is unlikely to have captured intra-individual variation so may not provide an adequate estimate of usual intake, possibly causing validity of the FFQs to be underestimated. Experts recommend that relative validity studies should ideally collect reference data on each day of the week (Gibson, 2005). If this is not practical, days should be randomly assigned, or weighted to represent the variation over different days.

In five studies the reference method and the FFQ covered the same length of time (Andersen, et al., 2003; Blum, et al., 1999; D'Ambrosio, et al., 2012; Parrish, et al., 2003; Stein, et al., 1992), as recommended by experts. However, in five studies the length of time covered by the FFQ and diet record differed (Huybrechts, et al., 2009; Huybrechts, et al., 2006; Taylor & Goulding, 1998; Treiber, et al., 1990; Williams & Innis, 2005). For six studies the timeframes were similar (Andersen, et al., 2004; Iannotti, et al., 1994; Marriott, et al., 2007; Marriott, et al., 2008; Marshall, et al., 2003; Rankin, et al., 2011), for example a 7-day food record compared to an FFQ that assessed intake over 15 days (Marriott, et al., 2007). This is preferable to large differences in timeframe (such as comparing twelve months of intake assessed by an FFQ to three consecutive days of intake assessed by a diet record). Timeframes covered by the FFQ and reference method were not reported in one study (Klohe, et al., 2005).

As discussed above, children may have multiple caregivers and it is unlikely that one caregiver will know everything their child has had to eat. Ten out of seventeen studies reported how dietary data were collected when children were cared for by others (such as early childhood education centres or nannies). Four studies asked parents to liaise with other carers to obtain information on their child's food intake while they were outside of their care (Andersen, et al., 2003; Klohe, et al., 2005; Marshall, et al., 2003; Rankin, et al., 2011). For Andersen et al (2003), this involved providing extra scales and a food record for other carers, and asking parents to train carers how to complete food records. In three studies the research staff contacted other carers directly to administer 24-hour recalls (Iannotti, et al., 1994; Parrish, et al., 2003) or to train carers how to complete diet records (Andersen, et al., 2004). Three studies relied on parents being able to report what their children ate when cared for by others (Blum, et al., 1999; Stein, et al., 1992; Williams & Innis, 2005). If parents are unaware of their child's food intake with other carers, this may decrease the quality of the data collected. Indeed, Stein et al (1992) noted that parents had limited confidence when reporting what their children ate when cared for by others, and consequently these data were eliminated from their analysis.

Correlation coefficients for the validation studies ranged from 0.16 (Marshall, et al., 2003) to 0.99 (Stein, et al., 1992). The highest correlations of 0.99 and 0.95 were for breastmilk (Marshall, et al., 2003), suggesting that parents estimate breastfeeding frequency accurately. Four studies had correlation coefficients that were all above 0.50 for the nutrients or foods compared via the FFQ and the reference method (Klohe, et al., 2005; Marriott, et al., 2008; Marshall, et al., 2003; Rankin, et al., 2011). **Table 2.2** presents the correlation coefficients for each study. Of the studies that specifically looked at children within the 12-24 month age range, the FFQ validated by Marriott et al (2008) in 12-month-old children validated particularly well with correlation coefficients between nutrients from the FFQ compared to 4-day weighed diaries ranging from 0.25-0.66, with a median of 0.59. However, Marriott et al (2008) identified that participants had changed their milk feeding patterns (for example from infant formula to cows' milk) between completing the FFQ and 4-day weighed food diary. This significantly impacted on the nutrient intakes, and led the investigators to analyse results excluding intakes of milk drinks (Marriott, et al., 2008). It is the results excluding milk drinks that performed particularly well. This highlights that genuine changes in feeding patterns can result in an underestimation of validity when validating FFQs for young children. Genuine changes in dietary patterns between the FFQ and reference method need to be carefully considered in validation studies.

Of the seventeen validation studies, sixteen used correlation analysis to assess validity (Andersen, et al., 2004; Andersen, et al., 2003; Blum, et al., 1999; D'Ambrosio, et al., 2012; Huybrechts, et al., 2009; Huybrechts, et al., 2006; Iannotti, et al., 1994; Klohe, et al., 2005; Marriott, et al., 2007; Marriott, et al., 2008; Marshall, et al., 2003; Parrish, et al., 2003; Rankin, et al., 2011; Stein, et al., 1992; Treiber, et al., 1990; Williams & Innis, 2005), ten used comparison of means (Andersen, et al., 2004; Andersen, et al., 2003; D'Ambrosio, et al., 2012; Huybrechts, et al., 2009; Huybrechts, et al., 2006; Iannotti, et al., 1994; Klohe, et al., 2005; Marshall, et al., 2003; Rankin, et al., 2011; Stein, et al., 1992; Williams & Innis, 2005), seven used the Bland-Altman method (Andersen, et al., 2004; Andersen, et al., 2003; D'Ambrosio, et al., 2012; Huybrechts, et al., 2009; Huybrechts, et al., 2006; Marriott, et al., 2007; Marriott, et al., 2008), and seven used cross-classification (Andersen, et al., 2004; Andersen, et al., 2003; Huybrechts, et al., 2009; Huybrechts, et al., 2006; Klohe, et al., 2005; Marshall, et al., 2003; Taylor & Goulding, 1998). The majority of studies used a combination of statistical methods as is recommended by experts, but three of the studies used correlation analysis alone (Blum, et al., 1999; Parrish, et al., 2003; Treiber, et al., 1990). As discussed in section 2.4.2, correlation analysis indicates whether there is a linear relationship between the reference and FFQ results, but does not demonstrate how well the results agree.

Only five of the seventeen validation studies tested reproducibility (D'Ambrosio, et al., 2012; Huybrechts, et al., 2009; Huybrechts, et al., 2006; Klohe, et al., 2005; Treiber, et al., 1990), and one study was identified that tested reproducibility but not validity (Metcalf, et al., 2003). Sample sizes for the reproducibility studies ranged from 14 (D'Ambrosio, et al., 2012) to 130 (Metcalf, et al., 2003), with D'Ambrosio et al (2012), Klohe et al (2005), Huybrechts et al (2006) and Huybrechts et al (2009) all using smaller samples for the reproducibility analysis compared to the validation analysis (n = 14, 25, 60 and 124 respectively). The length of time between the administrations of the FFQs was one week for one study (Treiber, et al., 1990), two weeks for two studies (Klohe, et al., 2005; Metcalf, et al., 2003), four weeks for one study (D'Ambrosio, et al., 2012) and five weeks for two studies (Huybrechts, et al., 2009; Huybrechts, et al., 2006). It is possible that high reproducibility could have resulted from these short intervals as respondents may have remembered their answers between the first and second administrations of the FFQs. However, longer timeframes could have resulted in an underestimation of reproducibility due to genuine changes in dietary intake, rather than flaws in the FFQ.

Overall, very few studies tested reproducibility. Those that did demonstrated high reproducibility, with mean or median correlations ranging from 0.67 (Treiber, et al., 1990) to

0.73 (Metcalf, et al., 2003). D'Ambrosio et al (2012) reported intra class correlation coefficients >0.70 for eight of twelve nutrients.

Only two of the studies discussed in this review were conducted in New Zealand preschool children (Metcalf, et al., 2003; Taylor & Goulding, 1998). One looked specifically at calcium intake (Taylor & Goulding, 1998), and the other looked food group intake (Metcalf, et al., 2003). However, the study that looked at food group intake only tested reproducibility and not validity (Metcalf, et al., 2003).

Table 2.1: Summary of food frequency questionnaires (FFQs) validated for preschool children

Author, year	Participants (country, age)	FFQ					Foods or nutrients of interest
		Tool	Period	Items	Admin.	Origin	
Blum et al, 1999	US, 1-5 y	Children's Harvard Service SQFFQ.	4 w	84	self	modified from Harvard Service SQFFQ.	Protein, carbohydrate, total fat, sucrose, dietary fibre, calcium, iron, vitamin C, vitamin B1, vitamin B2, niacin, vitamin B6, folate, vitamin B12, vitamin A, vitamin E, magnesium, zinc, cholesterol, total energy
Andersen et al, 2003	Norway, 12 m	SQFFQ	14 d	44	self	new	Energy, protein, fat, saturated fat, monounsaturated fat, polyunsaturated fat, carbohydrate, sugar, fibre, vitamin A, vitamin D, vitamin E, thiamin, riboflavin, vitamin C, calcium, iron. Cows' milk, infant formula, yoghurt, baby cereal, bread, cheese, boiled potatoes, vegetables, fruit and fruit juice, meat, commercial baby food, sweetened drinks, cod liver oil.
Andersen et al, 2004	Norway, 2 y	SQFFQ	14 d	39	self	new	Energy, protein, fat, saturated fat, monounsaturated fat, polyunsaturated fat, carbohydrate, sugar, fibre, vitamin A, vitamin D, vitamin E, thiamin, riboflavin, vitamin C, calcium, iron. Bread, cake, potatoes, vegetables, fruit, fruit juice, meat, fish, cheese, yoghurt, milk, soft drinks with sugar, soft drinks without sugar, chocolate and sweets, cod liver oil
Klohe et al, 2005	US, 1-3 y	SQFFQ	NR	191	self	Modified from a SQFFQ for adults	Breads, cereals, rice and pasta, dairy, fats and oils, sweets, fruit and fruit juices, meat, poultry, fish, beans, mixed dishes, soup, sweetened beverages, non-starchy vegetables, starchy vegetables

Table 2.1 continued

Author, year	Participants (country, age)	FFQ					Foods or nutrients of interest
		Tool	Period	Item	Admin.	Origin	
Williams et al, 2005	Can, 8-26 m	SQFFQ	2 w	191	interviewer	new	Energy, total iron, heme-iron, non-heme iron, vitamin C, calcium, dietary fibre Meat fish and poultry, mixed dishes, iron fortified infant formula, regular infant formula, breast milk, iron fortified infant cereal, other fortified cereal, fruit and fruit juice, milk and milk products, soy-based products
Parrish et al, 2003	US, 1-3 y	Willett SQFFQ	1 y	111	self	existing	Energy, protein, carbohydrate, fat vitamin C, alpha-tocopherol
Taylor et al, 1998	NZ, 3 -6 y	SQFFQ	12 m	35	self	existing	Calcium
Marshall et al, 2003	US, 0.5-5 y	QFFQ	1 w	16-18	self	existing	Calcium, vitamin D, beverage intakes
Rankin et al, 2011	US 0.5-5 y	QFFQ	1 w	11-16	self	new	Fluoride
Huybrechts et al, 2006	Belgium, 2.5-6.5 y	SQFFQ	1 y	47	self	new	Calcium
Huybrechts et al, 2009	Beligum, 2.5-6.5 y	SQFFQ	1 y	47	self	new	Beverages, breads and cereals, potatoes and grains, vegetables, fruit, milk products, cheese, meat game poultry and fish, snacks, sugared drinks, fruit juice, fried potatoes, sweet spreads.
Marriott et al, 2008	UK, 12 m	SQFFQ	28 d	78	interviewer	new	Energy, protein, fat, carbohydrate, total sugar, Na, K, Ca, Mg, P, Fe, Zn, Cu, retinol, vitamin D, vitamin E, thiamin, riboflavin, niacin, vitamin B6, folic acid, vitamin B12, vitamin C

Table 2.1 continued

Author, year	Participants (country, age)	FFQ					Foods or nutrients of interest
		Tool	Period	Item	Admin.	Origin	
Marriott et al, 2007	UK, 6 m	SQFFQ	1 w	34	interviewer	new	Energy, protein, fat, carbohydrate, total sugar, Na, K, Ca, Mg, P, Fe, Zn, Cu, retinol, vitamin D, vitamin E, thiamin, riboflavin, niacin, vitamin B6, folic acid, vitamin B12, vitamin C
Iannotti et al, 1994	US, 2-4 y	Willett SQFFQ	1 w	111	interviewer	existing	Energy, sodium, cholesterol, percentage energy from fat, percentage energy from saturated fat
Treiber et al, 1990	US, 3-5 y	Willett SQFFQ	3 m	111	interviewer	modified from 111-item Willett FFQ	Energy, total fat, saturated fat, polyunsaturated fat, monounsaturated fat, cholesterol, protein, carbohydrate, calcium, sodium, potassium.
Metcalf et al, 2003	NZ, 1-14 y	SQFFQ	4 w	117	self	new	Fruit, vegetables, mixed meat dishes, eggs, red meats, chicken, fish, bread, breakfast cereal, rice, spreads, convenience meals, dairy foods, biscuits and cakes, snacks and sweets, milk drinks, non-milk drinks
Stein et al, 1992	US, 44-60 m	Willett SQFFQ	6 m	111	interviewer	Modified from 111-item Willett FFQ	Energy, total fat, saturated fat, polyunsaturated fat, cholesterol, protein, carbohydrate, sodium, potassium, calcium
D'Ambrosio et al, 2012	Can, 12-36 m	SQFFQ	4 w	97	interviewer	new	Energy, protein, carbohydrate, fat, fibre, vitamin B12, vitamin C, folate, calcium, sodium, iron, caffeine.

US = United States; Can = Canada, NZ = New Zealand, UK = United Kingdom; SQFFQ = semi-quantitative food frequency questionnaire; QFFQ = quantitative food frequency questionnaire; d = day; w = week; m = month; y = year; Admin. = method of administration

Table 2.2: Methods for validating and testing reproducibility of food frequency questionnaires used in preschool children

Author, year	Study type	Participants (country, age)	Reference		Timeframe		Data collection from other carers	Corr.	Results (mean, range)
			Method	Days	FFQ	Ref.			
Blum et al, 1999	Validation	172 children (US, 1-5 y)	3 x 24-hr recalls	2 week 1 weekend	4 w	4 w	Parents only	PC	0.52, 0.26 (fibre) to 0.63 (magnesium)[a]
Andersen et al, 2003	Validation	64 infants (Norway, 12 m)	7-d WFR	All days of the week	14 d	14 d	Parents trained other carers	SC	0.50[d], , 0.18 (vitamin D) to 0.72 (polyunsaturated fatty acids) [b]
Andersen et al, 2004	Validation	187 children (Norway, 2 y)	7-d WFR	All days of the week	14 d	7 d	Direct contact with other carers	SC	Nutrients: 0.38[d], 0.26 (fat, saturated fat, monounsaturated fat, calcium) to 0.50 (vitamin A)[b] Nutrient densities: 0.46 (protein, polyunsaturated fatty acids) to 0.66 (vitamin A, iron) Foods: 0.48[d], 0.26 (potatoes) to 0.69 (cod liver oil)[b]
Klohe et al, 2005	Validation	77 children (US, 1-3 y)	1 x 24-hr recall and 2-d FR	One weekend day included	Not reported		Parents asked to collect from carers	SC	0.41, 0.54 (soup) to (0.84) non-starchy vegetables[b]
Parrish et al, 2003	Validation	68 children (US, 1-3 y)	4 x 24-hr recalls	63% weekdays 37% weekend days	12 m	12 m	Direct contact with other carers	PC	0.32, 0.08 (total energy) to 0.42 (vitamin C)[a]

Table 2.2 continued

Author, year	Study type	Participants (country, age)	Reference		Timeframe		Data collection from other carers	Corr.	Results (mean, range)
			Method	Days	FFQ	Ref.			
Williams et al, 2005	Validation	148 children (Can, 8-26 months)	3-d WFR	One weekend day included	2 w	3 d	Parents only	SC	0.63, 0.35 (non-haem iron) to 0.75 (calcium)[b] 0.69, 0.61 (haem iron) to 0.84 (non-haem iron)[a]
Taylor et al, 1998	Validation	67 children (NZ, 3 -6 y)	4-d EFR	Not reported	12 m	4 d	Not reported	-	84% of participants classified into the same or adjacent quartiles[e]
Marshall et al, 2003	Validation	240 children (US, 0.5-5 y)	3-d FR	1 weekend day 2 weekdays	1 w	3 d	Parents asked to collect from carers	SC	At 6 months: 0.57, 0.54 (water) to 0.99 (breastmilk)[b] At 12 months: 0.32, 0.26 (soft drinks) to 0.95 (breastmilk)[b] At 3 years: 0.56, 0.59 (soft drinks) to 0.76 (cows' milk)[b]
Rankin et al, 2011	Validation	753 children (US, 0.5-5 y)	3-d FR	1 weekend day 2 weekdays	7 d	3 d	Parents asked to collect from carers	SC	Not reported, 0.90 (fluoride at 6 months) to 0.65 (fluoride at 60 months)[b]
Huybrechts et al, 2006	Validation and reproducibility	1579 children (Belgium, 2.5-6.5 y)	3-d EFR	Not reported	12 m	3 d	Not reported	PC	0.52, or 0.59 when corrected for intra-variability[c] 42% participants classified correctly, 83% classified in same or adjacent category [e]

Table 2.2 continued

Author, year	Study type	Participants (country, age)	Reference		Timeframe		Data collection from other carers	Corr.	Results (mean, range)
			Method	Days	FFQ	Ref.			
Huybrechts et al, 2009	Validity and reproducibility	650 children (Belgium, 2.5-6.5 y)	3-d EFR	Not reported	12 m	3 d	Not reported	SC	Validity: 0.56, 0.35 (breads and cereals) to 0.75 (cheese) [c] 31% participants (for bread and cereals, potatoes and grains) to 44% (for fruit juice) classified into same category. Reproducibility: 0.65, 0.53 (snacks) to 0.86 (sugared drinks)
Marriott et al, 2008	Validation	50 children (UK, 12 m)	4-d WFR	Not reported	28 d	15 d	Not reported	SC	0.49, 0.25 (vitamin E) to 0.66 (sodium)[b] 0.50, 0.24 (vitamin B12) to 0.75 (sodium)[a] Not reported, 0.44 to 0.70[bf]
Marriott et al, 2007	Validation	50 children (UK, 6 m)	4-d WFR	Not reported	7d	15 d	Not reported	SC	0.74, 0.55 to 0.89[a]
Iannotti et al, 1994	Validation	17 children (US, 2-4 y)	3-d WFR	Not reported	7 d	3 d	Direct contact with other carers	PC	Not reported, 0.15 (fat)[g] to 0.74 (cholesterol)[a]
Treiber et al, 1990	Validation and reproducibility	55 children (US, 3-5 y)	2 x 24-hr recalls	Weekdays only	3 m	1 w	Not reported	PC	Validity: Not reported, 0.40 (potassium) to 0.62 (cholesterol)[c] Reproducibility: 0.67, 0.42 (total carbohydrate) to 0.74 (sodium)[b]

Table 2.2 continued

Author, year	Study type	Participants (country, age)	Reference		Timeframe		Data collection from other carers	Corr.	Results (mean, range)
			Method	Days	FFQ	Ref.			
Stein et al, 1992	Validation	224 children (US, 44-60 m)	4 x 24-hr recalls	Not systematic by day of week, no interviews on Sundays	12 m	12 m	Parents only	PC	Not reported, 0.16 (polyunsaturated fatty acids for boys) to 0.60 (potassium for girls)[b] Not reported, 0.04 (polyunsaturated fatty acids and sodium for boys) to 0.62 (potassium for girls)[a]
Metcalf et al, 2003	Repeatability	130 children (NZ, 1-14 y)	NA	NA	4 w	NA	NA	PC SC	PC: 0.73[d], 0.42 (bread) to 0.86 (non-milk drinks)[c] SC: 0.76[d], 0.50 (bread) to 0.82 (fruit)[c]
D'Ambrosio et al, 2012	Validation	22 Mexican Mennonites (Can, 12-36 m)	3 x 24-hr recalls	Not reported	4 w	4 w	Not reported	PC	0.41, 0.19 (vitamin C) to 0.797 (caffeine)[c]

US = United States; Can = Canada, NZ = New Zealand, UK = United Kingdom; d = day; w = week; m = month; y = year; WFR = weighed food record, EFR = estimated food record; Corr. = correlation; PC = Pearson's coefficient; SC = Spearman's coefficient; NA = not applicable

[a] energy-adjusted

[b] absolute

[c] energy-adjusted or absolute not specified

[d] median

[e] cross classification

[f] correlation coefficient after milk drinks excluded

[g] as a percentage of energy intake

2.7 FFQs validated for identifying dietary patterns

Eight studies investigated the relative validity of FFQs for determining dietary patterns, and these are summarised in **Table 2.3**. No studies validated FFQs for their ability to determine dietary patterns in young children so adult studies are reported here. Seven of the eight studies used the gold-standard reference method of weighed-diet records (Beck et al., 2012; Crozier et al., 2007; Hu et al., 1999; Khani et al., 2004; Nanri et al., 2012; Okubu et al., 2009; Togo et al., 2003), and one study used an estimated-diet record (Ambrosini et al., 2010). The estimated-diet record was used in a population of adolescents, from whom it could be difficult to obtain accurate weighed records. Diet records ranged in duration from three days (Ambrosini, et al., 2010), to four 7-day diet records spaced over one year (Khani, et al., 2004; Nanri, et al., 2012). Three studies used consecutive diet record days (Hu, et al., 1999; Nanri, et al., 2012; Togo, et al., 2003), whereas for five studies it was not reported whether diet record days were consecutive or non-consecutive (Ambrosini, et al., 2010; Beck, et al., 2012; Crozier, et al., 2007; Khani, et al., 2004; Okubu, et al., 2009). In six studies the FFQ and the diet record did not cover the same timeframe (Ambrosini, et al., 2010; Crozier, et al., 2007; Hu, et al., 1999; Khani, et al., 2004; Okubu, et al., 2009; Togo, et al., 2003). In one study it was unclear whether the FFQ and diet record covered the same timeframe, although the 4-day diet record was administered at some point during a single month (Beck, et al., 2012).

All eight studies used principal component analysis (PCA) to identify dietary patterns. Prior to using PCA, seven of the eight studies aggregated foods from the FFQs and food diaries together in two steps (Ambrosini, et al., 2010; Crozier, et al., 2007; Hu, et al., 1999; Khani, et al., 2004; Nanri, et al., 2012; Okubu, et al., 2009; Togo, et al., 2003):

1. Foods from the diet record were matched to categories or items on the FFQ
2. FFQ categories were collapsed into food groups to use in PCA

All of the studies matched foods from the diet records into the FFQ categories and excluded foods that did not fit. Excluding foods is appropriate because ingredients like flour and sugar cannot be accurately matched to an FFQ that asks about whole foods. If flour were put into a category such as “bread,” this would falsely inflate the frequency of bread intake from the food records, as the flour may have been used in another item, such as quiche or cake. As such, excluding ingredients like flour is preferable. Investigators tend to look at particular food groups of interest, such as characterising fruit, vegetable, bread, milk, meat and confectionary intake accurately in a population. More accurate estimates will be obtained for these food groups of interest by only including foods that fit into these categories.

However, diet records are the gold standard for dietary assessment and excluding so much detail at this point seems counter intuitive. Deciding which foods to exclude is also subjective. To address these issues, researchers should report the number and type of food items that were excluded from the study. Five of the eight studies reported how many foods were excluded from the diet records, ranging from 22 (Togo, et al., 2003) to 638 (Khani, et al., 2004). Excluded foods were:

- Constituents of cooked dishes such as herbs and spices (Crozier, et al., 2007; Okubu, et al., 2009).
- Foods that had a low frequency of consumption and did not match FFQ categories (Hu, et al., 1999; Togo, et al., 2003).
- Foods that did not match FFQ categories (Ambrosini, et al., 2010; Beck, et al., 2012; Khani, et al., 2004).

Togo et al (2003) also excluded five FFQ categories at this point, due to low frequency of consumption in the study population.

Prior to PCA, the FFQ categories were further aggregated into food groups by seven of the eight studies (Ambrosini, et al., 2010; Crozier, et al., 2007; Hu, et al., 1999; Khani, et al., 2004; Nanri, et al., 2012; Okubu, et al., 2009; Togo, et al., 2003). The rationale for aggregating foods into food groups is that as more items are entered into PCA, the amount of variance explained per factor decreases (Michels & Schulze, 2005). As such, it is desirable to collapse categories from the FFQs into food groups. The number of items entered into PCA is dependent on sample size. It is advisable, in order to obtain robust data, that sample size allows for inclusion of one item per ten participants (Floyd & Widaman, 1995). However, four of the eight studies exceeded this ratio (Beck, et al., 2012; Hu, et al., 1999; Khani, et al., 2004; Okubu, et al., 2009). The number of food groups entered into PCA ranged from 21 food groups for 1806 participants (Togo, et al., 2003) to 49 food groups for 585 participants (Crozier, et al., 2007).

Beck et al (2012) took an alternative approach when reducing the number of food groups. Instead of aggregating FFQ categories together, 30 of the most commonly consumed items from the 144-item FFQ were identified for use in PCA. The remaining 114 FFQ categories were excluded, thus discarding a large amount of detail collected in both the FFQ and diet records. However, Beck et al (2012) were specifically interested in iron-related dietary patterns, rather than overall dietary patterns. It could be considered appropriate to only select the most commonly consumed foods that relate to iron status in this situation.

One of the eight studies adjusted the food groups for energy intake prior to running PCA (Okubu, et al., 2009), and two studies performed the PCA with both energy adjusted, and unadjusted food groups (Ambrosini, et al., 2010; Nanri, et al., 2012). All eight studies performed separate PCA analyses for each method of dietary assessment (for example the food frequency questionnaire and the reference method). Six studies used scree plots (Ambrosini, et al., 2010; Beck, et al., 2012; Hu, et al., 1999; Nanri, et al., 2012; Okubu, et al., 2009; Togo, et al., 2003), five studies used eigenvalues (Ambrosini, et al., 2010; Beck, et al., 2012; Hu, et al., 1999; Khani, et al., 2004; Nanri, et al., 2012), and one study used percentage variation explained (Crozier, et al., 2007) to identify principal components to retain in the solution. Of the five studies that used eigenvalues, two used eigenvalues > 1 (Beck, et al., 2012; Hu, et al., 1999), one used eigenvalues >1.8 (Khani, et al., 2004), and two did not report the cut off used for eigenvalues (Ambrosini, et al., 2010; Nanri, et al., 2012). Six studies used orthogonal rotation to improve interpretability (Ambrosini, et al., 2010; Beck, et al., 2012; Hu, et al., 1999; Khani, et al., 2004; Nanri, et al., 2012; Okubu, et al., 2009), one used non-orthogonal rotation (Togo, et al., 2003), and one did not report if rotation was used (Crozier, et al., 2007). Principal component analysis identified either two or three factors for each of the eight studies. These are presented in **Table 2.3**.

All eight studies calculated dietary pattern scores for participants from each dietary assessment method, by summing the intake of each food group and weighting by the factor loading for that food group. These dietary pattern scores were then compared. All eight studies used correlation analysis to assess validity of the dietary patterns from the FFQ compared to the reference method. Four studies also used the Bland-Altman method (Ambrosini, et al., 2010; Beck, et al., 2012; Crozier, et al., 2007; Okubu, et al., 2009), and one study also used comparison of means and cross-classification (Beck, et al., 2012). Overall, the FFQs performed well with correlation coefficients between the patterns derived from FFQs and diet records ranging from 0.34 (Beck, et al., 2012; Togo, et al., 2003) to 0.89 (Nanri, et al., 2012). As discussed in section 2.4.2, correlation coefficients of 0.5-0.7 are generally considered good for FFQ validations, and Willett (2001) notes that correlations greater than 0.7 are rare. **Table 2.3** presents the patterns determined and the correlation coefficients for each study.

All eight studies reported the percentage of variation explained by the dietary patterns. For seven out of eight studies, the percentage variation explained for the questionnaire data ranged from 15.9% for two patterns (Crozier, et al., 2007) to 34% for three patterns (Khani, et al., 2004), and for the reference method from 14.3% for two patterns (Crozier, et al., 2007) to

32.9% for three patterns (Nanri, et al., 2012). In one study, the percentage of variation explained was substantially higher than the other studies, with two dietary patterns explaining 84% of the variation in the questionnaire data, and 53% of the variation in the reference method data (Ambrosini, et al., 2010). Although it is of interest to see the range in proportion of variation explained by dietary patterns, direct comparisons between studies are difficult because the proportion of variation explained will differ based on the number of variables included in the analysis (Michels & Schulze, 2005).

Only four of the eight studies measured the reproducibility of dietary patterns (Beck, et al., 2012; Hu, et al., 1999; Khani, et al., 2004; Nanri, et al., 2012). In each of the four studies, the results from administrations of the FFQ at different time periods were compared. Intervals between FFQ administrations ranged from one month for one study (Beck, et al., 2012) to one year for three studies (Hu, et al., 1999; Khani, et al., 2004; Nanri, et al., 2012). These intervals are considerably longer than the intervals discussed in section 2.5, again demonstrating that longer intervals are considered appropriate for adult populations whereas shorter intervals are more appropriate for preschool populations.

All four studies presented reproducibility results per dietary pattern. Hu et al (1999) found Pearson correlation coefficients of 0.70 and 0.67 for 'Prudent' and 'Western' patterns respectively between the first and second administrations of the FFQ. Khani et al (2004) reported Spearman correlations ranging from 0.63 ('Healthy' pattern) to 0.73 ('Drinker' pattern), and Nanri et al (2012) reported Spearman correlations ranging from 0.55 ('Prudent' pattern for women and 'Westernized' pattern for men) to 0.77 ('Traditional' pattern for men). Beck et al (2012) reported Pearson correlations of 0.76 for both a 'Healthy' dietary pattern, and a 'Sandwich and drinks' dietary pattern. Overall, the FFQs demonstrated high reproducibility for dietary patterns.

Table 2.3: Papers that examine the relative validity of food frequency questionnaires (FFQs) for determining dietary patterns

Authors (year)	Participants (country, age)	Aim	Tool being validated	Ref. tool	Statistical methods	Results		
						Patterns identified	Corr.	Var.
Hu et al (1999)	127 men (US, 40-75 y)	Validity and reproducibility of dietary patterns	131-item FFQ for intake over previous year	2 x 1-w WFR, consecutive days (6-7 m apart)	PCA with 40 food groups Pearson correlation coefficients	Prudent: vegetables, legumes, whole grains, fruit, oil and vinegar salad dressings, fish and seafood. Western: Processed meat, red meat, butter, high-fat dairy, refined grains, eggs, french fries.	Prudent: 0.45 Western: 0.58	FFQ: 20 %
Togo et al (2003)	3785 men and women (Denmark, 30, 40, 50 or 60 y).	Validity of dietary patterns	26-item FFQ for intake over previous year	7-d WFR, consecutive days	PCA with 21 food groups Spearman rank correlation coefficients	**Men** Green: wheat bread, rye bread with whole grains and/or bran, vegetables, fruits. Sweet: Cake, biscuits, candy, soft drinks, ice cream, jam, marmalade, honey. Traditional: Meat, paté, potatoes, butter, lard, hard margarine. **Women** Green: wheat bread, rye bread with whole grains and/or bran, vegetables, fruits Sweet-traditional: cake, biscuits, baked goods, candy or chocolate, paté, meat, white bread, butter, lard, hard margarine	**Men** Green: 0.61 Sweet: 0.55 Traditional: 0.34 **Women** Green: 0.61 Sweet-traditional: 0.57	**Men** FFQ: 30.5% WFR: 26.2% **Women** FFQ: 23.8% WFR: 19.8%

Table 2.3 continued

Authors (year)	Participants (country, age)	Aim	Tool being validated	Ref. tool	Statistical methods	Results		
						Patterns identified	Corr.	Var.
Khani et al, 2004	Validity study: 129 women Repeatability study: 212 women (Sweden, 40-74 y)	Validity and repeatability of dietary patterns	60-item FFQ for intake over previous 6 months	4 x 7-d WFR (3 m apart)	Factor analysis with 26 food groups Spearman correlation coefficients	Healthy: vegetables, fruits, fish, poultry, tomato, whole grains, cereal, low-fat dairy. Western: Processed meat, meat, refined grains, sweets, margarine, high-fat dairy, potatoes, soda. Drinker: wine, liquor, beer, snacks	Healthy: 0.59 Western: 0.50 Drinker: 0.85	FFQ: 34% WFR: 30%
Crozier et al, 2007	585 women in early pregnancy (UK, 16.3 – 43.3 y)	Validity of dietary patterns	Interviewer-administered 100-item FFQ for intake over previous 3 months	4-d WFR	PCA with 49 food groups Pearson correlation coefficients	Prudent: fruit, vegetables, wholemeal bread, rice, pasta, yoghurt, cheese, fish, reduced fat milk Western: red meat, processed meat, cakes and biscuits, puddings, Yorkshire puddings, savoury pancakes, chips, roast and boiled potatoes, sugar, sweets, chocolate.	Prudent: 0.67 Western: 0.35	FFQ: 15.9% FR: 14.3%

Table 2.3 continued

Authors (year)	Participants (country, age)	Aim	Tool being validated	Ref. tool	Statistical methods	Results Patterns identified	Corr.	Var.
Okubu et al, 2009	184 men and women (Japan, 31-72 y)	Validity of dietary patterns	145-item DHQ for intake over previous month	4-d WFR collected in each season over one year	Factor analysis with 33 food groups Pearson's correlation coefficient Bland-Altman	**Women** Healthy: green and yellow vegetables, fish, fruits, mushrooms, white vegetables, sea products, seaweeds, pickled vegetables, shellfish and pulses. Western: vegetable oil, processed meat, butter, eggs Japanese traditional: miso soup, rice **Men** Healthy: green and yellow vegetables, fruits, mushrooms, white vegetables, seaweeds, dairy products, sugar, miso, pulses Western: chicken, vegetable oil, processed meat, beef, pork	**Women** Western: 0.36 Japanese-traditional: 0.44 Healthy: 0.57 **Men** Healthy: 0.62 Western: 0.56	**Women** DHQ: 30.1 % DR: 30.8% **Men** DHQ: 21.5% FR: 25.8%
Ambrosini et al, 2010	783 adolescents (Australia, 14 y)	Validity of dietary patterns	212-item FFQ for intake over previous year	3-d EFR	PCA with 38 food groups Spearman's correlation coefficient Bland-Altman	Healthy: vegetables, fresh fruit, legumes, fish, whole grains, low-fat dairy, mineral water. Western: take-away foods, confectionary, soft drinks, crisps, refined grains, red meats, processed meats, fried potato, potato, high-fat dairy, sauces and dressings, cakes and biscuits, sugar, fried fish and poultry.	Healthy: 0.45 Western: 0.36	FFQ: 84% EFR: 53%

Table 2.3 continued

Authors (year)	Participants (country, age)	Aim	Tool being validated	Ref. tool	Statistical methods	Results		
						Patterns identified	Corr.	Var.
Beck et al, 2012	115 women (NZ, 18-44 y)	Relative validity and reproducibility of iron-related dietary patterns	144-item self-administered computerised iron FFQ	4-d WFR	PCA with 30 food groups Pearson's correlation Bland-Altman Cross - classification Weighted kappa statistic	Healthy: tomatoes, lettuce, capsicum, broccoli, carrots, onions, apples, almonds, yoghurt, brown bread, crackers, porridge, herbal tea, water. Sandwiches and drinks: brown bread, butter, cheese, beef, coffee, black tea, milk added to drinks.	Healthy: 0.34 Sandwich and drinks: 0.62	FFQ: 20% WDR: 19.2%
Nanri et al, 2012	498 men and women (Japan, 40-69 y)	Validity and reproducibility of dietary patterns	138 food item FFQ for intake over previous year	7-d consecutive WFR collected either twice or four times a year	PCA with 48 food groups Spearman's correlation coefficient	Prudent Japanese: vegetables, fruit, potatoes, soy products, mushrooms, seaweed, oily fish, green tea Westernized Japanese: bread, meat, processed meat, fruit juice, coffee, black tea, soft drinks, sauces, mayonnaise, dressing. Traditional Japanese: rice, miso soup, pickles, salmon, salty fish, seafood, fruit, and sake (men only).	**Men** Prudent: 0.89 Westernized: 0.82 Traditional: 0.75 **Women** Prudent: 0.82 Westernized: 0.75 Traditional: 0.47	**Men** FFQ: 29.4% WDR: 26.5% **Women** FFQ: 24.9% WDR: 26.5%

US = United States; UK = United Kingdom; NZ = New Zealand; d = day; w = week; m = month; y = year; Ref. tool = reference tool; WFR = weighed food record; EFR = estimated food record; DHQ =diet history questionnaire; Corr. = correlation; Var. = proportion variation explained in the population by dietary patterns.

2.8 Conclusion

This literature review demonstrates that FFQs can successfully determine food and nutrient intake in young children, and dietary patterns in adults. However, few FFQs for young children exist and none have been validated for dietary pattern analysis. Furthermore, no FFQs have been validated for their ability to assess food intake in New Zealand toddlers. More FFQs need to be developed for preschool populations, particularly the 12-24 month age group where FFQs are scarce. Food frequency questionnaires developed for this age group should be validated for their ability to determine dietary patterns as well as nutrient intake. Such tools would provide valuable insight into the dietary patterns of young children, and allow for the exploration of early dietary habits.

In summary, weighed food records are recognised as the gold-standard reference method for dietary validation studies, and several days of weighed food records should be collected to capture within-person variation and give an estimate of habitual diet. The reference method should also cover the same timeframe as the FFQ. When assessing the validity of an FFQ designed for ranking individuals into categories, cross-classification and correlation can be used. Although correlation does not measure agreement, it has been used in the majority of studies so is useful for comparative purposes. The Bland-Altman method is better suited for assessing differences in absolute dietary intake, rather than assessing the ability of an FFQ to rank individuals into categories.

3 Methods

3.1 Study design

The aim of the Eating Assessment in Toddlers (EAT) study was to test the relative validity and reproducibility of a food-frequency questionnaire (FFQ) designed for children aged 12-24 months. The EAT Study aimed to validate the FFQ for both dietary patterns and nutrients. This thesis focuses on validation and reproducibility for dietary patterns only. The validation study was conducted in the Department of Human Nutrition, University of Otago (Dunedin, New Zealand), and was undertaken in Wellington, Dunedin and Canterbury. Ethical approval was obtained from the University of Otago Ethics Committee (Appendix A), and Māori consultation was carried out with the Ngāi Tahu Research Consultation Committee (Appendix B).

3.2 Food frequency questionnaire development

The EAT FFQ was adapted from the interviewer-administered FFQ used in the Southampton Women's Survey (SWS) (Southampton Women's Survey Study Group, 2005) by researchers at the Department of Human Nutrition, University of Otago. The Southampton Women's Survey FFQ was designed to assess the dietary intakes of 12-month-old children in the United Kingdom over the previous 28 days and consists of 78 food item questions split into twelve food categories (Southampton Women's Survey Study Group, 2005).

Members of the research team used this FFQ as a starting point, but adapted it for New Zealand children aged 12-24 months. Appendix C presents a more detailed analysis of the modifications made. In brief, the food list was tailored to New Zealand toddlers by including foods that at least 10% of toddlers eat daily, based on published food intake data for 12-24 month old New Zealand toddlers (Szymlek-Gay et al., 2010). In addition, infant foods from the UK were replaced with infant and toddler foods available for sale in New Zealand, and British names of foods were replaced with the New Zealand equivalents. For example, "tinned peas" was changed to "peas," and "squash" to "cordial." Foods not commonly eaten in New Zealand were removed, such as "gammon" and "turkey."

The EAT Study FFQ contains 91 food item questions split into eleven food categories, and assesses food and fluid intake over the previous four weeks. The FFQ also has columns distinguishing between amount of food offered, and amount of food actually eaten. Parents

were asked to specify how much of a food they would usually offer their child, and then to specify how much of that food their child would actually eat. This feature was designed to help parents visualise how much their child eats rather than how much they are offered – as the researchers suspected parents may have a tendency to report what is offered rather than consumed, possibly contributing to the over reporting that is common in FFQs. This modification was not present in the original SWS FFQ but was considered to be particularly important for children of this age, who frequently do not consume all the food they are offered. The EAT Study FFQ is presented in Appendix D.

Data on frequency of food item consumption, but not amount, were used in the analysis reported in this thesis.

3.3 Data Coding

To obtain nutrient intakes from the FFQ data, each of the 91 food items were assigned data for nutrients of interest. Both EAT Study MSc candidates completed this data coding using Diet Cruncher (Way Down South Software, Otago). The grams of a food, kilojoules, milligrams of zinc, calcium, iron, vitamin C and grams of total fat, protein and carbohydrate were calculated for each of the 91 questions. Where more than one food item made up a question, nutrient data relevant to each food item in the question were assigned a weighting. For example for the question 'Cornflakes, rice bubbles' a weighting of 50% cornflakes and 50% rice bubbles was used. This was further split for both cornflakes and rice bubbles into two dominant brands: Kellogg's and Sanitarium. The nutrients per 100 grams of the four types of cereal were averaged to get one overall nutrient line for the "Cornflakes, rice bubbles" question. The density was also averaged so that number of grams of a food could be calculated when the volume eaten was entered into the FFQ. The nutrient coding data for the 91 questions was then recorded in a Microsoft Excel spreadsheet. The two MSc candidates completed half the data coding each, and both reviewed the data coding document once it was complete. The data coding is required when validating the FFQ for nutrients, but not for dietary patterns, so is not the focus of this thesis.

3.4 Participants and Recruitment

Participants (n = 160) were a self-selected convenience sample of parents of 12-24 month old infants recruited in Wellington, Dunedin and Canterbury (New Zealand) between September 2011 and May 2012. Participants were recruited using newspaper advertisements, social media, posters and flyers, and through email contact and word-of-mouth.

A total of twelve advertisements for the study were placed in community newspapers in the Wellington, Dunedin and Canterbury regions between September 2011 and February 2012. **Table 3.1** presents the newspapers advertisements were placed in and their circulation numbers. An advertisement also ran in a Parents Centre newsletter in Wellington in October 2011, delivered to 1500 homes. A paragraph about the study was put on the Te Papa Tongarewa Museum staff intranet in September 2011, and on a New-Zealand based breastfeeding support Facebook page (Breastmates) in January 2012.

Table 3.1: Advertisements in community newspapers between September 2011 and February 2012.

Paper	Number of advertisements	Circulation
Wellingtonian	5	72,000
Northern Courier and Petone Herald	1 in each	Combined circulation of 70,000
The Star (Dunedin)	3	43,500
Methven Snowfed	1	1600
Rakaia News	1	1200

Posters and flyers advertising the study were also placed in childcare centres, playcentres, music groups, libraries, museums, food outlets, sports centres, university campuses and other community centres in Wellington, Dunedin and Canterbury.

Emails advertising the study were sent to all staff at the University of Otago Dunedin campus, and to all staff and students at the University of Otago Wellington campus in September 2011. Another email was sent to all staff and students at the Wellington Campus in February 2012. Eight playcentres were contacted in Wellington, and six agreed to circulate an email to their members about the study. Plunket Society newsletters were also scanned for contact people such as coffee group coordinators, and music and dance teachers. These people were approached and asked to circulate information about the study to parents with 12-24 month old children. Participants who were recruited into the study were also encouraged to let other eligible parents know about the study.

Parents were eligible to participate if they had a child aged between 12 months and 24 months on the day of the first study appointment. Participants were excluded if their child had a

diagnosed health condition that affected feeding or growth, or if their child was born prior to 36 weeks gestation. Only one twin out of any set of twins was included in the study.

The candidate was responsible for the majority of the recruitment taking place in Wellington.

3.5 Sample size

A sample size of 160 participants was recruited, allowing for the examination of sixteen food groups using principal component analysis, as ten participants per variable are required to obtain robust results in PCA (Floyd & Widaman, 1995).

3.6 Data Collection

3.6.1 Participant appointments

Eligible participants were invited to have a first appointment with the EAT Study MSc candidates either as a home visit (Wellington, Dunedin and Canterbury participants) or at the University of Otago Wellington School of Medicine (Wellington participants only). Participants received a hard copy of the information form (Appendix E), and provided written informed consent at the first visit (Appendix F). In addition, participants completed a demographic questionnaire, and the interviewer-administered FFQ. Anthropometric measurements of the 12-24 month children were also taken. Participants who attended appointments at the University of Otago campus rather than having home visits were given a $10 supermarket voucher to compensate for travel costs.

Participants attended a second appointment after completing a weighed food record of their child's food intake over a 5-day period. The second appointment took place four to nine weeks after the first appointment depending on participant availability, with 82% of participants completing their second appointment between four and six weeks after the first appointment.

The candidate conducted interviews with over half the participants.

3.6.2 Demographic Questionnaire

Participants completed a demographic questionnaire (Appendix G) at the first visit, containing information on the parent's or caregiver's sex, age, parity, relationship to the child in the study and ethnicity. The questionnaire also collected information on the child's date of birth,

birth weight, birth length, number of weeks gestation, sex and ethnicity. Ethnicity questions were derived from the 2006 New Zealand census (Statistics New Zealand, 2006a).

3.6.3 Anthropometry

The EAT Study MSc candidates (who were trained in anthropometry) took weight, length and palm volume measurements of the toddlers at the first appointment. Measurements were taken in accordance with an anthropometry protocol (developed by another MSc candidate) to reduce both inter- and intra-person variation (Appendix H). Toddlers were weighed to the nearest 0.1 kg using calibrated Seca Alpha weighing scales (Model 770, Hamburg, Germany) wearing a dry, pre-weighed nappy, and a singlet. Length measurements were taken using a calibrated Harlow Healthcare Rollameter (UK), to the nearest 0.1 cm.

A scan of each child's hand was taken using a Canon Canoscan Scanner (Hanoi, Vietnam) (Appendix I) that had measuring tape affixed to provide a scale. The scans were used to measure length and width of the child's palm. Length was taken as the distance between the middle of the deepest wrist-crease to the middle of the base of the third digit. Width was taken as the maximum distance across metacarpal-phalangeal joints II and V. The scanned images were measured using public domain image processing software: ImageJ64 (developed by National Institutes of Health, USA). The scale was set in ImageJ64 using a known distance provided by the measuring tape on the scanned image, and then the palm width and length were measured and the measurements recorded on an Excel spreadsheet and in hard copy on the Anthropometric Measurement sheet. Palm depth was measured to the nearest 0.1 cm using calibrated bone callipers (Anthropometer, model 01291). Palm volume was then calculated as length multiplied by width multiplied by depth.

Weight, length, and palm depth were all measured in duplicate. The measurements were recorded immediately on anthropometric measurement sheets and then recorded on a Microsoft Excel Spreadsheet. If the duplicate measurements were not within 0.1 kg for weight, 0.7 cm for height and 0.2 cm for palm depth, a third measurement was taken. In this situation, the average of the two closest measurements was used, or if they were equidistant, the average of the three measurements.

3.6.4 Food Frequency Questionnaire administration

The design of the FFQ is described in section 3.2.

The FFQ was administered twice, once at the first appointment (FFQ1) before the food record was completed, and then again at the second appointment (FFQ2), after the food record had been completed. Food frequency questionnaires were labelled with the participant's unique study identification number. Names were not recorded on the questionnaires. Degree-qualified nutritionists (including the candidate) administered the FFQ each time, and repeat administrations were completed by the same nutritionist who administered the questionnaire at the first appointment.

The second administration of the FFQ (FFQ2) was used to assess reproducibility.

3.6.5 Food record

Participants were asked to complete a weighed food record of their child's food intake on five days over a four-week period. Days were randomly assigned and non-consecutive to account for day-of-the-week effects using a design developed by the study biostatistician. Five-day weighed food records (5DWFRs) were considered long enough to get an estimate of habitual diet, without over-burdening study participants. **Table 3.2** presents the distribution of days-of-the-week that 5DWFRs were collected on, over the study population.

Table 3.2 Days of the week that the five-day weighed food records were recorded on (for n=153 participants)

Day of the week	**Number**	**Percentage**
Monday	96	12.6
Tuesday	104	13.7
Wednesday	94	12.4
Thursday	114	15.0
Friday	114	15.0
Saturday	125	16.4
Sunday	114	15.0
Total	**761**	**100**

Participants were shown how to use the food record at the first appointment and were provided with Salter vista electronic kitchen scales (Kent, England) accurate to one gram. The kitchen scales were calibrated with a 100-gram calibration weight before and after each

participant had used them. Scales that read more than one gram above or below 100 grams were deemed inaccurate and were not used. Participants were shown how to use the scales and were provided with a written instruction sheet (Appendix J). Participants were shown how to change the batteries in the scales, and were provided with a spare set of batteries.

The food record (Appendix K) was developed by researchers at the Department of Human Nutrition, University of Otago and was based on the food record used in the Toddler Food Study (Szymlek-Gay et al., 2009). The food record had six columns to record:

- Where the child ate
- Time of day the child ate
- Name, brand and cooking method of food or drink
- Empty weight of the child's plate or mug
- The weight of the child's plate or mug with each food or drink added to it
- The weight of the plate or mug with any leftover food or drink

The food record booklet contained instructions explaining how to fill out the columns, an example page of a completed food record, instructions about how to record recipes, and instructions on how to estimate foods when they could not be weighed. Each food record page for each day also had a column to record the date, day of the week, whether the child was unwell that day, and if so whether this had increased, decreased or made no change to the child's appetite.

Participants were asked to weigh their child's plate or mug when empty and to record this weight. They then recorded the weight of each separate food item added to the plate or mug. They were also asked to describe what food was left over once the child had finished eating, for example "only peas left" or "half the chicken and half the broccoli left." Participants were encouraged to pick up any leftovers that had been thrown or spilled and weigh these along with the leftovers on the plate. The food record also contained a page to record supplement use for each day, and a page to record recipes for each day. Participants were asked to record the ingredients and amounts that went into each recipe, and then to estimate and record the proportion of the recipe their child ate.

Participants were shown how to estimate food and fluid intake when weighing was not possible. Each participant was provided with a supplementary page to assist with estimating portion sizes. The supplementary page included a ruler to measure foods against and circles with circumference measurements to compare round foods to. This was adapted from the Adult Nutrition Survey 08/09 (University of Otago & Ministry of Health, 2011). The other

side of the supplementary sheet contained photographs of portions of takeaway foods with gram weights next to them. Each photo included a ballpoint pen to provide an idea of scale. The photo sheet was adapted from the Toddler Food Study (Szymlek-Gay, et al., 2009).

The food record also provided instructions for other methods of estimating portion size, such as using household measures, recording the weight stated on the package for packaged food, and describing if pieces of fruit were small, medium or large.

Participants who had children who went to early childhood centres were provided with an "Away from Home" food record sheet (Appendix L). This sheet was developed to include some brief information about the study, and instructions for other carers about how to complete the sheet. Instructions on how to record recipes were specific to an early childhood centre situation, where bulk recipes may be made for many children. Centres were asked to provide the entire recipe, and the number of children the recipe served.

The EAT Study MSc candidates telephoned each participant after their first day of the food record to answer questions that may have arisen, and to check the record was being completed correctly. The candidates asked the participants to read out a section of the food record, and provided them with tips on how to complete the record correctly if there were any mistakes. A reminder text message or email was sent to participants each day before their assigned food record days.

At the second appointment, the EAT Study MSc candidates checked through the food records and asked for clarification from the participants if the records had sections that were not legible, or if there was missing information. The candidates also asked the participants to estimate what proportion of leftovers the participants had been unable to measure over the course of the five days of recording.

3.7 Data entry

3.7.1 Demographic questionnaire data entry

Data from the demographic questionnaires was entered into a Microsoft Excel spreadsheet.

3.7.2 Food frequency questionnaire data entry

An online interface to enter the FFQ data was created by the candidate using an open-source survey application: LimeSurvey version 1.90+. Different question formats such as array

questions, multiple-choice questions, yes or no questions, and short free text questions were used to reduce data entry fatigue and decrease the risk of data entry errors. The data entry interface was duplicated on LimeSurvey version 1.90+ so that each FFQ was entered for a second time after the first entry.

Degree-qualified nutritionists, including the candidate, completed the data entry. The data entered into LimeSurvey was exported into Excel spreadsheets. An Excel spreadsheet was developed to calculate the difference between the first and second data entries for each FFQ. Any differences detected were then double checked against the hard copy of the FFQ, and errors were manually corrected (these tasks were completed by another MSc candidate).

3.7.3 Food record data entry

The five-day food records were initially entered into nutrient analysis software Diet Cruncher (Way Down South Software, Dunedin, New Zealand) or Kai-culater (University of Otago, Dunedin, New Zealand) by four degree-qualified nutritionists, including the candidate. Diet record files from Diet Cruncher were then imported into Kai-culator so that all diet records were in the same programme. Diet records were initially entered into Diet Cruncher as Kai-culator was still under development. Data entry protocol was developed to limit inter and intra-person variation in data entry.

The two EAT Study MSc candidates provided participants with a nutrient analysis for their child (Appendix M), and a letter explaining how to interpret the nutrient analysis. Where nutrient results were unusually high or low compared to Nutrient Reference Values for New Zealand toddlers (Department of Health and Ageing et al., 2005), the MSc candidates double checked the data entry against the food records to identify and correct errors.

The data entry and calculations for each food record were double checked for accuracy by another MSc candidate and corrected. The candidate for the current thesis manually scanned output from Kai-culator to ensure data entry complied with the protocol. Inconsistencies in the data entry of recipes were identified, and the candidate compiled a list of the recipes with errors. Another MSc candidate then corrected these errors to comply with the protocol.

3.8 Data preparation

3.8.1 Collapsing food frequency questionnaire data into food groups

Data on ninety-one food items was collected in the FFQ. Ninety of the food items (water was excluded) were collapsed into sixteen food groups by the candidate, in order to obtain robust results from principal component analysis. **Table 3.3** displays the sixteen food groups, and the food items from the FFQ that were collapsed into each group.

Food items from the FFQ were initially collapsed into the broad groupings of "fruit", "vegetables", "breads and cereals", "milk and milk products", "meat and alternatives", "spreads", "confectionary", and "sweetened drinks". Then, the investigators identified where more detail would be of interest, and split the food groups further. The following decisions were made when creating the food groups:

- A "baby and toddler foods" group was added, as it was deemed of interest and relevance for children aged 12-24 months.
- Meat and alternatives was separated into "meat," "processed meat," and "eggs and beans" due to the different fat, micronutrient and fibre contents of these foods.
- Sweet drinks were separated into "sweet drinks" and "nutritive drinks," due to the different nutrient profiles of flavoured milk and fruit juice, compared to cordial and fizzy drinks.
- Milk and milk products were separated into "Milk and milk products," "Breast milk," and "Toddler milk and infant formula." This is because the three subcategories of milk products have vastly different nutrient profiles from one another.
- "Hot chips, roast potato and kumara" were put into a separate category from vegetables, as these foods have been demonstrated to contribute a large proportion of fat to the diets of children aged five years and over in national nutrition surveys (Ministry of Health, 2003).
- A "savoury snacks" category was created to separate high-fat, high-sodium cereals such as crackers, instant noodles and crisps from cereals lower in fat and sodium such as rice, pasta and bread.

Table 3.3: Sixteen food groups analysed in Principal Component Analysis

Food Group	FFQ Food Item
1. Baby and Toddler Foods	"Little Kids" cheesy ravioli
	Other "Little Kids" meals
	Other toddler meals
	"Simply Create" meat pouches
	Baby rice, baby muesli (e.g Farex) from packet
	Vegetable based meals
	Meat based meals
	Pasta or rice based savoury meals
	Rice and other cereal based desserts
	Custard and other milk based desserts
	Fruit puree
	Fruit based desserts
	Junior fruit drink
2. Bread, pasta, rice, low-sugar cereal	White bread, buns (not iced), crumpets
	Wholemeal or wholegrain bread, buns
	Rice cakes, rice wheels, crispbreads
	Weet-bix, fruity-bix etc
	Porridge (not instant porridge in sachets)
	Cornflakes, rice bubbles
	Other breakfast cereals (less than 15 g sugar per 100g)
	Rice
	Canned spaghetti
	Other pasta
	Fruit bread, currant buns
3. Meat	Other chicken
	Other fish
	Mince and patties
	Other meat (beef, lamb, pork, mutton)
4. Processed meat	Chicken nuggets or shapes, fish fingers or shapes, battered or crumbed fish
	Sausages, saveloys, hot dogs (including vegetarian)
	Ham, bacon, luncheon
	Meat pies and sausage rolls
5. Eggs & beans	Eggs
	Canned beans (including baked beans)
	Hummus (chickpea dip)
6. Vegetables	Potato and kumara (boiled, baked, microwaved, mashed)
	Frozen mixed vegetables
	Carrot
	Pumpkin
	Green peas

Table 3.3 continued

Food Group	FFQ Food Item
6. Vegetables continued	Sweet corn
	Broccoli and cauliflower
	Green leafy vegetables (silver beet, cabbage etc)
	Salad greens (e.g. lettuce, cucumber)
	Raw tomato
	Cooked tomato (pasta sauce, canned tomato)
	Other vegetables
7. Fruit	Canned fruit
	Banana
	Apples
	Pears
	Oranges, mandarins etc
	Kiwifruit
	Grapes
	Berries (fresh or frozen)
	Dried fruit
	Avocado
	Other fruit
8. Milk and milk products	Low-fat cows milk (green, light blue, yellow-top) as a drink
	Low-fat cows milk on cereal or other food (not custard or sauces)
	Cows milk (blue, silver top) as a drink
	Cows milk on cereal or other food (not custard or sauces)
	Other milk as a drink
	Cheese (including in recipes)
	Yoghurt, dairy food
	White sauce
	Custard and other milk puddings
9. Breastmilk	Breastmilk
10. Toddler milk and infant formula	"Toddler milk"
	Infant formula
11. Spreads	Butter
	Margarine
12. Cakes, biscuits, puddings, confectionary, sweet snacks, sweet cereals	Ice cream
	Biscuits – coated (with chocolate, icing, yoghurt)
	Biscuits – other
	Cakes, muffins, scones, slices
	Croissant, sweet buns, iced buns, pastries
	Puddings not yet described
	Chocolate, lollies

Table 3.3 continued

Food Group	FFQ Food Item
12. Cakes, biscuits, puddings, confectionary, sweet snacks, sweet cereals continued	Muesli, nut, cereal or puffed rice bars
	Fruit leather, fruit strings, fruit rollups
	Other breakfast cereals
13. Sweet drinks	Fruit drinks, Ribena, cordial, sachets
	Fizzy drinks (lemonade, coke)
14. Hot chips, roast potato and kumara	Hot chips, potato shapes, roast potato or kumara
15. Savoury snacks	Crackers (wheat, rice or corn-based)
	Instant noodles
	Crisps, corn chips, corn snacks (e.g. Cheezels)
16. Nutritive drinks	Fruit juice ("Fresh Up," "Just Juice," freshly squeezed)
	Flavoured milk (Milo, Quik, drinking chocolate, Up-and-go)

3.8.2 Collapsing food record data into food groups

The same sixteen food groups in **Table 3.3** were created in the Kai-culator database, with subgroups representing each question from the FFQ that had been collapsed into the sixteen food groups. Food items from the food records were assigned by the candidate to each of the subgroups from the FFQ in Kai-culator. A 'not applicable' category was also created for foods from the food records that could not be matched to the food groups from the FFQs. This included items such as herbs, spices, dressings, condiments, cooking oil, and baking ingredients such as flour, baking soda and baking powder. Appendix N presents a table of food items from the diet records that were collapsed into the sixteen food groups, and the "not applicable" category. In total, 1480 different food items were entered into kai-culator from the food records. Of these, 1339 (90.5%) were matched to the sixteen food groups, and 141 items could not be matched to the to the sixteen food groups so were excluded from the analysis.

3.8.3 Adjusting weighed food record data for day of the week

The candidate collated information in an Excel spreadsheet on the day of the week (weekend or weekday) that the 5DWFRs were recorded on for each participant. A programmer created a programme ("EAT-Calc", Department of Human Nutrition, University of Otago, Dunedin, New Zealand) to weight frequency of intake by day of the week using the food group frequency output from the Kai-culator diet entry and analysis programme, and the candidate's

day-of-the-week spreadsheet. In this way, the frequency of each food group for each participant on weekend days was multiplied by 2/7, and frequency of each food group for each participant on weekdays was multiplied by 5/7. This approach was taken to weight the data for weekdays and weekend days appropriately. The candidate calculated a sample of the data by hand to confirm the accuracy of the programme. The candidate weighted frequency of breastfeeding according to day of the week (weekday or weekend), using Microsoft Excel.

3.9 Statistics

Demographic data for the parent-child pairs was calculated including descriptive statistics on age, ethnicity, New Zealand Deprivation Index score, and birth characteristics and anthropometry at baseline for the child using R (2011, R Development Core Team, Vienna, Austria). The mean frequency of intake per day for each of the sixteen food groups from the first administration of the FFQ (FFQ1), the second administration of the FFQ (FFQ2) and the 5DWFR was calculated using Microsoft Excel (version 12.3.0, Microsoft, Seattle, USA) using the output from "EAT-Calc". The mean and standard deviation of the difference between FFQ1 and FFQ2, and FFQ1 and the 5DWFR were then calculated. Frequencies of intake from the 5DWFR were calculated as the mean intake over the five weighted days.

To identify dietary patterns, separate principal component analyses were conducted using Stata Statistical Software (release 12, StataCorp, College Station) on FFQ1, FFQ2 and the 5DWFR using the intake data for the sixteen food groups. Frequency data (without portion size) was used in these analyses. The dietary data from all 153 participants who completed the dietary assessment methods were included in the PCA, giving 9.6 participants per food group analysed. This is sufficient to produce stable PCA results (Floyd & Widaman, 1995). To simplify the structure and improve the interpretability of the PCA, the components were rotated using orthogonal varimax rotation. Eigenvalues greater than one and the interpretability of the components were considered when identifying the number of components to retain in the solution. Scree plots were also examined, with the break point separating components with large and small eigenvalues considered when selecting the number of components to retain. The percentage variation explained by each component depends on the number of variables analysed, so was not used as a decision criterion (Michels & Schulze, 2005). As recommended in the literature (Newby & Tucker, 2004), a quantitative approach to naming the dietary patterns was taken, with patterns named based on the first two food groups that loaded highly and positively on each component.

The relative validity of the dietary patterns was determined by comparing the dietary pattern scores from FFQ1 to the 5DWFR. FFQ2 results were not used in the validation analysis, as participants are likely to have been sensitised to their child's food intake after completing the 5DWFR, which would potentially lead to an over-estimation of the FFQ's relative validity. Cross-classification and Pearson correlation coefficients were used to assess the relative validity of the dietary patterns. For cross-classification, the diet pattern scores generated for each participant in the PCA from FFQ1 and the 5DWFR were divided into quartiles. The proportion of participants classified into the same quartile, the same or adjacent quartile, or grossly misclassified into opposite quartiles by FFQ1 compared to the 5DWFR was calculated. As discussed in section 2.4.2, classifying over 50% of participants into the correct tertile suggests good relative validity (Masson, et al., 2003), therefore classifying over 50% into the correct quartiles is indicative of even stronger validity.

Pearson correlation coefficients (the variables were normally distributed) were calculated between the dietary pattern scores from FFQ1 and the 5DWFR. Correlation measures whether there is a linear relationship between variables rather than agreement, but was used to enable comparison with other published studies. As discussed in section 2.4.2, correlation coefficients of 0.5-0.7 are considered good for FFQ validation studies, and coefficients above 0.7 are rare (Willett, 2001; Willett & Lenart, 1998).

Reproducibility of the dietary patterns was assessed by calculating Pearson correlation coefficients (the variables were normally distributed) and intraclass correlation coefficients between FFQ1 and FFQ2. As discussed in section 2.4.2, intraclass correlation coefficients greater than 0.4 indicate good agreement (Gibson, 2005).

The descriptive statistics for the demographic data were performed by the candidate using the statistical package R (2011, R Development Core Team, Vienna, Austria). The principal component analysis, intraclass correlation coefficients, and Pearson correlation coefficients were performed by the study biostatistician using Stata version 12 (StataCorp, 2012). Calculation of the mean and standard deviation of the differences in frequency of food group intake between the different dietary assessment methods, and cross-classification, was done by the candidate using Microsoft Excel (version 12.3.0, Microsoft, Redmond, USA).

4 Results

4.1 Participants and recruitment

In total, 160 parents of children aged 12-24 months were recruited from Wellington (n = 121), Mid-Canterbury (n = 9), and Dunedin (n= 30) between September 2011 and April 2012. One hundred and fifty-four participants completed the study, resulting in a completion rate of 96.3%. All of the completed diet records and food frequency questionnaires were determined as fit for inclusion, so no participants were excluded from the study based on the quality of dietary data. However, the FFQ results for one participant were unavailable due to a data entry error, so this participant was excluded from the analysis. There was a median interval of five weeks between the first and second appointments (IQR: 4.6 to 5.6).

The majority of parent-child pairs who completed the study were mother-child pairs (n = 146, 95.4%) and the remaining were father-child pairs. Parents had a mean age of 34.9 years (range: 22.1 - 46.4 years). Compared to the New Zealand population, the study population had lower proportions of individuals who identified as Maori or Pacific. Over three-quarters of the parents were New Zealand European (78.4%), 3.3% were Maori, and 1.3% were Pacific, compared to 67.6% New Zealand European, 14.6% Maori and 6.9% Pacific from the 2006 New Zealand census (Statistics New Zealand, 2006b). Over half of the parents had only one child (n= 86, 56.2%), 31.4% (n=48) had two children, and 12.4% (n=19) had three or more children. The parents who attended the appointments tended to be the caregiver in charge of food preparation for the child, with 82.4% reporting that their child was given a meal by another caregiver fewer than ten times per week. For children who were given meals by other caregivers, 91.5% of parents said they were able to include most or all of the meals given by other caregivers when answering FFQ1.

Characteristics of the 12-24 month old children who participated in the study are presented in **Table 4.1**. Infants had a median age of 16.8 months (range: 11.7 - 24.8 months). Approximately three-quarters (77.1%) of the toddlers were New Zealand European. Approximately 42.1% of the children were from the least deprived areas (deciles 1-3) and 10% from the most deprived areas (deciles 8-10) in New Zealand, based on New Zealand Deprivation Index 2006 scores (Salmond et al., 2007).

Table 4.1: Characteristics of toddler participants (n = 153)

Characteristic	**n or median** [1]	**% or IQR**[2]
Age (months)	16.8	14.0 – 20.9
Sex		
Male	80	51.9
Female	74	48.1
Ethnicity		
New Zealand European	119	77.3
Maori	12	7.8
Pacific Island	4	2.6
Other	19	12.3
Birth characteristics		
Birth weight (kg) [3]	3.55	3.18 – 3.94
Length of gestation (weeks) [4]	40	38.8 – 41
Anthropometry at baseline		
Length (cm)	81.9	78 – 85.5
Weight (kg)	11.1	10 – 12.2
Breastfed at baseline	44	28.6
New Zealand Deprivation Index 2006 [5]		
1-3	60	42.6
4-7	67	47.5
8-10	14	9.9

[1] Medians are presented because Shapiro-Wilk tests for normality revealed age, birth weight, gestation, length and weight data were not normally distributed
[2] IQR = interquartile range; kg = kilogram; cm= centimetre
[3] Birth weight data available for n = 149
[4] Number of weeks gestation available for n = 150
[5] The New Zealand Deprivation Index 2006; 1 = least deprived, 10 = most deprived

4.2 Food group intakes

The mean daily intake for each of the sixteen food groups is presented in **Table 4.2**. Food group frequencies from FFQ1 were comparable to the 5DWFR, with nine of the sixteen food groups having a mean difference in frequency of intake of 0.1 of a serve or less per day. The frequency of intake of 'cakes, biscuits, puddings, confectionary, sweet snacks and sweet cereals' was the closest to the 5DWFR, with an average difference of 0.00 (SD 0.79) servings per day between the two methods. FFQ1 values for meat were similar to those from the 5DWFR, with mean intake only 0.01 (SD 0.45) of a serve lower per day compared to the 5DWFR. The biggest differences were observed for 'vegetables,' and 'milk and milk products,' where FFQ1 underestimated frequency of vegetable intake by 0.55 (SD 1.94) of a serve per day, and 'milk and milk products' by 0.28 (SD 1.19) of a serve per day.

Frequencies of intake between FFQ1 and FFQ2 were similar; with twelve out of sixteen food groups having mean differences of 0.1 of a serve per day or less between the two administrations. Reproducibility was highest for 'hot chips, roast potato and kumara' with a mean difference of 0.00 (SD 0.17) servings per day between the two administrations. Reproducibility was also high for 'milk and milk products,' 'spreads,' and 'cakes, biscuits, puddings, confectionary, sweet snacks and sweet cereals,' with differences of 0.01 of a serve per day for each of these three groups. 'Fruit' had the largest difference between FFQ1 and FFQ2, with FFQ1 estimating 'fruit' intake a mean of 0.25 (SD 1.25) of a serve higher per day.

Table 4.2: Toddlers' intake of the sixteen food groups per day from FFQ1, FFQ2, and 5DWFR, and mean (SD) differences between FFQ1 vs 5DWFR, and FFQ1 vs FFQ2[1]

	Frequency of intake per day			Difference	
	FFQ1	FFQ2	5DWFR	FFQ1 vs 5DWFR	FFQ1 vs FFQ2
	‹——————Mean (SD) ——————›				
Baby and toddler foods	0.52 (0.81)	0.37 (0.69)	0.40 (0.70)	0.12 (0.45)	0.14 (0.43)
Bread, pasta, rice, low-sugar cereal	3.08 (0.92)	2.9 (0.87)	3.28 (1.05)	-0.21 (1.07)	0.17 (0.89)
Meat	0.73 (0.35)	0.71 (0.35)	0.74 (0.50)	-0.01 (0.45)	0.02 (0.35)
Processed meat	0.43 (0.32)	0.47 (0.31)	0.58 (0.45)	-0.15 (0.41)	-0.04 (0.22)
Eggs and beans	0.46 (0.37)	0.44 (0.34)	0.51 (0.47)	-0.05 (0.46)	0.02 (0.27)
Vegetables	3.07 (1.39)	2.98 (1.62)	3.62 (2.10)	-0.55 (1.94)	0.09 (0.10)
Fruit	3.76 (1.65)	3.51 (1.40)	3.51 (1.72)	0.24 (1.73)	0.25 (1.25)
Milk and milk products	3.38 (1.58)	3.37 (1.52)	3.66 (1.79)	-0.28 (1.19)	0.01 (0.90)
Breastmilk	0.83 (1.76)	0.74 (1.60)	0.73 (1.52)	0.10 (0.72)	0.08 (0.44)
Toddler milk and infant formula	0.63 (1.07)	0.52 (0.96)	0.59 (1.05)	0.04 (0.48)	0.11 (0.59)
Spreads	0.77 (0.59)	0.78 (0.59)	0.88 (0.67)	-0.11 (0.62)	-0.01 (0.48)
Cakes, biscuits, puddings, confectionary, sweet snacks, sweet cereals	1.47 (1.03)	1.48 (1.02)	1.47 (1.02)	0.00 (0.79)	-0.01 (0.74)
Sweet drinks	0.04 (0.16)	0.06 (0.22)	0.05 (0.20)	-0.02 (0.16)	-0.03 (0.17)
Hot chips, roast potato and kumara	0.14 (0.13)	0.14 (0.15)	0.10 (0.15)	0.04 (0.17)	-0.00 (0.13)
Savoury snacks	0.74 (0.66)	0.83 (0.70)	0.78 (0.55)	-0.04 (0.67)	-0.09 (0.65)
Nutritive drinks	0.10 (0.25)	0.14 (0.33)	0.14 (0.33)	-0.05 (0.27)	-0.05 (0.26)

[1] FFQ1 = food frequency questionnaire administered at the first appointment, FFQ2 = food frequency questionnaire administered at the second appointment, 5DWFR = five-day weighed food record.

4.3 Dietary patterns

Principal component analysis identified three dietary patterns that explained totals of 34.1% (for FFQ1), 34.8% (for FFQ2) and 38.2% (for 5DWFR) of the total variation. The proportion of variation explained is higher than seven of the eight FFQ validation studies for dietary patterns in adult populations, where percentage variation explained ranges from a total of 14.3% (Crozier, et al., 2007) to 34% (Khani, et al., 2004) for two to three dietary patterns, in the seven studies. As discussed in section 2.7, one study explained a substantially higher proportion of the variation than the other studies (up to 84%) (Ambrosini, et al., 2010).

Table 4.3 presents factor loadings for the three dietary patterns produced for FFQ1, FFQ2 and 5DWFR. High, positive loadings on a food group demonstrate the food group is strongly associated with a dietary pattern, and negative loadings demonstrate the food group is inversely associated with a pattern. The three patterns produced were: "sweet foods and hot chips" which loaded positively for 'cakes, biscuits, puddings, confectionary, sweet snacks and sweet cereals,' 'hot chips and roast potato and kumara,' 'spreads,' 'processed meat,' 'sweet drinks' and 'nutritive drinks'; "vegetables and meat," which loaded positively for 'vegetables,' 'meat,' 'eggs and beans' and 'fruit,' and negatively on 'baby and toddler foods'; and "milk and fruit," which loaded positively on 'milk and milk products' and 'fruit,' and negatively on 'breast milk' and 'toddler milk and infant formula.' The patterns were named quantitatively according to the two foods with the highest loadings on each pattern.

The three components from the PCA were generated in a different order for FFQ2 compared to FFQ1 and the 5DWFR, but as has been done in previous studies (Okubu, et al., 2009), the most similar patterns with high loadings on the same foods were compared for the validity and reproducibility analysis. Overall, the three dietary patterns generated from FFQ1, FFQ2 and the 5DWFR had high factor loadings on similar foods.

Each participant had a diet pattern score generated by the PCA for each of the three patterns, and for each of the dietary assessment methods so that each child had a total of nine diet pattern scores: a pattern score for patterns one, two and three for each of FFQ1, FFQ2 and the 5DWFR. The 25th, 50th and 75th percentiles were calculated for the pattern scores for each of the dietary patterns for FFQ1, FFQ2 and the 5DWFR. These percentiles were used in the cross-classification analysis to classify children into quartiles of dietary pattern from each dietary assessment method, based on their diet pattern scores.

Table 4.3: Factor loadings for three dietary patterns determined by principal component analysis (n=153)[1]

	FFQ1 [2]			FFQ2 [2]			5DWFR [2]		
	Sweet foods and hot chips	*Vegetables and meat*	Milk and fruit	*Vegetables and meat*	**Sweet foods and hot chips**	Milk and fruit	**Sweet foods and hot chips**	*Vegetables and meat*	Milk and fruit
Baby and toddler foods	**-0.34**	**-0.35**	0.08	-0.12	-0.12	-0.01	-0.26	**-0.43**	0.20
Bread, pasta, rice, low-sugar cereal	-0.03	0.19	0.23	**0.43**	0.06	0.07	-0.09	0.22	**0.42**
Meat	-0.14	**0.49**	-0.07	**0.49**	-0.07	-0.15	-0.12	**0.53**	-0.08
Processed meat	0.20	-0.19	0.19	-0.00	**0.40**	-0.14	**0.37**	-0.17	0.15
Eggs and beans	0.27	0.29	-0.06	0.15	0.01	**0.39**	0.07	0.28	0.21
Vegetables	-0.00	**0.54**	-0.02	**0.55**	0.00	-0.06	-0.02	**0.51**	0.09
Fruit	0.01	**0.37**	**0.38**	**0.44**	0.05	0.21	-0.05	0.18	**0.36**
Milk and milk products	-0.01	-0.03	**0.63**	-0.04	-0.04	**0.60**	-0.01	-0.13	**0.57**
Breastmilk [2]	0.02	0.12	**-0.45**	0.08	-0.04	**-0.38**	-	-	-
Toddler milk and infant formula	-0.11	-0.01	-0.27	0.11	-0.11	-0.25	-0.21	0.12	**-0.35**
Spreads	**0.30**	0.03	0.15	-0.01	**0.35**	0.21	0.25	0.04	0.25
Cakes, biscuits, puddings, confectionary, sweet snacks, sweet cereals	**0.47**	-0.06	0.12	0.05	**0.53**	0.10	**0.51**	-0.05	0.05
Sweet drinks	0.20	-0.03	0.03	-0.12	**0.38**	-0.12	**0.36**	-0.04	-0.09
Hot chips, roast potato and kumara	**0.40**	-0.17	-0.07	0.01	**0.42**	-0.28	**0.37**	0.07	-0.16
Savoury snacks	**0.36**	0.03	-0.17	-0.05	0.06	0.16	0.11	0.16	0.12
Nutritive drinks	**0.31**	-0.02	-0.10	0.02	0.29	0.13	**0.36**	0.13	-0.12
Eigenvalue	*2.22*	*1.80*	*1.42*	*2.06*	*1.96*	*1.54*	*2.23*	*2.17*	*1.34*
Explained variance (%)	*12.8*	*11.1*	*10.2*	*12.7*	*12.1*	*10.0*	*13.8*	*12.5*	*11.9*

[1] Absolute values ≥ 0.30 are in bold

[2] FFQ1 = food frequency questionnaire administered at the first appointment; FFQ2 = food frequency questionnaire administered at the second appointment; 5DWFR = five-day weighed food record.

4.4 Validity of the dietary patterns

Table 4.5 presents cross-classification results and Pearson correlation coefficients for FFQ1 compared to the 5DWFR. Cross-classification results demonstrate that the FFQ has a good ability to classify toddlers correctly into categories of dietary pattern scores. This was highest for the "sweet foods and hot chips" pattern, where 50.3% of the toddlers were correctly classified into the same quartile of pattern score for FFQ1 as the 5DWFR (compared to 25% by chance). For all three patterns, FFQ1 grossly misclassified 13.7 – 17.6% of the toddlers into the opposite quartile from the 5DWFR (compared to 25% by chance).

Pearson correlation coefficients between the dietary pattern scores for FFQ1 versus the 5DWFR were higher than 0.5 for all three patterns, indicative of good relative validity. The "sweet foods and hot chips" pattern had the highest Pearson correlation coefficient of 0.68. This is higher than the correlations observed for the similar "Western" and "Sweet" patterns produced in previous validation studies for adult populations, where Spearman or Pearson correlation coefficients between methods ranged from 0.35 (Crozier, et al., 2007) to 0.58 (Hu, et al., 1999).

4.5 Reproducibility of dietary patterns

Table 4.4 presents the reproducibility results, comparing the dietary pattern scores between FFQ1 and FFQ2. Strong Pearson correlation coefficients of 0.71 for the "sweet foods and hot chips pattern," and the "vegetables and meat pattern" and 0.72 for the "milk and fruit" pattern were observed. Strong intraclass correlation coefficients of 0.71, 0.71 and 0.72 were observed for the "sweet foods and hot chips pattern," the "vegetables and meat pattern," and the "milk and fruit" pattern respectively.

Table 4.4: Validity of FFQ1 compared to 5DWFR[1]

Dietary pattern	Cross-classification Proportion classified (%)			Correlation
	Correctly classified into same quartile	Classified into same or adjacent quartiles	Grossly misclassified into opposite quartiles	Pearson correlation coefficients
Chance	*25*	*50*	*25*	-
"Sweet foods and hot chips"	50.3	86.3	13.7	0.68
"Vegetables and meat"	46.4	82.4	17.6	0.56
"Milk and fruit"	41.8	83.7	16.3	0.58

[1]FFQ1 = first administration of food frequency questionnaire; 5DWFR = five day weighed food record.

Table 4.5: Reproducibility of FFQ1 compared to FFQ2[1]

Dietary pattern	Pearson correlation coefficient	Intraclass correlation coefficient
"Sweet foods and hot chips"	0.71	0.71
"Vegetables and meat"	0.71	0.71
"Milk and fruit"	0.72	0.72

[1]FFQ1 = first administration of food frequency questionnaire; FFQ2 = second administration of food frequency questionnaire.

5 Discussion

For a number of years, dietary patterns have been explored in populations of adults as an alternative and complementary approach to the analysis of single nutrient intake. Links between dietary patterns and risk of disease have been established (Michels & Schulze, 2005) suggesting this approach is a useful adjunct to single nutrient analysis in the exploration of diet-disease relationships. Several studies have demonstrated the relative validity and reproducibility of dietary patterns derived from FFQ data in adult populations (Ambrosini, et al., 2010; Beck, et al., 2012; Crozier, et al., 2007; Hu, et al., 1999; Khani, et al., 2004; Nanri, et al., 2012; Okubu, et al., 2009; Togo, et al., 2003). However, no studies to date have tested the relative validity and reproducibility of FFQs that can be used to identify dietary patterns in toddlers aged 12-24 months. This age is a time when young children are beginning to eat similar foods to their families, and dietary patterns and habits are being established. Validated tools for toddlers could provide insight into the development of dietary patterns early in life.

In the EAT Study, we tested the relative validity and reproducibility of an FFQ for identifying dietary patterns in toddlers aged 12-24 months. The EAT FFQ demonstrated an acceptable ability to estimate the intake of food groups, with frequencies of daily intake stable across FFQ1, FFQ2, and the 5DWFR. The biggest mean difference was observed for the 'vegetable' group, where FFQ1 underestimated vegetable frequency by approximately half a serve per day compared to the 5DWFR. This is equivalent to a 15% underestimation, which is relatively small. Underestimation of vegetable intake was unexpected, as the FFQ listed vegetables separately (as opposed to in groups), and the literature suggests this leads to overestimation of intakes (Cade, et al., 2002). However, it is likely that vegetable intake from the 5DWFR was actually overestimated in this analysis, as only the frequency data from the 5DWFR was used. Only using frequency data is likely to give higher estimates of vegetable intake than if the portion size data was used, as even a small amount of an item (such as a teaspoon of parsley or half a clove of garlic) would be counted as one serve of a vegetable when using frequency data. As such, the discrepancy in vegetable intake is likely to be due to an overestimate from the 5DWFR data rather than an underestimate from the FFQ data.

The FFQ demonstrated a good ability to identify dietary patterns. Three dietary patterns were identified using principal component analysis ("sweet foods and hot chips," "vegetables and meat," and "milk and fruit"), and these three patterns were similar across FFQ1, FFQ2 and the 5DWFR. As has been observed in other studies testing the validity of FFQs for determining dietary patterns, (Ambrosini, et al., 2010; Beck, et al., 2012; Crozier, et al., 2007; Hu, et al.,

1999; Nanri, et al., 2012; Okubu, et al., 2009; Togo, et al., 2003) the factor loadings for the three patterns differed slightly across the different dietary assessment methods, for example bread loaded highly on the "vegetable and meat" pattern for FFQ2, but not for FFQ1 or the 5DWFR. However, the types of food groups highly associated with each pattern were similar across the dietary assessment methods.

The **"sweet foods and hot chips"** pattern included 'cakes, biscuits, puddings, confectionary, sweet snacks and sweet cereals,' 'hot chips, roast potato and kumara,' 'spreads,' 'sweet drinks,' 'nutritive drinks' and 'processed meat.' As recommended in the literature (Newby & Tucker, 2004), the pattern was named quantitatively based on the foods most strongly associated with the pattern. However, despite a different name, the "sweet foods and hot chips" pattern is very similar to 'Western' dietary patterns identified for adult populations in several validation studies (Ambrosini, et al., 2010; Crozier, et al., 2007; Hu, et al., 1999; Khani, et al., 2004) and to the 'Sweet' pattern identified by one study (Togo, et al., 2003).

The 'Western' and 'Sweet' patterns in the literature are associated with intakes of similar foods across several studies including: processed meat, butter and margarine, refined grains, French fries or chips or roast or fried potato, confectionary, cakes, biscuits, sweets and sweet drinks. It is interesting that such a consistent dietary pattern has been established in adult populations in several different countries (the USA (Hu, et al., 1999), Sweden (Khani, et al., 2004), Denmark (Togo, et al., 2003), UK (Crozier, et al., 2007), and Australia (Ambrosini, et al., 2010)), and also transcends age groups to be found in a population of New Zealand toddlers aged 12-24 months. The similarity of this pattern between the adult and toddler populations suggests that between 12 to 24 months, children may already be eating what their parents or caregivers eat.

The "sweet foods and hot chips" pattern also resembles an 'adult foods' dietary pattern identified in infants aged 6 and 12 months in the Southampton Women's Survey (Robinson, et al., 2007). The 'adult foods' pattern was associated with high intakes of crisps, savoury snacks, processed meat, fruit, squash, chips, roast potatoes and white bread. The study supports the idea that infants' dietary patterns are similar to those of their caregivers, as mothers with high intakes of sweet foods and chips were more likely to have infants with high scores on the 'adult foods' pattern. The Southampton Women's Survey also suggests that dietary patterns track through infancy, with strong correlations between dietary patterns identified at 6 months of age and at 12 months of age (Robinson, et al., 2007). The EAT Study was primarily focussed on validation of the FFQ, and the sample was not random, therefore the dietary pattern results need to be interpreted cautiously. However, it would be

interesting to see if the "sweet foods and hot chips" pattern appears in samples of New Zealand toddlers who are more representative of the overall New Zealand population, and whether it tracks across different age groups as seen in the Southampton Women's Survey.

Although not as strikingly similar, the EAT Study **"vegetable and meat"** pattern bears some resemblance to 'healthy' and 'prudent' patterns established in the literature. In the EAT Study, the "vegetable and meat" pattern was associated with intakes of 'vegetables,' 'meat,' 'eggs and beans,' and 'fruit.' 'Healthy' or 'prudent' patterns for adults in the literature have been highly associated with intakes of vegetables, fruit, fish, legumes, whole grains or wholemeal bread, and low-fat dairy (Ambrosini, et al., 2010; Crozier, et al., 2007; Hu, et al., 1999; Khani, et al., 2004). The "vegetable and meat" pattern in the EAT study could be considered a 'healthy' dietary pattern for toddlers, and differences between adult and toddler 'healthy' patterns are to be expected. Food and nutrition guidelines produced by the Ministry of Health state that unlike adults, toddlers do not need foods that are very low-fat or high-fibre (Ministry of Health, 2008). This means a 'healthy' pattern for toddlers is unlikely to be characterised by low-fat milk products or wholegrain breads like the adult 'healthy' patterns.

However, this analysis is unable to determine whether this is the case because foods were collapsed into sixteen food groups to obtain robust results from the PCA. Dietary guidelines for toddlers were considered when creating these groups, for example as most toddlers are likely to consume full-fat milk it was unlikely that dividing full-fat milk and low-fat milk into separate food groups would have resulted in any meaningful differentiation within the population. This approach also meant that whole grain and wholemeal bread were included in the same food group as white bread. It would not have been possible to characterise a pattern high in low-fat dairy and whole grains from this arrangement of the food groups, reflecting that the dietary patterns characterised in each study will be influenced by the researchers' decision-making when collapsing foods into food groups prior to the PCA analysis. Nevertheless, the arrangement of food groups was considered appropriate for toddlers, and did result in dietary patterns that differentiated toddlers into what could be considered healthy and less healthy food intakes.

The **"milk and fruit"** pattern in the EAT Study was strongly associated with milk and fruit intake, but also had an inverse relationship with 'breast milk,' and 'toddler milk and infant formula.' This is perhaps not surprising, and may be reflective of a group of toddlers who have been weaned from breast milk or infant formula, onto cows' milk and other milk products. The "milk and fruit" pattern could be considered another variation of the 'healthy' pattern observed in the adult literature. Conversely, it would be reasonable to hypothesise that

it could be a dietary pattern specific to the toddler age group, with cows' milk replacing previously high intakes of breast milk or infant formula, and fruit a convenient snack acceptable to the taste preferences of toddlers. A pattern high in cows' milk was not observed in the Southampton Women's Survey (Robinson, et al., 2007), but this is to be expected, as the study population was aged 6-12 months, when cows' milk is not recommended as a main drink. More research is required into the dietary patterns of 12-24 month old children in New Zealand and internationally to detect whether there are indeed dietary patterns specific to toddler age groups.

The three patterns identified in the EAT Study from FFQ1 accounted for 34.1% of the variation in the population of toddlers, suggesting other dietary patterns may exist in this group. More than three components were identified in the principal component analysis, although these components were difficult to interpret as meaningful dietary patterns and had smaller eigenvalues so were not retained in the PCA solution. Furthermore, these extra components did not explain much more of the variation in the population. The percentage variation explained in the EAT study is comparable to or higher than the percentage of variation explained in most other FFQ validation studies for dietary patterns (Beck, et al., 2012; Crozier, et al., 2007; Hu, et al., 1999; Khani, et al., 2004; Nanri, et al., 2012; Okubu, et al., 2009; Togo, et al., 2003), all of which have been conducted in adults.

For the analysis of relative validity, cross classification demonstrated the FFQ has a good ability to classify toddlers into the same or adjacent quartiles of dietary pattern scores as the 5DWFR for each of the dietary patterns. This was particularly so for the "sweet foods and hot chips" pattern, with half of the toddlers being classified into the same quartile by FFQ1 as the 5DWFR. Also, Pearson's correlation coefficients for the dietary patterns between FFQ1 and the 5DWFR ranged from 0.56 ("vegetables and meat") to 0.68 ("sweet foods and hot chips"). Walter Willett, an expert in the field of dietary assessment and validation studies, notes that correlations greater than 0.70 in FFQ validation studies are rare, and suggests there is a ceiling of validity for FFQs of 0.6-0.7 (Willett, 2001). In that context, correlations of 0.58 to 0.68 indicate the dietary patterns generated from FFQ1 are relatively valid when compared to the gold-standard 5DWFRs. In addition, it is possible the validity of the EAT FFQ may have been underestimated. Experts agree that because FFQs and WFRs have independent sources of error, validity is more likely to be underestimated than overestimated when FFQs are validated against WFRs (Cade, et al., 2002; Willett & Lenart, 1998).

There are a number of reasons why the EAT FFQ showed good relative validity. Firstly, the FFQ was modified from the Southampton Women's Survey FFQ for 12-month old children

(Southampton Women's Survey Study Group, 2005), which had already demonstrated high validity in a population of toddlers in the UK (Marriott, et al., 2008). Secondly, the food list of the FFQ was specifically tailored to New Zealand toddlers based on published data. Third, the FFQ was interviewer-administered, so there were minimal missing data. Fourth, it is reasonable to expect that toddlers consume a narrower range of food items than adults, possibly resulting in higher validity when comparing two dietary assessment methods. Fifth, five days worth of weighed food records were collected per person on randomised non-consecutive days. This is likely to give a fairly good estimate of habitual intake and account for within-person variation, so is comparable to the habitual dietary data collected by the FFQ.

Overall, the EAT FFQ has an acceptable level of validity so it is likely to be a useful tool for characterising the dietary patterns of toddlers.

The reproducibility of all three dietary patterns was high, with intraclass correlation coefficients over 0.70 for all three patterns indicating strong agreement between FFQ1 and FFQ2, and Pearson correlation coefficients above 0.70 for all three patterns. Only half of the dietary pattern validation studies reviewed in this thesis also examined reproducibility, and none of these used intraclass correlation to measure agreement. However, all four presented either Spearman or Pearson correlation coefficients, ranging from 0.55 for 'Prudent' and 'Westernized' patterns in one study (Nanri, et al., 2012) to 0.77 for a 'Traditional' dietary pattern in the same study. Only the study by Beck et al (2012) had reproducibility correlations consistently above 0.70 for all of the dietary patterns, similar to the current study (Beck, et al., 2012). The EAT study, and the study by Beck et al (2012) had time intervals between the first and second administrations of the FFQ of approximately five weeks and four weeks respectively, compared to intervals of one year for the other three studies that looked at reproducibility. The shorter interval could be one factor contributing to the high reproducibility. However, the median interval of five weeks in the EAT Study is longer than or comparable to other studies that have tested FFQ reproducibility in preschool populations. Also, even with a short interval, the rapidly changing nature of toddlers' food intakes could be expected to result in lower reproducibility. In the EAT Study, frequency of consumption of baby and toddler foods, and breast and toddler milk decreased between FFQ1 and FFQ2, whereas frequency of consumption of savoury snacks increased, suggesting that toddlers may graduate towards a more 'adult' dietary pattern over a relatively short period of time.

The EAT Study has a number of strengths. A large number of participants were recruited (n=160) and the completion rate was exceptionally high, with 96.3% of participants

completing FFQs and 5DWFRs. This could be reflective of a highly motivated sample, and also of the high level of support provided to participants; all participants received phone calls to see how the first day of diet recording went, as well as reminder text messages or emails before each day of recording. Further strengths are that the gold standard method of 5-day weighed food records was used as the reference method, and both the FFQ and 5DWFR assessed the same length of time; dietary intake over four weeks. For the 5DWFR, the days of recording were randomised for each participant to capture within-person variation and provide a more representative picture of dietary intake over a month. Prior to analysis, the diet record days were also weighted according to weekday or weekend day to account for day-of-the-week-effects in dietary intake. A further strength is that the dietary patterns identified in the PCA are likely to be stable, as foods were collapsed into sixteen food groups, meaning there were 9.6 participants per food group analysed.

The EAT Study also has some limitations. The study population was not a random sample, but was made up of volunteers so response bias is likely. Those who volunteered for the study are likely to be highly motivated and interested in nutrition, possibly increasing the validity and reproducibility of the FFQ. The sample was also not representative of the New Zealand population, with lower proportions of Maori and Pacific people. Another limitation is that although weighed diet records are recognised as a gold standard for dietary assessment, errors in recording as well as changes in dietary habits as a result of keeping a record are inevitable, so even weighed diet records are unlikely to reflect true intake. However, they are acknowledged as the gold standard validation reference tool (Cade, et al., 2002).

The PCA methodology also has some limitations. In common with other studies, a number of subjective decisions had to be made, including how foods were grouped together, eigenvalue cut points and method of rotation, the number of components to retain in the solution, the interpretation of the factor loading matrix, and the naming of the dietary patterns. To account for this subjectivity, decisions made at these steps were documented and reported. Also, where possible, subjectivity was minimised, such as naming dietary patterns based on the two foods with the highest factor loadings. Nevertheless, different decisions at each of these steps could have resulted in differences in the dietary patterns identified, as well as the associated validity and reproducibility results.

The reproducibility analysis also has limitations. Participants are likely to have been sensitised to their child's diet while completing the 5DWFR in between FFQ1 and FFQ2, which could either increase or reduce reproducibility. The increased awareness of their child's diet by keeping the 5DWFR between FFQ1 and FFQ2 may have resulted in caregivers

altering what their children eat, therefore lowering reproducibility. On the other hand, reproducibility may have increased if keeping the 5DWFR resulted in better awareness of what their child ate over the study timeframe, causing more accurate responses to FFQ2.

Further validity and reproducibility analyses on the EAT FFQ can be undertaken in future to explore its full potential for dietary pattern analysis. The current study evaluated the performance of the EAT FFQ based on frequency data. However, the EAT FFQ uses a novel method to collect portion size data, by asking caregivers to estimate portion sizes relative to the volume of their child's palm. Results from the current study could be compared to patterns identified with principal component analysis based on grams of each food group per day rather than frequency per day. Further analyses could also be conducted using the data from the "cross-check" questions designed to adjust for over reporting of fruit and vegetables, to see if the adjusted data provides more accurate estimates of intake relative to the 5DWFR.

The EAT FFQ identified three dietary patterns: a "sweet foods and hot chips" pattern, a "vegetables and meat" pattern, and a "milk and fruit" pattern. Because the focus of the EAT Study was to test the relative validity and reproducibility of the EAT FFQ, these results cannot be extrapolated as representative of the dietary patterns likely to be found in toddlers throughout the New Zealand population. However, the relative validity and reproducibility of dietary patterns demonstrated in this study, means that further research using the EAT FFQ is warranted. In future, the EAT FFQ should be used to examine dietary patterns in populations of toddlers that are more representative of the New Zealand population in ethnicity, socioeconomic status, and geographic location. Now that there is tool available with good relative validity and reproducibility for dietary pattern analysis in toddlers, further research could be conducted to answer three key questions:

1. Are dietary patterns in toddlerhood predictive of dietary patterns in later childhood and adulthood?

2. Are dietary patterns in toddlerhood related to risk of obesity and nutrition-related diseases later in life?

3. Are aspects of dietary patterns identified in toddlerhood amenable to early intervention for the prevention of obesity and nutrition-related disease.

6 Conclusion

As far as we are aware, no other food frequency questionnaire (FFQ) in New Zealand or internationally has been tested for relative validity and reproducibility in identifying the dietary patterns of toddlers aged 12-24 months. Dietary pattern analysis has gained popularity as a complementary approach to single nutrient analysis in adult populations, as it allows relationships between whole diets and risk of disease to be explored. Food frequency questionnaires have been used for many years to determine habitual food intakes in populations, mainly for nutrient analyses. The low respondent burden and cost-effective administration and analysis make food frequency questionnaires appealing for research in large populations. Recently, it has also been demonstrated that food frequency questionnaires can be used to identify relatively valid and reproducible dietary patterns in adult populations.

This study has demonstrated that the Eating Assessment in Toddlers (EAT) FFQ has a good ability to identify dietary patterns, and a good ability to correctly classify toddlers into quartiles of dietary pattern scores. It can also be concluded that the patterns identified by the EAT FFQ are reproducible, as intraclass correlation coefficients demonstrated strong agreement between two administrations of the FFQ at different times. Furthermore, the EAT FFQ identified patterns similar to those that have been documented in the literature for adult populations, in several different countries. In summary, the EAT FFQ can be used to identify plausible dietary patterns with reasonable relative validity and high reproducibility in populations of New Zealand toddlers aged 12-24 months.

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Appendices

Appendix A	Human ethics application: category A and approval letter
Appendix B	Ngāi Tahu Research Consultation Committee letter
Appendix C	Examples of modifications made to the Southampton Women's Study FFQ to create the EAT FFQ
Appendix D	Eating Assessment in Toddlers FFQ
Appendix E	Information form
Appendix F	Consent form
Appendix G	Demographic questionnaire
Appendix H	Anthropometry protocol
Appendix I	Example of a child's palm scan
Appendix J	Scales instruction sheet
Appendix K	EAT food record
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Appendix M	Nutrient analysis sheet
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Appendix A: Human ethics application: category A and approval letter

HUMAN ETHICS APPLICATION: CATEGORY A

***PLEASE** read carefully the instructions "Filling out your Human Ethics Application" and important notes on the last page of this form. Provide a response to each question; failure to do so may delay the consideration of your application.*

1. University of Otago staff member responsible for project:

Heath, Anne-Louise, Dr

2. Department: Human Nutrition

3. Contact details of staff member responsible:

Email: anne-louise.heath@otago.ac.nz Phone: 03 4798379

4. Title of project:

Validation of a food frequency questionnaire to determine food and nutrient intake in toddlers aged 12 to 24 months

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

Staff Research	☐	**Names**	Assoc Prof Rachael Taylor Dr Paula Skidmore
Student Research	☐	**Names**	Virginia Mills Emily Watson
Level of Study (e.g. PhD, Masters, Hons)			Masters

6. Is this a repeated class teaching activity?

NO

7. Fast-Track procedure

Do you request fast-track consideration?

NO

8. When will recruitment and data collection commence? 1 June 2011

When will data collection be completed? 31st December 2012

9. Funding of project.

Is the project to be funded by an external grant?

NO

10. Brief description <u>in lay terms</u> of the purpose of the project (approx. 75 words)**:**

A Food Frequency Questionnaire (FFQ) has been developed to assess food and nutrient intake in toddlers 12-24 months old. After appropriate validation, this tool will be available for use in several new research projects in the Department of Human Nutrition.

Parents of 12-24 month old children will be asked to complete the FFQ (on two occasions) and a weighed 5-day diet record. The results from each method will be compared to see how well the FFQ is able to determine nutrient intake (particularly energy and iron), food intake (particularly meat, fruit and vegetables), and overall eating patterns.

11. Aim of project, including the research questions the project is intended to answer:

The aim of this project is:

a. To determine the relative validity and repeatability of a FFQ for assessing food and nutrient intake.

b. To assess the suitability of using palm size as a measuring tool in 12-24 month-old children.

12. Researcher or instructor experience and qualifications in this research area:

Anne-Louise Heath is a senior lecturer in the Department of Human Nutrition and has published two Food Frequency validation studies.

Rachael Taylor is the Karitane Research Asosc Prof in Early Childhood obesity and has been working with children and their families on a variety of issues for the past 11 years.

Paula Skidmore is a lecturer in the Department of Human Nutrition and has a PhD in Epidemiology and Public Health. She has 12 years experience in the use of FFQs and other methods of dietary assessment in epidemiological studies in adults and children

13. Participants

13**(a) Population from which participants are drawn:**

Participants will be a convenience sample of parents with children aged 12 to 24 months, recruited from the general population, with approximately half of participants recruited in Wellington, and half in Dunedin.

13**(b) Specify inclusion and exclusion criteria:**

Inclusion Criteria:

- Parents of children 12-24 months old

Exclusion Criteria:

- Parents of children who were born prematurely (< 37 weeks gestation)

- Parents of children with any health condition likely to affect feeding and/or growth

- Home address outside of Dunedin or Wellington and surrounding areas

13**(c) Estimated number of participants:**

200 participants will be recruited to take part in this study. 129 participants would be needed to estimate the 95% limits of agreement (reference interval) to within +/- 0.3 SDs of the differences using Bland and Altman's approach. We are going to be validating 20 food groups for subsequent use in principal composition analysis which requires 10 participants per food group, resulting in the need for 200 participants to be recruited.

13**(d) Age range of participants:**

18 years and over

13**(e) Method of recruitment:**

A convenience sample will be recruited using the following methods:

- Word of mouth – direct phone call, email and/or face-to-face communication with local preschools and mothers' groups, eg Mothers Network Inc, coffee groups, parenting forums
- Newspaper advertisements in local community newspapers in Wellington and Dunedin
- Posters in public spaces eg Wellington and Dunedin City Libraries, Plunket, Victoria University, the University of Otago

13**(f) Please specify any payment or reward to be offered:**

Participants will be entered into a draw to win one iPod Touch (of which there will be two – one in Dunedin and one in Wellington).

14. Methods and Procedures:

Study design: An interviewer administered computerised food frequency questionnaire and a demographic questionnaire will be administered to participants at baseline and 1-month afterward. The food frequency questionnaire will be administered by the student researcher in the participant's home or at the University. It will take approximately one hour to complete. At this same meeting, weight and length of the child will be measured, as well as a photocopy of the child's palm taken.

Participants will also be asked to complete a weighed diet record of their child's food intake. Participants will be provided with scales to weigh their child's food, and a diet record to record what their child eats. They will be given instructions showing how to record all food and beverages at the time of eating, including leftovers. The diet record will need to be completed by the participant for 5 non-consecutive days, including one

weekend day. The student researcher will collect the diet record from the participant upon completion.

Food intake data from the food frequency questionnaire and from the diet records will be entered into a dietary analysis computer program. Intakes of Vitamin C, iron, zinc, total fat, carbohydrate, protein and energy as well as foods and food groups, from the FFQs and diet records will then be compared.

Statistical Analysis: Multiple statistical methods will be used to determine validity – including correlation analysis, cross-classification, and the mean and standard deviation of the difference between the food frequency questionnaire and diet record for each nutrient.

Repeatability of the food frequency questionnaire will be assessed by using paired t-tests.

Dietary pattern scores will also be used to determine overall patterns of dietary intake.

15. Compliance with The Privacy Act 1993 and the Health Information Privacy Code 1994 imposes strict requirements concerning the collection, use and disclosure of personal information. These questions allow the Committee to assess compliance.

15(a) Are you collecting and storing personal information directly from the individual concerned that could identify the individual?

YES

15(b) Are you collecting information about individuals from another source? Please explain:

NO

15(c) Collecting Personal Information:

- Will you be collecting personal information?

  YES

- Will you be informing participants of the purpose for which you are collecting the information and the uses you propose to make of it?

  YES

- Will you be informing participants who will receive the information?

  YES

- Will you inform participants of the consequences, if any, of not supplying the information?

  YES

- Will you inform the participants of their rights of access to and correction of personal information?

  YES

15(d) Please outline your data storage and security procedures.

Identifying personal information will be stored in a locked filing cabinet in Anne-Louise Heath's office at the University of Otago, and will be destroyed at the end of the study by the Principal Investigator. Original data collected will be stored in a locked filing cabinet at the University of Otago, and will be kept for at least five years after the publication of study results

15(e) Who will have access to personal information, under what conditions, and subject to what safeguards?

The student researchers and their academic supervisors for this project will have access to personal information during data collection and analysis. This information will be treated as confidential. To maintain anonymity, participants will be assigned a code and data will be collected under this code. The connection between the code, the participant, and their personal information will be stored in a locked filing cabinet at the University of Otago to prevent unauthorized disclosure. At the end of the study participants will be presented with both individual and group results.

Will participants have access to the information they have provided?

Participants will be provided with their individual results at the end of the study.

15(f) Do you intend to publish any personal information they have provided?

NO

15(g) Do you propose to collect demographic information to describe your sample? For example: gender, age, ethnicity, education level, etc.

Group baseline characteristics including the parents; sex, relation to child, date of birth, ethnicity, and the child's; date of birth, sex, ethnicity, birth weight and length, gestation period and NZ Deprivation Index will be collected and may be published to describe the study population. However, no identifying personal information will be published, and nothing that links any individual participant to the demographic data will be published.

15 (h) Have you, or do you propose to undertake Māori consultation? Please choose one of the options below, and delete the options that do not apply:

YES We WILL undertake consultation

16. Does the research or teaching project involve any form of deception?

NO

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

No physical harm or discomfort for participants is involved in this study.

18. Applicant's Signature: .....

[Principal Applicant: as specified in Question 1]

Date: .....

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

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

Name of Signatory (please print): …….

Date: .....

**(In cases where the Head of Department is also the principal researcher then an appropriate senior staff member in the department must sign)*

Please attach copies of the Information Sheet, Consent Form, and Advertisement for Participants

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

Academic Services
Manager, Academic Committees, Mr Gary Witte

11/122

2 August 2011

Dr A-L Heath
Department of Human Nutrition
Division of Sciences

Dear Dr Heath

I am again writing to you concerning your proposal entitled "**Validation of a food frequency questionnaire to determine food and nutrient intake in toddlers aged 12 to 24 months**", Ethics Committee reference number **11/122**.

Thank you for sending to me confirmation of the change of title from 26 to 24 months, and for evidence of Maori consultation.

On the basis of this response, I am pleased to confirm that the proposal now has full ethical approval to proceed.

Approval is for up to three years. If this project has not been completed within three years from the date of this letter, re-approval must be requested. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing.

Yours sincerely,

Gary Witte

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

c.c. Emeritus Professor L J Holloway Head Department of Human Nutrition

Appendix B: Ngāi Tahu Research Consultation Committee letter

NGĀI TAHU RESEARCH CONSULTATION COMMITTEE
TE KOMITI RAKAHAU KI KĀI TAHU

12/07/2011 - 83
Tuesday, 12 July 2011

Dr Heath
Human Nutrition
Dunedin

Tēnā koe Dr Heath

Title: Validation of a food frequency questionnaire to determine food and nutrient intake in toddlers aged 12-24 months.

The Ngāi Tahu Research Consultation Committee (The Committee) met on Tuesday, 12 July 2011 to discuss your research proposition.

By way of introduction, this response from the Committee is provided as part of the Memorandum of Understanding between Te Rūnanga o Ngāi Tahu and the University. In the statement of principles of the memorandum, it states "Ngāi Tahu acknowledges that the consultation process outlined in this policy provides no power of veto by Ngāi Tahu to research undertaken at the University of Otago". As such, this response is not "approval" or "mandate" for the research, rather it is a mandated response from a Ngāi Tahu appointed committee. This process is part of a number of requirements for researchers to undertake and does not cover other issues relating to ethics, including methodology; they are separate requirements with other committees, for example the Human Ethics Committee, etc.

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

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

The Committee considers the research to be of importance to Māori health.

As this study involves human participants, the Committee strongly encourage that ethnicity data be collected as part of the research project. That is the questions on self-identified ethnicity and descent, these questions are contained in the 2006 census.

The Ministry of Health website http://www.maorihealth.govt.nz/moh.nsf/indexma/publications contains a list of Māori health publications. The Committee recommends you review the Māori health publications on this website, eg. Unequal Impact II: Māori and Non-Māori Cancer Statistics by Deprivation and Rural-Urban Status 2002-2006 and Tatau Kahukura: Māori Health Chart Book 2010. Another Publication, Hauora: Māori Standards of Health IV (200-2005), has

its own website, http://www.hauora.maori.nz/. These publications provide information on a range of Māori health issues and will assist in ensuring your research has an appropriate Māori health focus.

The Committee suggests dissemination of the research findings to Māori health organisations regarding this study.

We wish you every success in your research and the Committee also requests a copy of the research findings.

This letter of suggestion, recommendation and advice is current for an 18 month period from Tuesday, 12 July 2011 to 12 January 2013.

The recommendations and suggestions above are provided on your proposal submitted through the consultation website process. These recommendations and suggestions do not necessarily relate to ethical issues with the research, including methodology. Other committees may also provide feedback in these areas.

Nāhaku noa, nā

pp NTRCC

Mark Brunton
Kaitakawaenga Rangahau Māori
Facilitator Research Māori
Research Division
Te Whare Wānanga o Otāgo
Ph: +64 3 479 8738
email: mark.brunton@otago.ac.nz
Web: www.otago.ac.nz

The Ngāi Tahu Research Consultation Committee has membership from:

Te Rūnanga o Ōtākou Incorporated
Kāti Huirapa Rūnaka ki Puketeraki
Te Rūnanga o Moeraki

Appendix C: Examples of modifications made to the Southampton Women's Study FFQ to create the EAT FFQ

Examples of modifications made to the Southampton Women's Study FFQ to create the EAT FFQ

Modification	Southampton FFQ	EAT FFQ
Foods omitted	Dried Baby Food	-
	Liver, Kidney, Faggots	-
	Marmite and Bovril	-
	Peanut Butter	-
	Jam and sweet spreads	-
	Sugar	-
	Tea	-
	Gammon	-
	Turkey	-
	Quiche and savoury flan	-
	Peaches, nectarines, melons	-
	Strawberries, raspberries, mango and kiwi	-
	Vegetarian burgers, sausages and nuggets	-
	Pizza	-
	Low cal squash	-
	Low calorie fizzy drinks	-
Foods renamed	Beefburgers	Mince and patties
	Chicken or turkey in batter or breadcrumbs	Chicken nuggets or shapes
	Sausages	Sausages, saveloys, hot dogs (including vegetarian)
	Beans and pulses	Canned beans (including baked beans)
	Tinned peas, carrots, sweetcorn and mixed vegetables	Frozen mixed vegetables
	Boiled and baked potatoes	Potato and kumara (boiled, baked, microwaved, mashed)
	Chips, potato shapes and roast potatoes	Hot chips, potato shapes, roast potato or kumara
	Tinned fruit	Canned fruit
	Oranges and satsumas	Oranges, mandarins etc
	Custard and sweet white sauce	Custard and other milk puddings
	Yoghurt and fromage frais	Yoghurt and dairy food
	Sweets	Lollies
	Cakes, buns and pastries	Cakes, muffins, scones, slices
	Chocolate and digestive biscuits	Biscuits – coated (with chocolate, icing, yoghurt)
	Squash	Cordial
	Crisps and savoury snacks	Crisps, corn chips, corn snacks (e.g. Cheezels)

Modification	Southampton FFQ	EAT FFQ
Foods added	-	New Zealand specific baby foods e.g. the "Little Kids" range
	-	Rice cakes, rice wheels, crispbreads
	-	Weet-bix, fruity-bix etc
	-	Cornflakes, rice bubbles
	-	Instant noodles
	-	Canned spaghetti
	-	Hummus (chickpea dip)
	-	Cheese (including in recipes)
	-	Fruit bread, currant buns
	-	Fruit leather, fruit strings and fruit rollups
	-	Kiwifruit
	-	Berries (fresh or frozen)
	-	Avocado
	-	Dried fruit
Structural changes	Milk or Formula Feeding behaviour	Removed
	Vitamin and mineral supplement	Removed
	One portion size column: "Average amount per serving"	Two portion size columns: "How much would be given each time" and "Amount eaten"
	-	Cross-check questions added for fruit and vegetables e.g. "How often has you toddler had vegetables in the past month?" and "When you think about one of these occasions how many different vegetables would you offer?"
Portion size changes	Household measures and natural units e.g. spoons, cups or number of crackers or slices of bread	Palm size or natural units e.g. volume of the child's palm, or number of crackers or slices of bread

Appendix D: Eating Assessment in Toddlers food frequency questionnaire (formatting was changed for binding)

Food Frequency Questionnaire

To be completed by toddler's main carer

EAT study number

Date completed DD MM YY



Instructions for completing the questionnaire:

- This questionnaire is about the foods and drinks your toddler has had in the last 4 weeks. That is **since (date 4 weeks ago):** .....
- Each food should only be reported once – so, custard and fruit for pudding should be entered as custard, and fruit – not under puddings.
- Whenever you see a ***** next to a word, we have given you some more information at the bottom of the page to help you answer the question.

Instructions (continued)

This questionnaire asks you about the **foods and drinks** your toddler has had to eat and drink in the **past 4 weeks**.
It will ask you how <u>often</u> he has eaten certain foods and also the <u>amount</u> of food he had.

For each food we need to know 3 things:

A = **How often** you offer the food
B = **Average amount** offered each time
C = **Amount actually eaten** (that is not left on his plate, dropped on the floor, in his hair …)

An example:

Billy doesn't like buns or crumpets but <u>every day</u> Billy's Mum offers him <u>a whole slice</u> of bread. He usually <u>eats half a slice</u> so his Mum would fill out the table like this:

		A = **How often**								**B** = **Average amount**		**C** = **Amount eaten**	
	Food and Drink items	**Tick** box if not offered this month **OR** →	**Tick** box if offered less than once a week this month **OR** →	**Tick** the box for the number of times offered a week this month **OR** → 1	2	3	4	5	6	7	If more than once a day **– how many times a day** – this month	**How much would be given <u>each</u> time?**		**Amount <u>eaten</u>**	
15.	White bread, buns (not iced), crumpets									✓		Number of toaster slices*	1 .	Number of toaster slices*	1/2

A question about breads

Offered 7 days a week **(A)**

Remember to check the note at the bottom of the page whenever you see one of these *

1 slice offered **(B)**

Half a slice eaten **(C)**

In this questionnaire we are using a new way of measuring food – the size of the palm of your toddler's hand. We will use the photocopy from the measurement session to work out how big her palm is.

When we ask you to use the size of your toddler's palm to measure the amount she has eaten, we mean the size of her actual palm itself – not the amount she can hold in her palm.

To work out how big your child's palm is, please imagine a block **(1)** that is as wide and long as your child's palm not counting her fingers **(2)**, and as thick as her palm **(3)**



Your toddler may sometimes be fed by a relative, friend or someone else. If you know the type of food and approximate amount she has eaten at these times please include them.

If you have any questions at all – or would like someone to talk you through the questionnaire – please call us.

Baby and toddler foods

1. Did your toddler eat any baby food or toddler food from a jar, tin or packet in the last 4 weeks?

   No [please go to Question 15 on the breads and crackers page]

   Yes

If so, please complete the table below for each baby or toddler food your child has been offered in the last 4 weeks

		A = **How often**										**B** = **Average amount**				**C** = **Amount eaten**	
	Food and Drink items	**Tick** box if not offered this month **OR →**	**Tick** box if offered less than once a week this month **OR →**	**Tick** the box for the number of times offered a week this month **OR →** 1	2	3	4	5	6	7	If more than once a day **– how many times a day** – this month	**Number for size of jar or can*** or write "palm"	**Average number** of jars, cans or palms given on each occasion			**Amount eaten**	
2.	"Little Kids" cheesy ravioli													.			
3.	Other "Little Kids" meals													.			
4.	Other toddler meals													.			
5.	"Simply create" meat pouches													.			

***** Please write down the number for the size of jar or can your toddler had: **1** = Stage 1 (Blue) "from 4-6 months" = Small size (110g)
2 = Stage 2 (Yellow or red) "from 7 months" = Medium size (110-170g)
3 = Stage 3 (Green) "from 8-9 months" = Large size (170-210g)
4 = Stage 4 (Orange) "from 1 year" = Toddlers/ Growing kids (200-220g)

		A = **How often**										**B** = **Average amount**				**C** = **Amount eaten**	
	Food and Drink items	**Tick** box if not offered this month **OR →**	**Tick** box if offered less than once a week this month **OR →**	**Tick** the box for the number of times offered a week this month **OR →**							If more than once a day **– how many times a day** – this month	**Number for size of jar or can** or write "palm"	**Average number** of jars, cans or palms <u>given</u> on <u>each</u> occasion			**Amount <u>eaten</u>**	
				1	2	3	4	5	6	7							
6.*	Baby rice, baby muesli (e.g. Farex) from packet													.			
7.**	Vegetable based meals													.			
8.**	Meat based meals													.			
9.	Pasta or rice based <u>savoury</u> meals													.			
10.	Rice or other cereal based <u>desserts</u>													.			
11.	Custard or other milk based desserts													.			
12.	Fruit puree													.			
13.	Fruit based desserts													.			
14.	Junior fruit drink													.			

***** Baby rice or muesli from a jar are entered as "Rice or other cereal based desserts" (i.e. #10 above) [this is because it doesn't have iron added to it]

****** Meal-in-one infant foods, for instance "pasta, vegetables and beef" that have both vegetables and meat are included in Vegetable based meals (i.e.,#7 above)

Bread and crackers

	Food and Drink items	A = How often: **Tick** box if not offered this month OR →	**Tick** box if offered less than once a week this month OR →	**Tick** the box for the number of times offered a week this month OR → 1	2	3	4	5	6	7	If more than once a day **– how many times a day** – this month	B = Average amount: **How much would be given <u>each</u> time?**			C = Amount eaten: **Amount <u>eaten</u>**	
15.	White bread, buns (not iced), crumpets											Number of toaster slices*		.	Number of toaster slices*	
16.	Wholemeal or wholegrain bread, buns											Number of toaster slices*		.	Number of toaster slices*	
17.	Crackers (wheat, rice or corn-based)											Number of crackers**		.	Number of crackers**	
18.	Rice cakes, rice wheels, crispbreads											Number of rice wheels***		.	Number of rice wheels***	

***** 1 sandwich slice = ¾ toaster slices
1 breadmaker slice = 1¾ toaster slices
1 small bun = 1 toaster slice
1 hamburger bun = 1¾ toaster slices
1 crumpet = 1¼ toaster slices

For example: **2 sandwich slices** = **2 x ¾** toaster slices, so you write **2 x ¾** in the amount column (B).

****** 1 snax = 1 cracker
1 cream cracker = 1½ crackers
1 rice cracker = ½ cracker

For example: **2 cream crackers** = **2 x 1½** crackers

******* 1 rice cake = 17 rice wheels
1 baby rice cake = 3 rice wheels
1 mini corn cake = 3 rice wheels
1 crispbread = 9 rice wheels
1 cruskit = 9 rice wheels

NB: Rice <u>wheel</u> = tiny kid's size rice cake (~ 50c coin in diameter)
Rice <u>cracker</u> = small round disc shaped, hard crunchy texture
Rice <u>cake</u> = puffed rice cracker the size of a large cookie (~ a large rice wheel)

Breakfast cereals

	Food and Drink items	A = How often: Tick box if not offered this month OR →	Tick box if offered less than once a week this month OR →	Tick the box for the number of times offered a week this month OR → 1	2	3	4	5	6	7	If more than once a day – how many times a day – this month	B = Average amount: How much would be given each time?			C = Amount eaten: Amount eaten		
19.	Weet-bix, fruity-bix etc.											Number of weet-bix*		.		Number of weet-bix*	
20.	Porridge** (not instant porridge in sachets)											Number of palms		.		Number of palms	
21.	Cornflakes, rice bubbles											Number of palms		.		Number of palms	
22.	Other breakfast cereals											Number of palms		.		Number of palms	
23.	What is the name of the main "other breakfast cereal"?:																

* 1 fruity-bix = ¼ weet-bix

For example: **2 fruity-bix** = **2 x ¼** weet-bix, so you write **2 x ¼** in the amount column (B).

** If porridge is made with milk then record porridge here and milk in the milk section

Rice and pasta

	Food and Drink items	A = How often: **Tick** box if not offered this month **OR →**	**Tick** box if offered less than once a week this month **OR →**	**Tick** the box for the number of times offered a week this month **OR →** 1	2	3	4	5	6	7	If more than once a day **– how many times a day** – this month	B = Average amount: **Average number** of jars, cans or palms given on each occasion				C = Amount eaten: **Amount eaten**	
24.	Rice											Number of palms		.		Number of palms	
25.	Instant noodles											Number of palms		.		Number of palms	
26.	Canned spaghetti											Number of medium cans*		.		Number of medium cans*	
27.	Other pasta											Number of palms**		.		Number of palms	

***** Small can = ¾ medium can
Large can = 2 medium cans

For example: **2 small cans** = **2 x ¾** medium cans, so you write **2 x ¾** in the amount column (B).

****** Pasta amount refers to the amount of pasta – not sauce or other ingredients (i.e. lasagne would be 1/3rd pasta (#27), 1/3rd white sauce (#77), 1/6th pasta sauce (#51), 1/6th mince (#34))

Meat, chicken, fish, eggs, beans

	Food and Drink items	A = How often: **Tick** box if not offered this month OR →	**Tick** box if offered less than once a week this month OR →	**Tick** the box for the number of times offered a week this month OR → 1	2	3	4	5	6	7	If more than once a day – **how many times a day** – this month	B = Average amount: **How much would be given <u>each</u> time?**				C = Amount eaten: **Amount <u>eaten</u>**	
28.	Chicken nuggets or shapes, fish fingers or shapes, battered or crumbed fish											Number of palms		.		Number of palms	
29.	Other chicken											Number of palms		.		Number of palms	
30.	Other fish											Number of palms		.		Number of palms	
31.	Sausages, saveloys, hot dogs (including vegetarian)											Number of sausages*		.		Number of sausages*	
32.	Ham, bacon, luncheon											Number of palms		.		Number of palms	
33.	Meat pies and sausage rolls											Number of palms		.		Number of palms	
34.	Mince & patties											Number of palms		.		Number of palms	
35.	Other meat (beef, lamb, pork, mutton)											Number of palms		.		Number of palms	

***** 1 cheerio = ¼ sausage

For example: **2 cheerios** = **2 x ¼** sausages, so you write **2 x ¼** in the amount column (B)

		A = How often									**B = Average amount**				**C = Amount eaten**	
	Food and Drink items	**Tick** box if not offered this month **OR →**	**Tick** box if offered less than once a week this month **OR →**	**Tick** the box for the number of times offered a week this month **OR →** 1	2	3	4	5	6	7	If more than once a day – **how many times a day** – this month	**How much would be given <u>each</u> time?**				**Amount <u>eaten</u>**	
36.	Eggs											Number of eggs		.		Number of eggs	
37.	Canned beans (including baked beans)											Number of palms		.		Number of palms	
38.	Hummus (chickpea dip)											Number of palms		.		Number of palms	

Vegetables

39a. How often has your toddler had vegetables in the past month:

Never
1-3 per month
times a week
times a day

39b. When you think about one of these occasions how many different vegetables would you offer?

		A = How often										**B = Average amount**				**C = Amount eaten**			
	Food and Drink items	**Tick** box if not offered this month **OR →**	**Tick** box if offered less than once a week this month **OR →**	**Tick** the box for the number of times offered a week this month **OR →** 1	2	3	4	5	6	7	If more than once a day – **how many times a day** – this month	**How much would be given <u>each</u> time?**				**Amount <u>eaten</u>**			
40.	Potato and kumara (boiled, baked, microwaved, mashed)											Number of palms		.		Number of palms			
41.	Hot chips, potato shapes, roast potato or kumara											Number of palms		.		Number of palms			
42.	Frozen mixed vegetables*											Number of palms		.		Number of palms			

* Frozen mixed vegetables refers to the carrot-pea-corn type mixed vegetables – please record stir fry vegetables as separate vegetables

	Food and Drink items	A = How often: Tick box if not offered this month OR →	Tick box if offered less than once a week this month OR →	Tick the box for the number of times offered a week this month OR → 1	2	3	4	5	6	7	If more than once a day – how many times a day – this month	B = Average amount: How much would be given each time?				C = Amount eaten: Amount eaten		
43.	Carrot											Number of palms		.		Number of palms		
44.	Pumpkin											Number of palms		.		Number of palms		
45.	Green peas											Number of palms		.		Number of palms		
46.	Sweet corn											Number of palms		.		Number of palms		
47.	Broccoli and cauliflower											Number of palms		.		Number of palms		
48.	Green leafy vegetables (silver beet, cabbage etc)											Number of palms		.		Number of palms		
49.	Salad greens (e.g. lettuce, cucumber)											Number of palms		.		Number of palms		
50.	Raw tomato											Number of palms		.		Number of palms		
51.	Cooked tomato (pasta sauce, canned tomato)											Number of palms		.		Number of palms		
52.	Other vegetables											Number of palms		.		Number of palms		

A friendly reminder

You're halfway there! Thank you for the time and effort you are putting into filling out this questionnaire — we <u>really</u> appreciate it

For each food we need to know 3 things:

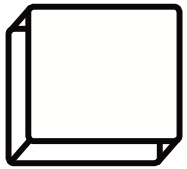
A = **How often** you offer the food

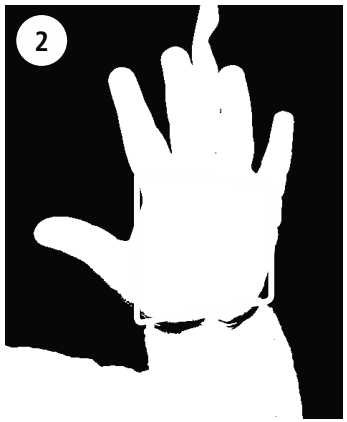
B = **Average amount** offered each time

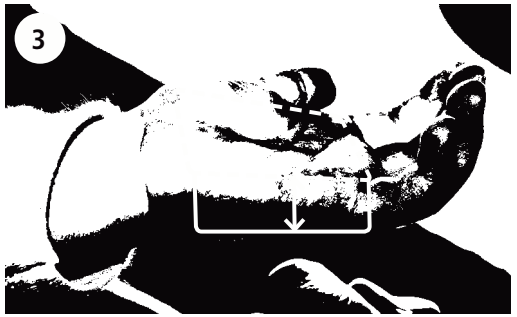
C = **Amount actually eaten** (that is not left on his plate, dropped on the floor, in his hair …)

When we ask you to use the size of your toddler's palm to measure the amount she has eaten, we mean the <u>size of her actual palm itself</u> – not the amount she can hold in her palm.

1







If you have any questions at all – or would like someone to talk you through the questionnaire – please call us.

Fruit

53a. How often has your toddler had fruit in the past month:

Never
1-3 per month
times a week
times a day

53b. When you think about one of these occasions how many different fruits would you offer?

	Food and Drink items	**A** = **How often** — **Tick** box if not offered this month **OR** →	**Tick** box if offered less than once a week this month **OR** →	**Tick** the box for the number of times offered a week this month **OR** → 1	2	3	4	5	6	7	If more than once a day – **how many times a day** – this month	**B** = **Average amount** — **How much would be given <u>each</u> time?**	**C** = **Amount eaten** — **Amount <u>eaten</u>**
54.	Canned fruit											Number of palms	Number of palms
55.	Banana											Number of bananas*	Number of bananas*
56.	Apples											Number of apples	Number of apples
57.	Pears											Number of pears	Number of pears

* 1 bobby banana = ½ banana

For example: **2 bobby bananas** = **2 x ½** bananas, so you write **2 x ½** in the amount column (B).

	Food and Drink items	A = How often **Tick** box if not offered this month **OR →**	**Tick** box if offered less than once a week this month **OR →**	**Tick** the box for the number of times offered a week this month **OR →** 1	2	3	4	5	6	7	If more than once a day – **how many times a day** – this month	B = Average amount **How much would be given <u>each</u> time?**				C = Amount eaten **Amount <u>eaten</u>**	
58.	Oranges, mandarins etc											Number of oranges*		.		Number of oranges*	
59.	Kiwifruit											Number of kiwifruit		.		Number of kiwifruit	
60.	Grapes											Number of grapes		.		Number of grapes	
61.	Berries (fresh or frozen)											Number of palms		.		Number of palms	
62.	Dried fruit											Number of palms		.		Number of palms	
63.	Avocado											Number of avocado		.		Number of avocado	
64.	Other fruit											Number of palms				Number of palms	

***** 1 mandarin = ½ orange

1 orange segment = 1/10 orange

1 mandarin segment = 1/20 orange

For example: **2 mandarin segments** = **2 x 1/20 orange**, so you write **2 x 1/20** in the amount column (B).

Dairy and dairy products

	Food and Drink items	A = How often: **Tick** box if not offered this month OR →	**Tick** box if offered less than once a week this month OR →	**Tick** the box for the number of times offered a week this month OR → 1	2	3	4	5	6	7	If more than once a day – **how many times a day** – this month	B = Average amount: **How much would be given <u>each</u> time?**				C = Amount eaten: **Amount <u>eaten</u>**		
65.	Low-fat cows milk (green, lite blue, yellow-top) as a drink											Number of cups*		.		Number of cups*		
66.	Low-fat cows milk on cereal or other food (not custard or sauces)											Number of cups*		.		Number of cups*		
67.	Cows milk (blue, silver-top) as a drink											Number of cups*		.		Number of cups*		
68.	Cows milk on cereal or other food (not custard or sauces)											Number of cups*		.		Number of cups*		
69.	"Toddler milk"**											Number of cups*		.		Number of cups*		
70.	Infant formula											Number of cups*		.		Number of cups*		
71.	Breastmilk																	

* 1 cup = 250mls [i.e. to the top of an "Arcoroc" mug]

** "Toddler milk" is a fortified milk powder made for toddlers – the cans often have the number "3" on them (e.g. Heinz Nurture Toddler 3)

	Food and Drink items	**A** = **How often** — **Tick** box if not offered this month **OR** →	**Tick** box if offered less than once a week this month **OR** →	**Tick** the box for the number of times offered a week this month **OR** → 1	2	3	4	5	6	7	If more than once a day – **how many times a day** – this month	**B** = **Average amount** — **How much would be given <u>each</u> time?**				**C** = **Amount eaten** — **Amount <u>eaten</u>**	
72.	Other milk as a drink											Number of cups*		.		Number of cups*	
73.	Cheese (including in recipes)											Number of palms		.		Number of palms	
74.	Yoghurt, dairy food											Number of small pottles**		.		Number of small pottles**	
75.	Custard and other milk puddings											Number of palms		.		Number of palms	
76.	Ice cream											Number of palms		.		Number of palms	
77.	White sauce											Number of palms		.		Number of palms	
78.	Butter											Number of "buttered" palms		.		Number of "buttered" palms	
79.	Margarine											Number of "buttered" palms		.		Number of "buttered" palms	

***** 1 cup = 250mls [i.e. to the top of an "Arcoroc" mug]

****** Small pottle (140g) = "Blues Clues" size
Medium pottle (250g) = 2 small pottles (140g)
Tiny pottle (80g) = ½ small pottle

For example: **2 tiny pottles** = **2 x ½** small pottles, so you write **2 x ½** in the amount column (B).

Cakes, biscuits and snacks

	Food and Drink items	A = How often: **Tick** box if not offered this month OR →	**Tick** box if offered less than once a week this month OR →	**Tick** the box for the number of times offered a week this month OR → 1	2	3	4	5	6	7	If more than once a day – **how many times a day** – this month	B = Average amount: **How much would be given <u>each</u> time?**			C = Amount eaten: **Amount <u>eaten</u>**	
80.	Biscuits – coated (with chocolate, icing, yoghurt)											Number of biscuits	.		Number of biscuits	
81.	Biscuits – other											Number of biscuits	.		Number of biscuits	
82.	Cakes, muffins, scones, slices											Number of palms	.		Number of palms	
83.	Croissant, sweet buns, iced buns, pastries											Number of palms	.		Number of palms	
84.	Fruit bread, currant buns											Number of palms	.		Number of palms	
85.	Puddings not yet described											Number of palms	.		Number of palms	
86.	Chocolate, lollies											Number of lollies*	.		Number of lollies*	

***** 1 square of chocolate = 2½ lollies

1 fun/treat size bar = 9 lollies

1 M&M/Smartie = ½ lolly

For example: **2 squares of chocolate** = **2 x 2½** lollies, so you write **2 x 2½** in the amount column (B).

		A = How often										B = Average amount				C = Amount eaten	
	Food and Drink items	**Tick** box if not offered this month **OR →**	**Tick** box if offered less than once a week this month **OR →**	**Tick** the box for the number of times offered a week this month **OR →** 1	2	3	4	5	6	7	If more than once a day – **how many times a day** – this month	**How much would be given <u>each</u> time?**				**Amount <u>eaten</u>**	
87.	Crisps, corn chips, corn snacks (e.g. Cheezels)											Number of packets*		.		Number of packets*	
88.	Muesli, nut, cereal or puffed rice bars											Number of medium bars**		.		Number of medium bars**	
89.	Fruit leather, fruit strings, fruit rollups											Number of palms		.		Number of palms	

***** 1 packet = 40g
1 crisp = 1/20 packet
1 corn chip = 1/20 packet
1 kiddy "multipack" packet = ½ packet

****** 1 puffed rice bar (22g) = ½ medium bar
1 "Little Kids" bar (15g) = ½ medium bar
Fruit sticks, Milkies (20g) = ½ medium bar

For example: **2 crisps** = **2 x 1/20** packets, so you write **2 x 1/20** in the amount column (B).

Drinks

	Food and Drink items	A = How often: **Tick** box if not offered this month **OR →**	**Tick** box if offered less than once a week this month **OR →**	**Tick** the box for the number of times offered a week this month **OR →** 1	2	3	4	5	6	7	If more than once a day – **how many times a day** – this month	B = Average amount: **How much would be given <u>each</u> time?**				C = Amount eaten: **Amount <u>eaten</u>**	
90.	Fruit juice ("Fresh up", "Just Juice", freshly squeezed)											Number of cups*		.		Number of cups*	
91.	Fruit drinks, Ribena, cordial, sachets											Number of cups*		.		Number of cups*	
92.	Fizzy drinks (lemonade, coke)**											Number of cups*		.		Number of cups*	
93.	Flavoured milk (Milo, Quik, drinking chocolate, Up-and-go)											Number of cups*		.		Number of cups*	
94.	Water as a drink											Number of cups*		.		Number of cups*	

* 1 cup = 250mls [i.e. to the top of an "Arcoroc" mug]

** Low calorie or diet versions – please record with regular drink (e.g. record Diet Coke as Coke)

Other foods and drinks

95. Is there anything else your toddler has had to eat or drink 4 or more times (that is about once a week or more) in the past 4 weeks that we have not already included?

No [please go to Question 99]
Yes

		A = How often								**B = Average amount**				**C = Amount eaten**	
	Brand/Description of Food and Drink items	**Tick** the box for the number of times offered a week this month							If more than once a day – **how many times a day** – this month	**How much would be given <u>each</u> time?**				**Amount <u>eaten</u>**	
		1	2	3	4	5	6	7							
96.										Number of palms		.		Number of palms	
97.										Number of palms		.		Number of palms	
98.										Number of palms		.		Number of palms	

Other carers

99. On average over the past 4 weeks, how many meals per week were given to your baby by someone other than yourself?

Meals

If more than 0 then:

100. How many of the meals given by others have you been able to include in the questionnaire?

None
Some
Most
All

How long did it take you to fill out this questionnaire? minutes:

Thank you

We really appreciate the time and effort you have put into completing this questionnaire

Comments

Is there anything else you would like to tell us so that we have a better idea of your toddler's foods and drinks over the last month?

Appendix E: Information form (resized for binding)



Validation of a food frequency questionnaire to determine food and nutrient intake in toddlers aged 12 to 24 months

Diet is an important aspect of everyone's health and is just as vital during infancy as it is later in life. Diet can have long-term consequences, with the foods eaten during infancy potentially affecting health in adulthood. It is therefore very important that we are able to measure the diet of toddlers. To do this we usually ask parents to record everything that their child eats in a food diary, which can be complicated. However, we have developed a new questionnaire called a food frequency questionnaire which will allow us to collect this data more easily. This new questionnaire uses your child's palm size as an indicator of the amount of food that they eat. We are doing this project to see if this new questionnaire will give accurate results compared to those from the food diary.

We are looking for parents of children aged 12-24 months who live in either Dunedin or Wellington.

If you would like to take part in our study, you can come to an appointment at the University of Otago Campus in Newtown, Wellington or we may visit you at your home and begin by asking you a few questions about your family. As part of the study we will then measure your child's length and weight and take a photocopy of your child's palm. You will then complete the food questionnaire which asks about the types of food your child has eaten in the past four weeks. This should take approximately 1 hour.

At this same visit we will provide you with a diary and a set of scales and show you how to use them. With the use of these, we ask that you weigh and record every food and drink item your child consumes over five non-consecutive days, over the next month. One of these days should include a weekend day.

We will have a second appointment one month later to collect the scales and food diary. We will also ask you to repeat the same food questionnaire you did at the beginning of the month.

We will ask you some personal information including your name, phone number and address so that we can contact you to arrange an appointment time to fill in the questionnaire. This information will not be published.

We will also collect your age, and your child's birth date and ethnicity so that we are able to describe our study participants as a whole. All personal information will be kept private with only the researchers able to access it for the intended purpose of the study. The group results may be published but no one will be individually identified, with all personal information destroyed at the

end of the study. The University research policy requires that we keep the raw data related to the results of the study for five years, after which it will also be destroyed.

If you change your mind and no longer want to take part in our study, you may withdraw at any time, with no disadvantage to either yourself or your child.

We will provide you with an expert analysis of your child's results.
Everyone who completes our study can go into a draw to win an iPod touch.
Parking costs will be compensated.

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

Emily Watson
Department of Human Nutrition
Email eatstudy.dunedin@otago.ac.nz
Answer phone 479 8454

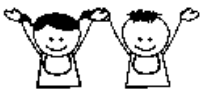
Virginia Mills
Department of Human Nutrition
Email eatstudy.wellington@otago.ac.nz
Answer phone 0800 852456

Dr Anne-Louise Heath, Dr Paula Skidmore or Assoc Prof Rachael Taylor
Department of Human Nutrition
Phone (03) 479 7960

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph (03) 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.



Appendix F: Consent form



EAT: Eating Assessment in Toddlers aged 12 to 24 months

CONSENT FORM FOR PARTICIPANTS

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

I know that:-

1. My participation in the project is entirely voluntary;

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

3. Personal identifying information (names, address, phone number) will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for at least five years;

4. This project involves weighing and recording my child's food intake for five days. This project also involves two visits with a nutritionist who will ask questions about my child's food intake, and measure my child's palm size, height and weight.

5. I will be entered into a draw to win an iPod Touch;

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

I agree to take part in this project.

....

(Signature of participant) (Date)

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Appendix G: Demographic questionnaire



Eating Assessment in Toddlers aged 12 to 24 months

Please complete the following questionnaire about yourself, and your child participating in this study

1. What is your sex? Male / Female (please circle)

2. How are you related to the child in this study? _____

3. What is your date of birth? _____ Day/month/year

4. How many children do you have? _____

5. To which ethnic group(s) do you belong to? *Please tick all the boxes that apply*

- ☐ NZ European
- ☐ Maori
- ☐ Samoan
- ☐ Tongan
- ☐ Cook Island Maori
- ☐ Niuean
- ☐ Chinese
- ☐ Indian

If other, please state: _____

6. If Maori, please provide your tribal affiliations _____

7. What is your child's date of birth? _____ Day/month/year

8. What is your child's sex?: Male / Female (please circle)

9. Which ethnic group(s) does your child belong to?

☐ NZ European

☐ Maori

☐ Samoan

☐ Tongan

☐ Cook Island Maori

☐ Niuean

☐ Chinese

☐ Indian

If other, please state: _____

10. If Maori, please provide your tribal affiliations for your child

_____

11. Is your child descended from Maori (that is do they have a Maori birth parent, grandparent or great-grandparent etc)?
Yes / No / Don't know (please circle)

Thank you!

Interviewer administered Questions

1. What is the child's birth weight? _____

2. What is the child's birth length? _____

3. How many weeks pregnant were you when this child was born?

_____

Appendix H: Anthropometry protocol

P3b. Anthropometry Protocol

(Prepared by Emily Watson, 22 July 2011)

Objectives

1. To undertake anthropometric measurements (weight and height of 12 -24 month old children
2. To undertake hand measurements of the child (thickness and scanning)
3. Record measurements immediately in the data sheet
4. Enter the measurements on computer

Equipment required

EAT Measurement Protocol (this protocol)

Anthropometric data sheet

List of parent's name, toddler's name, and address

Portable scanner

Scales

Equipment bag:

- Bone calipers
- Length mat
- Hand sanitiser
- Pencil (for recording results on data sheet)
- Pen to mark anatomical points on skin
- Eraser
- Nappies (pre-weighed)
- Wipes
- Sanitary sheets
- Bag (to keep rubbish in one place and ensure it is taken away at end of visit)

Measuring equipment

- All measuring equipment must be highly accurate, precise, sturdy and portable
- Scales and length mat should be calibrated monthly;
  - Length mat should be calibrated with a standard length rod
  - Scales should be calibrated with a standard weight
- Seca alpha weighing scale: portable electronic scale that has taring capability and calibrated to 0.1 kg.
- Rolla meter 100c
- Bone caliper (also for hand thickness)

Steps - Before

1. Ensure each participant has received a reminder phone call regarding date, time and venue of session
2. Confirm that all supplies needed for the measurements are with you
3. Information should be entered on data sheet including:
    - Date, names (child and mother), ID number, Toddler's sex

Remember

- Measurements should be taken and recorded twice
- It is important to follow the same technique and protocol during successive measurements
- Any measurements falling outside the maximum allowed differences should be repeated and entered in designated boxes on the data sheet
- Data should be entered on the sheet using a pencil
- Immediately record the measurements after it is read, it helps to have your pencil and data sheet near you
- Record the measurement directly onto the data sheet. The more times the measurement is copied, the more chances of error there are.
- Record measurements clearly and neatly, the same way every time.

Steps – During

1. Introduce yourself
2. Thank for taking time to meet today
3. Ensure that the parents understand what is happening and they are comfortable with the process
4. Go over what will be covered in today's session:
    a. Child length and weight
    b. Child hand measurements (scan and thickness)

General Guidelines for Measuring and Recording

1. **Always tell the participant what you are going to do before you do it.** Explain what you are doing and why. Remain professional at all times.
2. Always **watch children carefully at all times** because they can quickly and easily fall.
3. Explain to the parent that information will only be used for this study. We can give them a copy of the measurements if they wish.
4. Confidentiality of information must be assured
5. Confidence and poise is important for reassuring both the parents and child, and includes maintaining eye contact and talking to the child in calm, reassuring voice.

Carry out measurements in the order of:

1. *Child's right hand thickness (bone calipers) 1*
2. *Child's right hand thickness (skin fold calipers) 1*
3. *Ask the parent to undress the child to a singlet and one of our nappies*
4. *Child's length 1*
5. *Child's weight 1*
6. *Child's length 2*

7. *Child's weight 2*
8. *Check the differences between the measurements 1 and 2 are acceptable. If not, then repeat measurement a third time now.*
9. *Ask the parent to redress the child*
10. *Child's right hand thickness (bone calipers) 2*
11. *Child's right hand thickness (skin fold calipers) 2*

The maximum allowable differences between the two measurements are:

Measurement	Maximum allowable difference
Weight	0.1 kg
Length	0.7cm
Hand Thickness	2mm

Weight

Place the scale on a flat, hard, even surface. Be sure there is adequate light to read measurement.

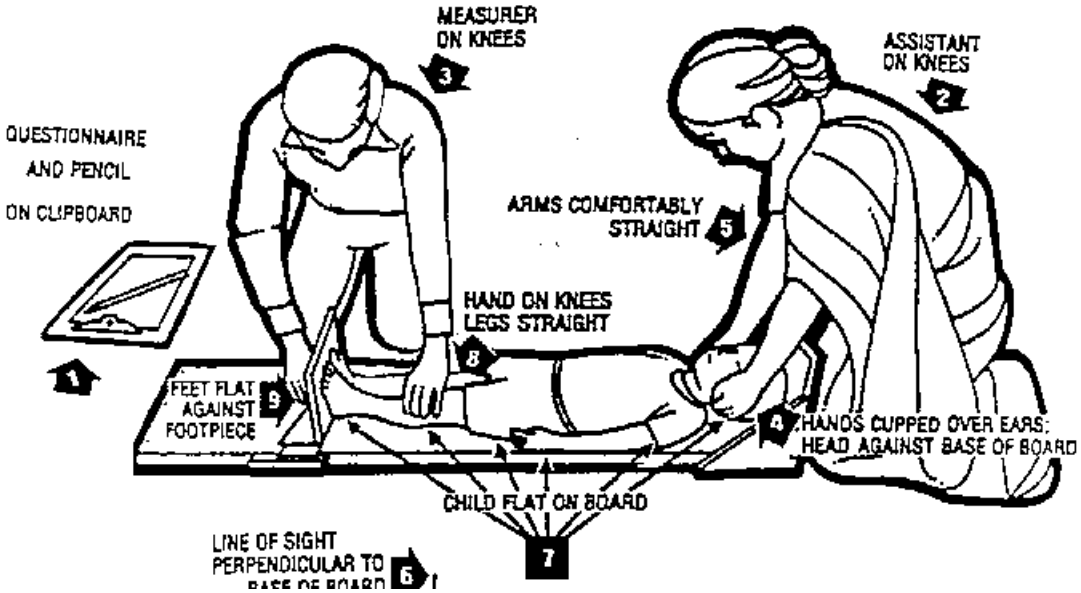
1. Explain to the participant the procedure for weighing
2. Ask the mother to remove all the child's clothes so only a singlet being worn and put on a dry nappy (of known weight)
3. Turn on the scales
4. Ask the mother to stand on the scales
5. Tare the scales
6. Then give the child to the mother and ask to stand still until the child's weight is recorded
7. Immediately record the measurement to the nearest 0.1 kg.

Length

Explain to the mother the procedure for measuring length, the mother will be required tro help with measurement and to soothe and comfort the child.

1. Place the length board on a flat hard and stable surface
2. Cover the length board with a thin cloth or soft paper for hygiene and for the child's comfort
3. Ask the mother to remove hair ornaments, and lay the child on his/her back against the fixed headboard, compressing the hair
4. Quickly position the head so that the crown touches the head board. An ***imaginery vertical line from the ear canal to the lower border of the eye socket is perpendicular to the board (Frankfor Line).*** The child's eyes should be looking straight up. Ask the mother to move behind the headboard and hold the head in this position
5. Stand on the side of the length board where you can see the measuring tape and move the footboard.

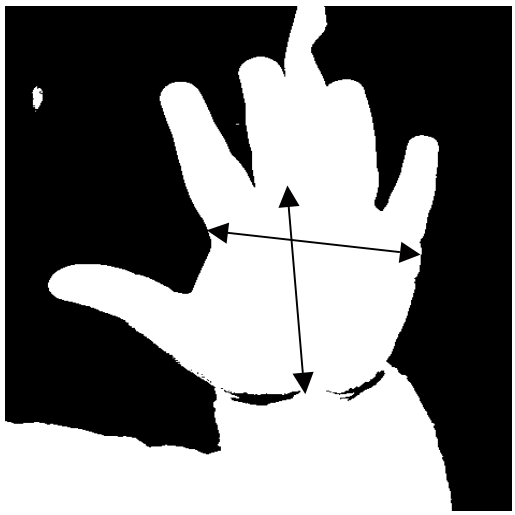
6. Check the child lies straight along the board and does not change position. Shoulders should touch the board, and the spine should not be arched. The arms rest against the sides of the trunk.
7. Hold the child's legs down with one hand and move the footboard with the other. Apply gentle pressure to the knees to straighten the legs as far as they can go without causing injury (minimum pressure). If both legs cannot be held in position, measure with one leg in position.
8. While holding the knees, pull the footboard against the child's feet. The soles of the feet should be flat against the footboard, toes pointing upwards.
9. Immediately record the child's length in cm to the last completed 0.1cm.
10. If the child refuses to lie on the length board, record his height and add 0.7 cm to the recorded height to get the length. Put a note in the data sheet.



Hand Size

1) Measuring hand thickness:
    a. with Harpenden calliper, measure the thickness of the hand in the middle of the palm (usually the deepest part of the palm). Take two measurements and if the difference between them is > 2mm, take a third one.
    b. With Bone caliper, measure the thickness of the hand in the middle of the palm, apply minimal pressure. Take two measurements and if the difference between them is > 2mm, take a third one.
2) Hand scanning: put the right hand of the child on the scanner with hand naturally opened, wrist extended and the third finger close to the cm tape.
3) Make sure the scanner is connected to the laptop. Scan then to be taken.
4) Save the scanned copy on the specific file. The scan will be analysed using special program to record the length and width of the hand.

5) Palm length will be measured as the distance from the middle of the wrist crease (the deepest one) to the middle of the base of third digit.
6) Hand width will be the maximum width across the metacarpal- phalangeal joints II and V.



Steps – After

- Refer to Protocol 2. First Visit
- Transfer recorded measurements from paper onto computer

Appendix I: Example of a child's palm scan

Appendix J: Instructions for using the scales

Instructions for using scales (SALTER Electronic)

Please weigh EVERYTHING in grams using the scales we have given you

Step 1: Turn on the scales

1. Place scales on a **stable, flat** work surface away from the microwave
2. Press the ON ZERO button once (quite firmly) in the centre
3. A '0' with a 'g' (above the zero) should appear on the display
4. If a '0' with an 'oz' appears on the display, please push the 'KG LB' button to convert to 'g'

Step 2: Weigh the empty plate or bowl

Place bowl or plate on the platform. Read the weight and record it in the column labelled **"Weight of plate or mug"** on your food diary

Step 3: Weigh the plate or bowl with food (before eating)

1. Add the first food to the plate or bowl. Read the weight and record it in the column labelled **"Weight of food or drink + plate or mug"** on your food diary
2. Add the next food to the plate or bowl. Read the weight and record it in the column labelled **"Weight of food or drink + plate or mug"** to your food diary
3. Repeat as needed, do not zero the scales in between weighing foods

Step 4: Weigh the plate or bowl with leftover food (after eating)

1. Place the bowl or plate with the food leftovers on the platform
2. Read the weight and record it in the column labelled **"Weight of leftover + plate or mug"** on your food diary
3. Estimate the proportion of each food that was leftover (e.g., ½ baked beans, ¼ slice bread)

Step 5: Turn off the scales

Press the 'OFF' button once to switch it off (scales will turn off automatically if left for 3 minutes).

Changing the batteries

It a picture of a battery appears on the display it means the battery is low and needs replacing
Remove the back cover
Take out battery box and remove inner box
Place two batteries on top of each other with the + terminal on top
Place boxes into original position and close back cover

Note

- **'Err'** means you have put too much weight on the scale – try a lighter plate. These scales cannot be used with any plate, bowl or container that weighs more than approximately 2 kg.
- It a picture of a **battery** appears on the display it means the battery is low and needs replacing.
- Clean scales with a slightly **damp cloth** – please DO NOT immerse in water or use chemical/abrasive cleaning agents
- Please clean scales **immediately** after a spill
- Don't use the scales next to your **microwave** – this will interfere with the display
- The scales with automatically **switch-off** after 1 minute if the display has been showing '0' continuously, or after 3 minutes if one reading has been displayed continuously for that time

If you have any questions please leave a message and we will get back to you

Dunedin
Answer phone 479 8454
Email eatstudy.dunedin@otago.ac.nz



Wellington
Answer phone 0800 852456
Email eatstudy.wellington@otago.ac.nz

Appendix K: Example of the EAT food record (day one included only, size and formatting changed for binding)

EAT Food Diary



Please read through these pages before starting your food diary

We would like you to please:

- Write down **everything** your toddler eats and drinks, when s/he eats it. Please don't rely on your memory at the end of the day.
- Write down any supplements you give your toddler.
- Weigh your toddler's food and drink using the scales provided.

On these days:

1. ……..
2. ……..
3. ……..
4. ……..
5. ……..

Please try not to change what you give your toddler just because you are keeping a diary!

Thank you very much for your help and co-operation

How to fill out your Diet Record:

- Record the amount and description of **ALL foods and drinks consumed** — all meals and all snacks.
- **Begin each new day on its labelled page,** (for example, Day 1) and please fill in all the information at the top of the page (the date, day of the week and the questions about your toddler's health).
- Use a **new line for each food or drink.** (You can use more than one line for a food or drink, but please start each new food or drink on a separate line).
- Also please remember to **include any additions to foods,** (for example, tomato sauce, salad dressing, gravy).

How to fill out each column

Where	Time of day	Name, brand and cooking method of food or drink	Weight of plate or mug	Weight of food or drink + plate or mug	Weight of leftover + plate or mug	Amount eaten
Please write down **where** your toddler ate each meal, snack or drink.	Please write down the **time** your toddler had something to eat or drink, including **am** or **pm**.	**Name:** Describe the food or drink. **Brand:** Name the brand. **Cooking method:** If the food was cooked write down how it was cooked (roasted, steamed, fried). If the food was **coated** in something or you added things like sauce or butter please record this. If **a recipe** was used to make a dish please write "see recipe" and write out the recipe on the page labelled "Recipes".	**1) Weigh an empty plate or mug** using the scales provided. 2) Write down the weight.	1) Place the first food or drink on the plate/mug on the scales. 2) Write down the weight. 3) If you add several foods to the same plate you will need to write down the **weight of each food** as you add it.	1) After your toddler has eaten their meal place the **same plate or mug with all the leftovers** on the scales and write down the total weight of the food or drink and the plate or mug. 2) Estimate how much of each food was left over (for example, 1 tablespoon mince, half the potato). "Leftovers" are **everything** that your toddler didn't eat so please try and scrape everything your toddler didn't eat back on to the plate and weigh.	Office use

An example filled out by the parents of a 14 month old toddler

Day 1 Date: *9 March 2011* Day of week: *Thursday* Is your child unwell? (YES) / NO

If unwell, did this influence your child's appetite? (No)

Yes – decreased appetite Yes – increased appetite

Where	Time of day	Name, brand and cooking method of food or drink	Weight of plate or mug	Weight of food or drink + plate or mug	Weight of leftover + plate or mug	Amount eaten
Home	*7:30am*	*Breastfeed 15 minutes* *1 slice white bread toast slice, Tip Top, toasted* *Butter, Mainland salted* *Marmite, Sanitarium*	*115g*	*135g* *140g* *142g*	*127g*	Office use
At Café with Gran	*10am*	*Fruit cake* *Bobby banana* *Water* *Breastfeed 10 minutes*		*2 match boxes* *small* *2 sips from my glass*		
McDonald's	*12pm*	*Medium fries 45g (from supplementary page)* *McDonalds size small lemonade*			*1/8 leftover* *1/3 leftover*	
Home	*3pm*	*Breastfeed 20 minutes*				
Home	*6pm*	*Home-made mince (see recipe),* *Potato, boiled* *Butter* *Peas, frozen, boiled* *Fruit juice, Just Juice, Orange and mango*	*115g* *42g*	*145g* *195g* *197g* *211g* *210g*	*155g* *(One teaspoon mince, half the potato, no peas)* *44g*	
Home	*8pm*	*Breastfeed 10 minutes*				

Please write down if you have toast or sandwich slice bread.

If you are having fruit and don't have your scales you can write down whether it is a small, medium or large piece of fruit.

If you don't have your scales with you please estimate the amount.

Please weigh the total amount of food left over + weight of plate or mug.

Then of the total amount that is left over please tell us how much there is of each food (for example, half the mince, half the potato, no peas).

Write down every time your toddler has a breast or formula feed. For formula please fill out all the columns. For breast milk please write down the duration of breastfeed.

If you are using a sippy cup or bottle remember to take the top off before you weigh the leftovers.

Example

Recipes – Day 1

Please write down:

1. Name of the recipe(s) (ie. the name you used in the diary)
2. Amount of each ingredient (for example, 3 medium carrots, 500g lean beef mince etc)
3. Any water added.
4. The proportion of the whole recipe that your child was served in the diary (For example, write "Home-made mince" in the "**name, brand and cooking method of food or drink**" column, and "one tenth (1/10)" in the "**weight of food or drink**" column).

Name of recipe: *Home-made mince*

300g standard beef mince (browned in 1 tablespoon olive oil)
50g onion, diced
60g carrot, diced
1 clove garlic, minced
60g beef stock (Campbells)
30g tomato sauce (Watties)
60g diced potatoes
40g diced kumara
40g frozen mixed vegetables (Watties)
60g water
5g white flour

Cooking method: *Mince was stewed in a small pot with lid on.*

One tenth (1/10) of the recipe was served to my child at dinner.

Please remember to record the amount served to your child in the "weight of food or drink" column in the diary (i.e. 1/10).

Important things to remember

We are NOT looking for a "healthy" diet. We need to know what toddlers actually eat.

- Always record food eaten at the time it is eaten.
- Please give us as much information as possible about the food.
- Estimate foods if you can't weigh them.
- Record all leftovers.

Remember all information that you give us is **strictly confidential.**

How to estimate amounts of food when you can't weigh them

Please record an estimated amount in the "weight of food or drink" column.

- **HOUSEHOLD MEASURES** – Household measures like cups, tablespoons and teaspoons can be useful. Please tell us whether it was a heaped or level amount.
- **WEIGHTS MARKED ON PACKAGES** – Use the weight marked on canned or packet foods e.g., half a 220g can of baked beans, one 60g pottle of yoghurt.
- **RULER** – Foods such as cheese, cakes and meat can be measured using the ruler provided on the supplementary page, e.g. slice of luncheon sausage 8cm x 4cm x 1mm (remember to give length, width and depth!).
- **CIRCLES** – Round foods such as biscuits and muffins can be measured using the circles provided on the supplementary page, e.g. one muffin 6cm circle x 7cm high (height estimated using the ruler).
- **BREAD** – Tell us the number and the size of the slices e.g., sandwich, medium, or toast slice.
- **FRUIT** – Tell us whether the piece of fruit is small, medium or large. Alternatively you could use the circles for round fruit such as mandarins.

TAKEAWAY FOODS

The supplementary page provided has photographs of commonly eaten takeaway foods. Please write down the weight from the photograph that best describes the amount of food your toddler was served and write it in the "Weight of food or drink" column. Your toddler might not have exactly the amount in the photos so feel free to tell us if she had "two x 40g pizza".

Day 1 Date: Day of week: Is your child unwell? YES / NO

If unwell, did this influence your child's appetite? No

Yes – decreased appetite Yes – increased appetite

Where	Time of day	Name, brand and cooking method of food or drink	Weight of plate or mug	Weight of food or drink + plate or mug	Weight of leftover + plate or mug	Amount eaten
						Office use

Supplement Use – Day 1

(a) Did your child take any supplements (e.g., multi-vitamin, etc.) today?

No ☐ (please go to Day 2, page 11)
Yes ☐

(b) **If yes,** please record the following:

Type of supplement (e.g., cod liver oil):
Brand name (e.g., Smith's):
Amount (number of mls, drops, tablets, capsules, etc.) taken (e.g., 5mls):

(c) **If yes,** does the supplement contain iron? (check the label)

No ☐
Yes ☐

If yes, please record the type of iron (e.g., ferrous fumerate, ferrous sulphate and anything else with the words "iron", "ferric" or "ferrous") and amount of iron per tablet (e.g., 10mg, etc.):

Type of iron (e.g., ferrous sulphate): Amount per dose (e.g., 7mg in 5ml):

THE INTERVIEWER WILL HELP YOU FILL IN THIS PAGE IF YOU ARE NOT SURE - please keep the bottle or packet

Appendix L: ‘Away from Home’ recording sheet



EAT Food Record – Day Care

Name _____ Date_____

_____ is involved in a study looking at the best way to measure what toddlers eat. We would appreciate it if you could record a complete description of what _____ eats today while at the day care centre, following the instructions below:

We would like you to please:

- Record the amount and description of **ALL foods and drinks** _____ eats or drinks today, when s/he eats or drinks it, including water.
- Record how much _____has **EATEN**, rather than how much you offered.
- Estimate the amount of food and drink eaten. You can use household measures (eg cups or spoons), sizes of packets (eg 140g yoghurt pottle, 15g "Little Kids" bar), or if you have kitchen scales, you can weigh the food.
- If any foods eaten are recipes made at the centre, please attach a copy of the recipe to this sheet, including the number of portions the recipe makes. Then in the "amount eaten" column, please record how many of these portions _____ ate eg. ½ a portion or 2 portions.

Here's an example of how to fill out the record:

Time of day	Name, brand and cooking method of food or drink	Amount eaten
10 am	*Red apple*	*½ medium apple*
	Sugar-free Raro fruit drink	*¾ cup*
12 noon	*Lasagne made at day care– attach recipe and total number of portions the recipe makes*	*one portion*
	Watties frozen peas - boiled	*¼ cup*
	"Little Kids" bar	*1 bar (15g)*

Food record:

Time of day	Name, brand and cooking method of food or drink	Amount eaten

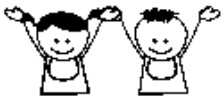
Thank you!

Day Care Recipes

Please record the full recipe and the number of portions it makes:

Thank you!

Appendix M: Nutrient Analysis sheet for child



Nutrient Analysis

Nutrient	Estimated Average Requirement	Recommended Dietary Intake	Your toddler's average daily intake
Protein	12 grams	14 grams	32 grams
Calcium	360 mg	500 mg	619 mg
Iron	4 mg	9 mg	9.7 mg
Zinc	2.5 mg	3 mg	6.3 mg
Vitamin C	25 mg	35 mg	117 mg

What can this nutrient analysis tell me?

This nutrient analysis shows your child's average intake of nutrients over the 5 days you kept the food diary. From this you can see how likely it is that they are getting enough of each nutrient. Please note – if your child has a low intake of a nutrient this does not necessarily mean they are deficient in that nutrient. The only way to diagnose a nutrient deficiency is from tests such as blood tests.

What is the "Recommended Dietary Intake?"

The Recommended Dietary Intake (you may have seen it called "RDI" on food packets) is the daily intake of a nutrient that will meet the needs of almost every child aged to 1-3 years. If your child has a nutrient intake that is the same as, or higher than the RDI it is very likely they are getting enough of that nutrient.

What is the "Estimated Average Requirement?"

The Estimated Average Requirement or EAR is the daily intake of a nutrient that will meet the needs of half of all 1-3 year old children. If your child has nutrient intakes that are the same as or above the EAR, there is still a good chance they are getting enough of the nutrients they need.

What does it mean if my child has a nutrient intake below the RDI?

If your child has a nutrient intake below the RDI but above the EAR, there is still a good chance they are getting enough of that nutrient. If you're concerned you could try offering more foods that contain the nutrient or nutrients you're worried about. See page two of this sheet for some ideas.

What does it mean if my child has a nutrient intake below the EAR?

If your child has a nutrient intake below the EAR, then it's possible they may not be getting enough of that nutrient. See the bottom of this sheet for some ideas about what foods to offer to boost their intake of the nutrient or nutrients you're concerned about.

How accurate is this nutrient analysis?

The accuracy of this nutrient analysis depends on how accurate and detailed the food diary was. There are also other factors that can affect the accuracy of the nutrient analysis, for example if your child was unwell and had a decreased appetite while you were keeping the food diary, their nutrient intake may actually be higher than this analysis has shown. There's also a chance that the 5 days of recording weren't representative of what your child usually eats – for example if on the 5 days you were recording your child didn't eat any of a particular food that they usually eat then the analysis may not be an accurate reflection of their nutrient intake.

Breast milk was also unable to be included in the analysis. This means that if your child is breastfed, their nutrient intakes are likely to be higher than stated.

Good sources of protein are:

Meat, chicken, fish, eggs, milk, cheese, yoghurt, beans (e.g. baked beans), lentils and tofu.

Good sources of calcium are:

Breastmilk, cow's milk, cheese, yoghurt, custard, calcium-fortified soymilk and calcium-fortified soy yoghurt.

Good sources of iron are:

Beef, lamb, other meats, chicken, fish, shellfish, eggs, beans (e.g. baked beans), lentils, tofu and breakfast cereals. Eating vitamin C containing foods (see list below) at the same time as iron-containing foods increases iron absorption.

Good sources of zinc are:

Beef, lamb, other meats, chicken, fish, shellfish, eggs, cheese, milk and other dairy, beans (e.g. baked beans), lentils and tofu.

Good sources of vitamin C are:

Fruit such as oranges and mandarins, kiwifruit, berries, apples, bananas, pineapple and colourful vegetables such as tomatoes, capsicum (for example "red pepper"), broccoli, cauliflower, cabbage and kumara.

Appendix N: Foods from the food diary matched to the sixteen food groups from the food frequency questionnaire

1. Baby and Toddler Foods

Foods from 5 d WDR assigned to "baby and toddler foods"
Apple & oatmeal,pureed,can,Heinz Watties,
Asst fruits & semolina,pureed,can,HW
Carrot & rice,pureed,can,Heinz Watties
Cereal,baby rice,Farex,Heinz Watties,dry
Cereal,baby rice,Farex,Heinz Watties,rte
Cereal,infant riceFruit SaladRobinsons
Cereal,original mixed,Farex,HW,rte
Custard,banana,Farex,Heinz Watties,rte
Custard,banana,smooth,can,Heinz Watties
Custard,egg,Robinsons,rte
Custard,egg,smooth,canned,Heinz Watties
Dessert,peach and apple
Dessert,rice pudding,smooth,Robinsons
Dessert,yoghurt,vanilla&apricot,smth,HW
Fruit,apple,pureed,canned,Heinz Watties
Fruit,fruit salad,pureed,Heinz Watties
Juice,apple,strained,rtd,Heinz
Lambsfry & bacon,pureed,can,HeinzWatties
Muesli,finely ground,Heinz Watties,dry
Muesli,oat apple,Farex,Heinz Watties,dry
Muesli,oat apple,Farex,Heinz Watties,rte
Parsnip carrot & kumara,pureed,canned,HW
Porridge,apricot,Heinz Watties,rte
Potato peas & brocolli,pureed,canned,HW
Savoury,chic,pasta&veg,chunky,toddler,HW
Savoury,chicken,noodles & veg,pureed,HW
Savoury,rice & beef,chunky,toddler,HW
Savoury,steak & veg,mashed,Heinz Watties

2. Bread, pasta, rice, low-sugar cereal

Foods from 5 d WDR assigned to "bread, pasta, low-sugar cereal"
All bran,kelloggs
Bagel,plain
Bagel,wheat
Barley,pearl,boiled
Bran cereal
Bread mix,wheat & gluten free,simple,healtheries
Bread naan,indian restaurant
Bread roll,mxd grain,supermarket fresh
Bread roll,whgrn,lower north island,pre-packaged
Bread roll,whgrn,pre-packaged
Bread roll,white,lower north island,pre-packaged
Bread roll,white,pre-packaged
Bread roll,white,south island,pre-packaged
Bread roll,white,spmkt fresh,lower north island
Bread roll,white,spmkt fresh,south island
Bread roll,white,supermarket fresh
Bread roll,whml,south island,pre-packaged
Bread roll,wholemeal,supermarket fresh
Bread,ancient grains,vogels
Bread,bun/roll,white,with cheese and bacon topping
Bread,bun/roll,white,with pizza topping topping
Bread,bun/roll,with cheese topping
Bread,ciabatta
Bread,currant,sliced,ppkd,lower north island
Bread,currant,sliced,ppkd,south island
Bread,currant,sliced,prepacked

Foods from 5 d WDR assigned to “bread, pasta, low-sugar cereal”
Bread,currant,spmkt fresh,lower north island
Bread,currant,spmkt fresh,south island
Bread,currant,supermarket fresh,
Bread,currant,toasted
Bread,garlic,toasted
Bread,mighty white,tip top
Bread,multi-grain light
Bread,multi-grain,burgen
Bread,multi-grain,gluten free,prepacked
Bread,multi-grain,heavy,prepacked
Bread,multi-grain,heavy,sl,ppkd,lower north island
Bread,multi-grain,heavy,sl,ppkd,south island
Bread,multi-grain,light,sl,ppkd,lower north island
Bread,multi-grain,light,sl,ppkd,south island
Bread,multi-grain,light,sliced,prepacked
Bread,multigrain light with seeds
Bread,multigrain medium
Bread,pita,garlic butter,pre-packaged
Bread,pita,white (nzr)
Bread,pita,wholemeal,pre-packaged
Bread,roti,indian resturant style
Bread,rye,with seeds
Bread,soy&linseed,sl,ppkd,south island
Bread,soy&linseed,sl,prepacked
Bread,soy&linseed,sliced,ppkd,lower north island
Bread,sunflower&barley,sl,ppkd,south island
Bread,fresh
Bread,vienna,cheese topping
Bread,wheat/oat,sliced
Bread,wheat/rye,sliced & unsliced
Bread,wheatmeal
Bread,wheatmeal,sliced,ppkd,lower north island
Bread,wheatmeal,sliced,prepacked
Bread,white,crumbs,dried
Bread,white,gluten free,prepacked
Bread,white,high fibre,sl,ppkd
Bread,white,high fibre,sl,ppkd,lower north island
Bread,white,high fibre,sl,ppkd,south island
Bread,white,pizza topping
Bread,white,sl,ppkd,upper north island
Bread,white,sliced,ppkd,lower north island
Bread,white,sliced,ppkd,south island
Bread,white,sliced,prepacked
Bread,white,toasted
Bread,white,with seeds
Bread,wholemeal,sl & unsl,norths extra
Bread,wholemeal,sliced & unsliced
Bread,wholemeal,toasted
Bread,wheatmeal
Bread,whtml,sliced,ppkd,south island
Breadcrumbs,dried,assorted breads
Bun,burger,mcdonalds
Cereal,muesli,untoasted/natural,unsweetened,homemade,no fruit-nuts-coconut
Cheese roll
Corn flakes
Corn flakes with psyllium,freedom fds
Corn flakes,kelloggs
Corn flakes,sanitarium
Couscous,cooked
Cracker,crispbread,wholemeal
Crispy noodles

Foods from 5 d WDR assigned to “bread, pasta, low-sugar cereal”
Crumpet
Crumpet,toasted
Fettuccine,fresh,herb & garlic,cooked
Fruitful porridge,cooked,hubbards
Fruity bix,wildberry,sanitarium
Macaroni cheese
Macaroni,boiled
Mini wheat-blackcurrant,kelloggs
Mini wheats,blackcurrant,kelloggs
Muffin,assorted flavours,toasted
Muffin,toasted
Muffin,fruit
Noodle,wheat,aisan style (hokkien noodle)
Noodles,egg,boiled
Noodles,egg,fried
Noodles,instant,boiled,water drained
Noodles,udon,boiled
Noodles,rice,boiled
Oat bran
Oatmeal
Oats,rolled,nz and aus
Oats,rolled,raw
Oats,whole grain,raw
Pasta dish,(not stuffed),tomato sauce,bought sauce
Pasta,egg,boiled
Pasta,filled,cheese only
Pasta,filled,chicken & ricotta
Pasta,filled,chicken and meat
Pasta,filled,vegetables/funghi,with cheese
Pasta,plain,boiled
Pasta,spinach,boiled
Pasta,wholemeal,boiled
Pikelet,plain
Pikelets,plain
Pizza base
Pizza,fr,reg,combination,bkd
Pizza,frozen,premium,meat lovers,baked
Pizza,pizza hut,meatlovers,thin base
Pizza,single topping,phut
Pizza,vegetarian,lge,bkd,thickcrust
Porridge,milk and water,nz oats
Porridge,milk,nz & aus oats
Porridge,milk,nz oats
Porridge,prep w/milk&water,salt added
Porridge,prepared with milk
Porridge,prepared with water
Porridge,water,nz & aus oats
Porridge,water,nz oats
Quinoa,cooked
Ravioli,beef,bpepper,olive,tmt&gar,ckd
Ravioli,chicken,roast garlic&pesto,ckd
Ravioli,fresh,beef and pork,cooked
Rice bubbles,kelloggs
Rice cake,brown rice,plain
Rice cake,original
Rice cake,tangy tmt,sour cream & chives
Rice dish,risotto (from packet),composite flavours,chicken and vegetables added (ns as to fat added)
Rice dish,risotto (from packet),composite flavours,meat and vegetables added,with oil – other (polyunstaturated)
Rice dish,uncle bens express rice,composite flavours
Rice puffs,with psyllium,freedom foods

Foods from 5 d WDR assigned to “bread, pasta, low-sugar cereal”
Rice,basmati,cooked,indian restaurant
Rice,brown,boiled
Rice,jasmine,cooked
Rice,white,parboiled
Rice,white,polished,boiled
Rice,white,steamed,thai restaurant
Ricies,sanitarium
Semolina,cooked
Spaghetti,boiled
Spaghetti,in tomato sauce,canned
Spaghetti,in tomato sauce,canned,pams
Spaghetti,in tomato sauce,canned,watties
Special k,kelloggs
Steamed bun,meat
Sushi
Sushi,chicken
Tortellini,fresh,spinach,cooked
Tortilla,flour (nzr)
Weetbix,sanitarium
Wheat biscuits,signature range

3. Meat

Foods from 5 d WDR assigned to “meat”
Beef patty,frozen,fried
Beef,blade steak,l&f,trm,stewed,drained
Beef,blade steak,lean,stewed,drained
Beef,bolar roast,lean & fat,raw,trimmed
Beef,bolar roast,lean & fat,trm,roasted
Beef,bolar roast,lean,raw
Beef,bolar roast,lean,roasted
Beef,composite cuts,lean,cooked
Beef,corned,silverside,lean
Beef,fillet steak,lean,grilled
Beef,mince,lean & fat(6%),stewed,drained
Beef,mince,lean,stewed
Beef,mince,lean&fat(12%),stewed
Beef,mince,lean&fat(20%),stewed,drained
Beef,mince,lean&fat(6%),fried
Beef,mince,mince (extra lean),pan fried/stir fried/sauteed,fat not skimmed,with no fat used
Beef,mince,steak/beef mince,fried
Beef,mince,steak/beef mince,grilled/dry fried,fat not skimmed,with no fat
Beef,mince,steak/beef mince,pan fried/stir fried/sauteed,fat not skimmed,with no fat
Beef,mince,steak/beef mince,stewed/boiled/simmered/poached,fat not skimmed,with no fat
Beef,mince,topside mince (lean),pan fried/stir fried/sauteed,fat not skimmed,with no fat
Beef,patty,mcdonalds
Beef,roast,topside/corner cut/eye,fat trimmed,with no fat
Beef,rump steak,lean,grilled
Beef,schnitzel,crumbed,fried
Beef,schnitzel,lean,grilled
Beef,schnitzel,pan fried/stirfried/sauteed,coated -eaten,with no fat
Beef,schnitzel,pan fried/stirfried/sauteed,not coated,with no fat
Beef,scotch fillet,lean,grilled
Beef,silverside cured,lean,boiled
Beef,sirloin steak,lean,prime,fried
Beef,steak,rump,fat not trimmed,grilled/dry fried,with no fat used
Beef,steak,rump,fat trimmed,pan fried/stir fried/sauteed,with default ANS08 fat
Beef,steak,stewing cuts,fat trimmed,pan fried/stir fried/sauteed,with no fat
Beef,topside roast,lean,roasted
Burger,cheese,mcdonalds

Foods from 5 d WDR assigned to “meat”
Casserole,hot pot
Chicken,breast (includes sliced),panfried/ stir-fried/ sauteed,skin remove before cooked,not coated
Chicken,breast,baked/roasted,skin eaten,coated-eaten
Chicken,breast,baked/roasted,skin eaten,not coated
Chicken,breast,baked/roasted,skin eaten,not coated,with oil - peanut,olive,canola,ricebran (monounstaturated)
Chicken,breast,baked/roasted,skin remove before cooked,coated-eaten,with no fat
Chicken,breast,baked/roasted,skin remove before cooked,not coated
Chicken,breast,baked/roasted,skin remove before cooked,not coated,with no fat
Chicken,breast,baked/roasted,skin remove before cooked,not coated,with oil - peanut,olive,canola,ricebran (monounstaturated)
Chicken,breast,baked/roasted,skin removed before eaten,not coated,with no fat
Chicken,breast,deli-cooked,supermarket
Chicken,breast,flesh,grilled
Chicken,breast,flesh,roasted
Chicken,breast,grilled/dry-fried,skin remove before cooked
Chicken,breast,grilled/dry-fried,skin removed before eaten,not coated
Chicken,breast,l,f&s,rstd in oven bag
Chicken,breast,lean&fat,roasted
Chicken,breast,panfried/stir-fried/sauteed,skin eaten,not coated,with no fat
Chicken,breast,panfried/stir-fried/sauteed,skin remove before cooked,coated-eaten,with no fat
Chicken,breast,panfried/stir-fried/sauteed,skin remove before cooked,not coated,with no fat
Chicken,breast,panfried/stir-fried/sauteed,skin remove before cooked,not coated,with oil - peanut,olive,canola,ricebran (monounstaturated)
Chicken,breast,smoked,skin removed before eaten
Chicken,breast,stewed/boiled/simmered/poached,skin remove before cooked
Chicken,combination of dark and light meat,baked/roasted,skin eaten
Chicken,combination of dark and light meat,baked/roasted,skin removed after cooking,with fat nfs
Chicken,combination of dark and light meat,stewed/boiled/simmered,skin removed before cooking,with no fat
Chicken,comp cuts,lean & fat,roasted
Chicken,drumstick,baked/roasted,skin eaten,coated-eaten
Chicken,drumstick,baked/roasted,skin eaten,coated-eaten,with default ANS08 fat
Chicken,drumstick,baked/roasted,skin eaten,not coated,with default ANS08 fat
Chicken,drumstick,baked/roasted,skin eaten,not coated,with oil - peanut,olive,canola,ricebran (monounstaturated)
Chicken,drumstick,bbqd,skin eaten,coated-eaten,with no fat used
Chicken,drumstick,flesh,grilled
Chicken,drumstick,flesh,roasted
Chicken,drumstick,l&f,rstd in oven bag
Chicken,drumstick,stewed/boiled/simmered/poached,skin eaten
Chicken,flesh,cooked
Chicken,flesh,deli-cooked,supermarket
Chicken,flesh,roasted
Chicken,leg,flesh,grilled
Chicken,light meat,baked/roasted,skin eaten,with no fat
Chicken,patty/finger/stick,not crumbed
Chicken,skin,roasted
Chicken,thigh,baked/roasted,skin eaten,coated-eaten,with default ANS08 fat
Chicken,thigh,bbqd,skin eaten,not coated
Chicken,thigh,flesh,roasted
Chicken,thigh,l,f&s,rstd in oven bag
Chicken,thigh,lean&fat,roasted
Chicken,thigh,panfried/stir fried/sauteed,skin eaten,not coated,with default ANS08 fat
Chicken,thigh,panfried/stir fried/sauteed,skin remove before cooked,not coated,with oil - peanut,olive,canola,ricebran (monounstaturated)
Chicken,thigh,panfried/stir fried/sauteed,skin removed before eaten,not coated,with oil - peanut,olive,canola,ricebran (monounstaturated)
Chicken,whole chicken,baked/roasted/rotisserie,breast meat,skin removed after cooking,with oil - peanut,olive,canola,ricebran (monounstaturated)
Chicken,whole chicken,baked/roasted/rotisserie,dark and light meat,skin eaten,with oil - peanut,olive,canola,ricebran (monounstaturated)
Chicken,wing,flesh,grilled

Foods from 5 d WDR assigned to “meat”
Cod,flesh,baked
Dumpling,savoury,jiaozi/gow/mandu (crescent shaped),pork,no vegetables,boiled
Fish cake,homemade,baked/roasted,plain
Fish,cake,baked
Fish,cod,red,pan fried/ stir-fried
Fish,cod,red,pan fried/stir-fried,with default ANS08 fat
Fish,fresh fillet,baked/roasted
Fish,fresh fillet,baked/roasted,with no fat used
Fish,fresh fillet,steamed /microwaved
Fish,gurnard,pan fried/stir-fried,with default ANS08 fat
Fish,gurnard,steamed/microwaved,with default ANS08 fat
Fish,hoki,battered fillet,baked/roasted
Fish,hoki,crumbed fillet,grilled/dry fried,with no fat used
Fish,hoki,fresh fillet,pan fried/stir fried,with default ANS08 fat
Fish,hoki,smoked fillet (plain),baked/roasted
Fish,kahawai,smoked,not further cooked
Fish,salmon,baked/roasted,with default ANS08 fat
Fish,salmon,grilled/dry fried,with no fat used
Fish,tarakihi,pan fried/stir-fried/sauteed,with default ANS08 fat
Fish,tarakihi,poached/boiled/stewed/simmered,with no fat
Fish,trevally,pan fried/stir-fried/sauteed
Flounder,flesh,baked
Gurnard,flesh,grilled
Hoki,flesh,baked
Hoki,flesh,grilled
Hoki,flesh,microwaved
Kebab,lamb,oriental marinade
Lamb,chops/cutlets,forequarter/shoulder,baked/roasted,fat not removed,crumb eaten,with no fat used
Lamb,chops/cutlets,forequarter/shoulder,grilled/dry fried,fat removed,with no fat
Lamb,chops/cutlets,loin,stewed/boiled/poached/simmered,fat removed,with no fat
Lamb,comp.cuts,lean,cooked
Lamb,comp.cuts,lean&fat,trimmed,cooked
Lamb,forequarter,lean,cooked
Lamb,mince,pan fried/stir fried/sauteed,regular
Lamb,mince,pan fried/stir fried/sauteed,with no fat used
Lamb,roast,leg,fat trimmed,with no fat
Lamb,shoulder chop,lean,stewed
Lamb,shoulder,lean,roasted
Lamb,steak,baked/roasted,fat removed,with oil - peanut,olive,canola,ricebran (monounstaturated)
Lamb,steak,grilled/dry fried,fat removed,with no fat used
Lamb,steak,pan fried/stir fried/sauteed,fat removed,with no fat
Lamb,steak,pan fried/stir fried/sauteed,fat removed,with oil - peanut,olive,canola,ricebran (monounstaturated)
Meatballs,plain,beef/veal,with default ANS08 fat
Meatballs,plain,beef/veal,with no fat used
Meatloaf,beef/veal,cereal & vegetables,with no fat
Patty burger,bought ready to eat,beef
Patty burger,bought ready to eat,beef,with no fat
Patty/burger,homemade,beef,with egg,not crumbed
Pork,belly slices,lean,grilled
Pork,chops,shoulder,grilled/dry fried,fat removed,with no fat used
Pork,comp cuts,intramuscular fat,cooked
Pork,deli slice
Pork,ham
Pork,leg roast,lean,roasted
Pork,leg roast,lean&fat,roasted
Pork,leg steak,lean&fat,grilled
Pork,loin,fillet steak,lean,grilled
Pork,mince,grilled
Pork,mince,grilled/dry fried
Pork,mince,pan fried/stir fried/sauteed,fat not skimmed,with no fat
Pork,schnitzel,lean,fried

Foods from 5 d WDR assigned to “meat”
Pork,scotch fillet,lean,grilled
Pork,separable hard fat,cooked
Pork,shoulder roast,l,s&f,roasted
Pork,spare ribs,barbecue sauce
Pork,steak,medallion,pan fried/stirfried/sauteed,fat not removed,not coated/not eaten,with oil - peanut,olive,canola,ricebran (monounstaturated)
Prawn cutlets (nzr)
Prawn,grilled/dry fried
Prawn,pan fried/stir-fried,with no fat
Salmon,flesh,smoked,export quality
Salmon,red,canned
Scallop,baked/roasted,with no fat
Seafood,chowder
Snapper,flesh,baked
Soup,cream of chicken,canned
Squid,in flour,fried
Stew,beef
Tarakihi,flesh,baked
Tarakihi,flesh,grilled
Tuna,canned in brine,drained
Tuna,canned in brine,drained-
Tuna,canned,thai curry/satay flavour,drained
Tuna,in oil,canned,drained
Tuna,in spring water,canned,drained
Turkey,meat,baked/roasted,skin not eaten
Venison,mince,cooked,

4. Processed meat

Foods from 5 d WDR assigned to “processed meat”
Bacon bits,stewed/boiled/simmered/poached
Bacon,middle,baked/roasted,fat trimed,with no fat
Bacon,middle,grilled/dry fried,fat not trimed
Bacon,middle,pan fried/stir-fried/sauteed,fat not trimed,with no fat
Bacon,middle,pan fried/stir-fried/sauteed,fat trimed,with no fat
Bacon,separable lean,dry fried
Bacon,separable lean,grilled
Bacon,shoulder,pan fried/stir-fried/sauteed,fat trimed,with no fat
Bacon,streaky,baked/roasted,with no fat
Chicken,patty/finger/stick,crumbed,with no fat
Chicken,patty/finger/stick,crumbed,with oil - peanut,olive,canola,ricebran (monounstaturated)
Crab meat stick,imitation,surimi
Fish finger,battered,grilled/dry fried
Fish,battered fillet,deep fried,with fat nfs
Fish,battered fillet,deep fried,with oil nfs
Fish,battered,deep fried
Fish,crumbed fillet,baked/roasted
Fish,crumbed fillet,pan fried,with default ANS08 fat
Fish,fillet,crumbed,frozen,baked
Fish,fillet,crumbed,frozen,fried
Fish,finger,baked/roasted
Fish,fingers,baked
Fish,fingers,grilled
Fish,hoki,crumbed fillet,baked/roasted,lite/reduced fat
Frankfurter,regular,pan fried/stir-fried,no coating,with oil - peanut,olive,canola,ricebran (monounstaturated)
Frankfurters,precooked
Ham and pork,canned
Ham,boneless carvery,fat not trimmed
Ham,sandwich/processed slices
Ham,sliced,premium

Foods from 5 d WDR assigned to “processed meat”
Ham,sliced,sandwich
Nugget,chicken,battered,baked
Nugget,chicken,battered,fried
Nugget,chicken,crumbed,baked
Nugget,chicken,mcdonalds
Nugget,chicken,tegel,battered,baked
Pate,chicken liver
Pate,pork liver
Pie,bought,mince & cheese,1 pastry crust only (no topping)
Pie,bought,mince,1 pastry crust only (no topping)
Pie,bought,mince,potato topping only (no crusts)
Pie,bought,vegetable,top & bottom pastry crust
Pie,ham/bacon and egg
Pie,homemade,mince,top & bottom pastry crust
Pie,mince and cheese
Pie,mince,individual size,spmkt,rte
Pie,steak,individual size,spmkt,rte
Pork,bacon,rashers,lean and fat,fried
Pork,bacon,rashers,lean,fried
Salami,low fat
Sausage meat,stewed/casseroled
Sausage roll,flaky pastry (nzr)
Sausage roll,individual size,microwaved
Sausage roll,party size,baked
Sausage,beef,baked/roasted,with no fat
Sausage,beef,bbq,with no fat
Sausage,beef,dry fried
Sausage,beef,grilled
Sausage,beef,grilled/dry fried,with no fat
Sausage,chicken luncheon
Sausage,chicken,bbq,no coating
Sausage,chicken,pan fried,crumbed,with oil - other (polyunstaturated)
Sausage,deep fried
Sausage,flavoured (eg beef,chicken,garlic,pizza,italian,with herbs/spices),bbq,with no fat
Sausage,fresh,dry fried,asst meats&flvr
Sausage,fresh,grilled,asst meats & flavour
Sausage,ham and chicken luncheon
Sausage,lamb,bbq,baked/roasted,pan fried
Sausage,mixture of meats (eg mutton,beef,pork),baked/roasted,with default ANS08 fat
Sausage,mixture of meats (eg mutton,beef,pork),bbq,with default ANS08 fat
Sausage,mixture of meats (eg mutton,beef,pork),pan fried,with no fat
Sausage,mixture of meats (eg mutton,beef,pork),pan fried,with oil - peanut,olive,canola,ricebran (monounstaturated)
Sausage,pork,baked,no coating,with no fat used
Sausage,pork,dry fried
Sausage,pork,grilled
Sausage,pork,regular,stewed/boiled/simmered,with no fat
Sausage,preckd,dry fried,asst meats&flvr
Sausage,preckd,grilled,asst meats & flavour
Sausage,salami,uncooked
Sausage,saveloy,uncooked
Sausages,flavoured (eg beef,chicken,garlic,pizza,italian,mexican,with herbs/spices),/stewed/boiled/simmered,with no fat
Sausages,vegetarian (soya/tofu based),grilled/dry fried,brand name not known
Saveloy,battered,fried
Saveloy,boiled
Savoury,egg & bacon,1 crust only
Spring roll,trad,w/meat,comm,deep fried
Spring roll,vegetarian,commercial,baked

5. Eggs and beans

Foods from 5 d WDR assigned to “eggs and beans”
Baked beans,canned,in tomato sauce
Baked beans,canned,in tomato sauce,oaks
Baked beans,canned,in tomato sauce,pams
Baked beans,canned,in tomato sauce,watties
Beans,black,cooked
Beans,butter,boiled
Beans,canned two bean mix,chickpeas,split peas
Beans,green,frozen,uncooked
Beans,green,raw
Beans,haricot,raw
Beans,kidney,refried
Beans,mexican style
Beans,mixed,in brine,canned,drained
Beans,mung,dahl,cooked
Beans,red kidney,boiled
Egg,baked
Egg,chicken,boiled
Egg,fried in vegetable oil
Egg,fried,mcdonalds
Egg,omelette,plain
Egg,pan fried/stir-fried
Egg,pan fried/stir-fried,with no fat
Egg,pan fried/stir-fried,with oil - peanut,olive,canola,ricebran (monounstaturated)
Egg,poached
Egg,scrambled,plain
Egg,scrambled,plain,with butter
Egg,scrambled,plain,with no fat
Egg,scrambled,with cheese
Egg,white,cooked
Egg,whole,fried in butter
Egg,whole,fried wo fat
Egg,whole,scrambled
Egg,yolk,cooked
Falafels,with default ANS08 fat
Hummus
Hummus,original,6.5% fat,commercial
Hummus,rstd capsicum,7.5% fat,commercial
Hummus,sundried tomato,7.5% fat,comm
Lentils,red,cooked
Lentils,split,boiled,drained
Omelette,cheese
Peas,chick,cooked
Soup mix (lentils/split peas/barley)
Soup,lentil
Tahini
Tofu,fried
Tofu,pressed,marinated (extra firm),not cooked

6. Vegetables

Foods from 5 d WDR assigned to “vegetables”
Asparagus,canned,drained
Asparagus,comb.cultivars,steamed,drained
Asparagus,combined cultivars,raw
Asparagus,from fresh,baked/rosted,with no fat
Basil,fresh
Beans,green,boiled
Beans,green/runner,baked/roasted,with no fat

Foods from 5 d WDR assigned to “vegetables”
Beans,green/runner,pan fried/stir-fried/sauteed,with no fat
Beans,mung,sprouts,raw
Beetroot,canned,drained
Beetroot,flesh,boiled
Broccoli,baked/roasted,with default ANS08 fat
Broccoli,baked/roasted,with no fat
Broccoli,boiled
Broccoli,fresh,raw
Broccoli,microwaved
Broccoli,stir-fried/pan fried,with default ANS08 fat
Broccoli,stir-fried/pan fried,with no fat
Cabbage,chinese,cooked
Cabbage,green/white,steamed/microwaved,with no fat
Cabbage,red,boiled/ stewed/ simmered
Cabbage,red,stir-fried/pan fried/sauteed,with no fat
Cabbage,white,boiled,drained
Cabbage,white,inner and outer leaves,raw
Carrot,baked/roasted,with default ANS08 fat
Carrot,baked/roasted,with dripping/animal fat/lard
Carrot,baked/roasted,with no fat
Carrot,baked/roasted,with oil - peanut,olive,canola,ricebran (monounstaturated)
Carrot,boiled/stewed/poached/simmered,with default ANS08 fat
Carrot,boiled/stewed/poached/simmered,with no fat
Carrot,flesh,boiled,drained
Carrot,from fresh,boiled/stewed/poached/simmered
Carrot,grilled/dry fried
Carrot,pan fried/stir-fried/sauteed,with no fat
Carrot,raw
Carrot,steamed/microwaved,with no fat
Cauliflower,baked/roasted,with no fat
Cauliflower,boiled,drained
Cauliflower,cooked with sauce,cheese,with default ANS08 fat
Cauliflower,pan fried/stir-fried/sauteed,with default ANS08 fat
Cauliflower,pan fried/stir-fried/sauteed,with no fat
Cauliflower,raw
Celery,boiled,drained
Celery,grilled/dry fried
Celery,pan fried/stir-fried/sauteed,with default ANS08 fat
Celery,pan fried/stir-fried/sauteed,with no fat
Celery,stem,raw
Chives,raw
Coleslaw
Corn,canned-baby cobs,cooked,with no fat
Corn,from fresh,pan fried,kernels,with no fat
Corn,from frozen,baked/roasted,kernels,with no fat
Corn,from frozen,boiled/steamed,kernels,with no fat
Corn,sweet,baby,canned,drained
Corn,sweet,canned,drained
Corn,sweet,comb.cultivars,frozen,unckd
Corn,sweet,creamed
Corn,sweet,kernels on cob,boiled
Corn,sweet,kernels on cob,boiled,drained
Courgette,boiled/stewed/simmered,with no fat
Courgette,grilled/dry fried
Courgette,grilled/dry fried,with no fat
Courgette,raw
Courgette,roasted/baked,with default ANS08 fat
Courgette,roasted/baked,with no fat
Courgette,steamed/microwaved,with no fat
Courgette,stir-fried/pan fried/sauteed,with no fat used
Courgette,stir-fried/pan fried/sauteed,with oil - peanut,olive,canola,ricebran (monounstaturated)

Foods from 5 d WDR assigned to “vegetables”
Cucumber,cooked
Cucumber,flesh,raw
Eggplant,baked/roasted,with default ANS08 fat
Eggplant,pan fried/stir-fried,with default ANS08 fat
Eggplant,pan fried/stir-fried,with no fat
Garlic,cloves,raw,peeled
Garlic,dry fried
Garlic,fresh,cooked
Garlic,fresh,cooked,with no fat
Gherkin,in sweetened brine,drained
Kumara,assorted variety,flesh,boiled
Kumara,baked/roasted,with default ANS08 fat
Kumara,baked/roasted,with fat nfs
Kumara,baked/roasted,with no fat
Kumara,baked/roasted,with ns as to fat added
Kumara,baked/roasted,with oil - other (polyunstaturated)
Kumara,boiled/steamed
Kumara,boiled/steamed,with default ANS08 fat
Kumara,boiled/steamed,with no fat
Kumara,croquette,pan fried,with oil - other (polyunstaturated)
Kumara,flesh & skin,salt added,baked
Kumara,flesh,salt add,rstd in beef drip
Kumara,mashed,butter
Kumara,mashed,milk,butter
Kumara,mashed,milk,margarine
Kumara,owairaka red,fl,salt added,boiled
Kumara,owairaka red,fl&s,micw,salt add
Leek,pan fried/stir fried,with no fat
Leeks,bulb,boiled,drained
Lettuce,assorted variety,heart,fresh
Lettuce,hydroponic varieties
Mushroom,baked/roasted,with no fat
Mushroom,from fresh,steamed/ microwaved
Mushroom,grilled/dry fried bbq
Mushroom,pan fried/stir-fried/sauteed,with butter
Mushroom,pan fried/stir-fried/sauteed,with no fat
Mushroom,pan fried/stir-fried/sauteed,with oil - peanut,olive,canola,ricebran (monounstaturated)
Mushroom,steamed/microwaved,with default ANS08 fat
Mushroom,steamed/microwaved,with no fat
Mushroom,stewed/poached/boiled/simmered,with no fat
Mushrooms,flesh&stem,fried in dripping
Mushrooms,fried in butter
Mushrooms,fried in oil
Olive,green,stuffed,drained
Olives,black,plain,in oil
Olives,in brine,bottled
Onion,flesh,boiled,drained
Onion,flesh,fried in dripping
Onion,flesh,raw
Onion,mature (regular),fried
Onion,mature (regular),grilled/ dry fried
Onion,pan fried/stir-fried/sauteed,with butter
Onion,pan fried/stir-fried/sauteed,with default ANS08 fat
Onion,pan fried/stir-fried/sauteed,with no fat
Onion,pan fried/stir-fried/sauteed,with oil - other (polyunstaturated)
Onion,pan fried/stir-fried/sauteed,with oil - peanut,olive,canola,ricebran (monounstaturated)
Onion,roasted,with no fat
Onion,spring,flesh of bulb,raw
Onion,spring,fried
Onion,steamed/microwaved,with no fat
Onion,stewed/boiled/poached/simmered,with default ANS08 fat

Foods from 5 d WDR assigned to “vegetables”
Onion,stewed/boiled/poached/simmered,with no fat
Parsley,leaves,raw
Parsnip and carrot,mashed
Parsnip,baked/roasted,with no fat
Parsnip,flesh,boiled,drained
Pasta sauce,tomato based,creamy
Peas,green (plain or minted),cooked
Peas,green,boiled,drained
Peas,green,frozen,boiled
Peas,green,frozen,uncooked
Peas,green,raw
Peas,snowpea,cooked,with no fat
Pepper,capsicum,green,baked/roasted,with no fat
Pepper,capsicum,green,flesh,raw
Pepper,capsicum,green,grilled/dry fried
Pepper,capsicum,green,stir fried/pan fried,with no fat
Pepper,capsicum,red,boiled
Pepper,capsicum,red,raw
Pepper,capsicum,red/yellow/orange,baked/roasted,with no fat
Pepper,capsicum,red/yellow/orange,grilled/dry fried
Pepper,capsicum,red/yellow/orange,stir fried/pan fried,with default ANS08 fat
Pepper,capsicum,red/yellow/orange,stir fried/pan fried,with no fat
Pizza,frozen/,reg,hawaiian & supreme,bkd
Popcorn,air-popped
Popcorn,buttered,salted,commercial
Potato and gravy,kfc
Potato,assorted variety,flesh & skin,boiled
Potato,assorted variety,flesh,boiled
Potato,baked/roasted/microwaved (plain),peeled,with butter
Potato,baked/roasted/microwaved (plain),peeled,with default ANS08 fat
Potato,baked/roasted/microwaved (plain),peeled,with fat nfs
Potato,baked/roasted/microwaved (plain),peeled,with no fat
Potato,baked/roasted/microwaved (plain),with skin,with dripping/animal fat/lard
Potato,baked/roasted/microwaved (plain),with skin,with no fat
Potato,baked/roasted/microwaved (plain),with skin,with oil - peanut,olive,canola,ricebran (monounstaturated)
Potato,boiled/steamed,from fresh,peeled
Potato,in skin,microwaved
Potato,mashed,from raw potato,milk
Potato,mashed,from raw potato,milk,butter
Potato,mashed,from raw potato,milk,margarine
Potato,mashed,milk,butter & salt added
Potato,rua,baked,salt added
Potato,rua,boiled,salt added
Potato,rua,fl,rstd in beef drip,salt add
Potato,rua,flesh,microwaved,salt added
Pumpkin,baked/roasted,with fat nfs
Pumpkin,baked/roasted,with no fat
Pumpkin,baked/roasted,with oil - other (polyunstaturated)
Pumpkin,flesh & skin,roasted
Pumpkin,flesh,baked
Pumpkin,flesh,boiled,drained
Pumpkin,mashed,with no fat used
Pumpkin,pan fried/stir-fried/sauteed,with no fat
Sauce,pasta,chunky vege,tomato based
Sauce,pasta,tomato-based,comm.,heated
Sauce,simmer,butter chicken,heated
Sauce,tomato based/pasta sauce,basic ingredients
Seaweed,dried
Silverbeet,boiled for 10 minutes
Silverbeet,pan fried/stir-fried/sauteed,with no fat
Soup,cream of mushroom,canned

Foods from 5 d WDR assigned to “vegetables”
Soup,cream of tomato,canned
Soup,lentil & vege,watties,ready to serve
Soup,pumpkin,homemade
Soup,pumpkin,ready to serve,pouch,commercial
Soup,tomato,condensed,canned
Spinach,grilled/dry fried
Spinach,leaves,boiled,drained
Spinach,nz,leaves & upper stem,boil,drnd
Spinach,nz,leaves & upper stem,raw
Spinach,stewed/ boiled/ poached/ simmered
Spinach,stewed/boiled/poached/simmered,with no fat
Squash,buttercup,flesh,steamed
Swede,flesh,boiled,drained
Tomato paste,salted
Tomato puree
Tomato,baked/roasted,with no fat
Tomato,canned,not drained,basil/garlic/olive oil/parmesan
Tomato,grilled,with no fat
Tomato,raw,grilled,with default ANS08 fat
Tomato,steamed/microwaved,with no fat
Tomato,stewed/poached/boiled/simmered,with no fat
Tomatoes,assorted variety,flesh,skin and seeds,raw
Tomatoes,canned,drained
Tomatoes,fl,s&sds,fried in dripping
Tomatoes,in tomato juice,canned
Tomatoes,sun-dried
Turnip,flesh,boiled,drained
Vegetable,mixed (frozen pre-packaged),chunky vegetable mix,steamed/microwaved
Vegetable,mixed (frozen pre-packaged),green vegetables mix,boiled/simmered/poached/stewed
Vegetable,mixed (frozen pre-packaged),international mix,pan fried/sauteed/stir-fried,with oil - peanut,olive,canola,ricebran (monounstaturated)
Vegetable,mixed (frozen pre-packaged),international mix,steamed/microwaved
Vegetable,mixed (frozen pre-packaged),peas and corn,boiled/simmered/poached/stewed,with no fat
Vegetable,mixed (frozen pre-packaged),peas and corn,steamed/microwaved
Vegetable,mixed (frozen pre-packaged),peas/corn and carrot,pan fried/sauteed/stir-fried,with no fat
Vegetable,mixed (frozen pre-packaged),peas/corn and carrot,steamed/microwaved
Vegetable,mixed (homemade),steamed/microwaved,coloured mix (e.g capsicum,carrots and greens)
Vegetables,3 mixed,frozen,boiled,drained
Vegetables,3 mixed,frozen,uncooked
Vegetables,4 mixed,frozen,boiled,drained
Yam,flesh,boiled,drained
Yam,flesh,roasted,without oil,south island

7. Fruit

Foods from 5 d WDR assigned to “fruit”
Apple,assorted variety,flesh&skin,fresh
Apple,combined cultivars,fl&s,fresh
Apple,cooking,flesh,fresh
Apple,cooking,flesh,without sugar,baked
Apple,coxs orange,flesh & skin,fresh
Apple,dried
Apple,flesh,fresh
Apple,gala,flesh & skin,fresh
Apple,granny smith,flesh & skin,fresh
Apple,red delicious,flesh & skin,fresh
Apples,cooking,fl&jui,stewed without sugar
Apples,cooking,fl&jui,w/sugar,stewed
Apricot,flesh & skin,fresh
Apricots,canned in juice

Foods from 5 d WDR assigned to “fruit”
Apricots,canned in syrup,drained
Apricots,dried
Apricots,fruit & juice,stewed without sugar
Avocado,assorted variety,flesh,fresh
Banana,cooking,fresh
Banana,flesh,fresh
Banana,opine,cooking,baked
Blueberries,jersey,unsweetened,frozen
Blueberry,freeze dried
Cherries,flesh & skin,fresh
Cranberries,fresh
Currants,dried
Dates,dried,flesh and skin
Feijoas,triumph,flesh,fresh
Figs,dried,whole fruit
Fruit mincemeat
Fruit salad,canned,juice,drained
Fruit salad,canned,juice,not drained
Fruit salad,canned,light syrup,drained
Fruit salad,fresh
Fruit salad,fruit and syrup,canned
Fruit,berries (mixed),frozen
Grapes,black,flesh,fresh
Grapes,red or green,european type,raw
Grapes,white,flesh & skin,fresh
Kiwifruit zespri organic green (hayward)
Kiwifruit zespri gold (hort16a)
Kiwifruit zespri green (hayward' reference
Kiwifruit zespri green (hayward)
Kiwifruit,fl & sds,comb. cultivars,fresh
Kiwifruit,hayward,flesh and seeds,fresh
Kiwifruit,zespri,gold,fresh,raw
Lemon,juice,freshly extracted
Mandarin,fresh
Mango,dried
Mango,flesh,fresh
Melon,honeydew,flesh,fresh
Melon,rock,comb. cultivars,flesh,fresh
Mixed fruit,dried
Nectarine,flesh and skin,fresh
Nectarine,flesh,fresh
Orange,flesh,fresh
Passion fruit,flesh and seeds,fresh
Peach,flesh,fresh
Peaches,canned in juice
Peaches,canned in light syrup
Peaches,canned in pear juice,drained
Peaches,canned,syrup drained
Peaches,canned,syrup not drained
Peaches,flesh and skin,fresh
Peaches,in pear juice,canned
Pear,assorted variety,flesh&skin,fresh
Pear,cooking,flesh,fresh
Pear,flesh,fresh
Pear,nashi,flesh,fresh
Pear,packhams triumph,flesh&skin,fresh
Pears,canned in light syrup
Pears,canned in pear juice
Pears,canned in pear juice,drained
Pears,canned,w/syrup
Pears,comb.cultivars,canned,w/syrup

Foods from 5 d WDR assigned to “fruit”
Pears,combined cultivars,fl&s,fresh
Pears,cooking,fl&jui,without sugar,stewed
Pineapple,canned in light syrup
Pineapple,canned,w/syrup
Pineapple,canned,without syrup
Pineapple,cnd in pineapple juice,drained
Pineapple,dried
Pineapple,flesh,cnd in pineapple juice
Pineapple,flesh,fresh
Plum,black doris,flesh & skin,fresh
Plum,coes golden drop,flesh&skin,fresh
Plum,combined cultivars,fl&s,fresh
Plum,omega,flesh and skin,fresh
Plums,cooking,stewed with sugar
Prunes,dried,flesh and skin
Prunes,dried,stewed without sugar
Raisins,seedless
Raisins,yoghurt coated
Raspberries,fresh
Raspberries,marcy,frozen,unsweetened
Raspberries,without sugar,stewed
Strawberries,fresh,nz
Sultanas
Tangelo,flesh,fresh
Watermelon,flesh,fresh

8. Milk and Milk Products

Foods from 5 d WDR assigned to “milk and milk products”
Cheese spread,full,philadelphia
Cheese,blue vein
Cheese,camembert
Cheese,cheddar,mild
Cheese,cheddar,mild,valumetric
Cheese,cheddar,tasty
Cheese,cheddar,tasty,anchor
Cheese,cheddar,tasty,mainland
Cheese,cheddar(mild,tasty,vintage),colby edam regular (for recipe analysis)
Cheese,colby
Cheese,colby,alpine,rolling meadow
Cheese,colby,mainland
Cheese,colby,valumetric
Cheese,cottage
Cheese,cream
Cheese,cream,reduced fat (16%)
Cheese,edam
Cheese,edam,alpine,rolling meadow
Cheese,edam,anchor
Cheese,edam,mainland
Cheese,edam,valumetric
Cheese,egmont
Cheese,feta
Cheese,mozzarella
Cheese,parmesan,powder
Cheese,parmesan,ungrated
Cheese,processed
Cheese,processed,colby-based
Cheese,processed,edam-based
Cheese,processed,sliced,reduced fat
Cheese,ricotta

Foods from 5 d WDR assigned to “milk and milk products”
Cheese,spread
Cheese,swiss
Coconut milk,raw
Cottage cheese,light,1% fat
Cream,double,brie
Cream,sour,cultured
Cream,sour,light
Cream,sour,reduced fat
Custard,(sauce),from custard powder
Custard,(sauce),from custard powder,banana
Custard,(sauce),from custard powder,plus egg
Dairy food,blues clues,flavored
Dairy food,calciyum,chocolate
Dairy food,calciyum,flavored
Dessert,dairy food,assorted flavours
Dessert,dairy food,chocolate flavour
Fruit corner,yoghurt & berry fruit
Fruit corner,yoghurt & stone fruit
Milk standard-blue fluid,2.5-3.5% fat (for recipe analysis) composite
Milk,anchor calci xtra
Milk,anchor,light blue
Milk,anchor,super blue
Milk,anchor,super trim
Milk,anchor,trim
Milk,calci kid,enriched,tararua
Milk,cows milk - ready to drink,whole milk (farmhouse,4% fat),not enriched
Milk,cows milk- fluid made from powder,standard/whole milk powder
Milk,evaporated,whole
Milk,flavored,calciyum wicked chocolate milk
Milk,fluid,skim
Milk,fluid,whole
Milk,high calcium,0.1% fat,composite
Milk,lite,1.5% fat,akl,may,anchor
Milk,lite,1.5% fat,akl,nov,anchor
Milk,lite,1.5% fat,composite
Milk,powder,instant,non-fat
Milk,soy milk- vitasoy light original
Milk,super,xtra,ultra trim,0.3% fat,composite
Milk,trim,0.5% fat,akl,may,anchor
Milk,trim,0.5% fat,akl,nov,anchor
Milk,trim,0.5% fat,composite
Milk,uht,standardised
Milk,uht,whole,evaporated
Milk,whole,3.3% fat,composite
Pasta sauce,cheese based
Pudding,custard egg
Pudding,custard,plain
Rice milk,assorted,composite
Sauce,cheese
Sauce,cheese,basic ingredients
Sauce,cheese,made from dry mix
Sauce,white,basic ingredients
Sauce,white,savoury
Smoothie,berry fruit,fortified
Smoothie,ready-to-drink,fruit and yoghurt
Soy drink so good,vanilla,sanitarium
Soy drink,calci plus,vitasoy
Soy drink,calci-plus high fibre,vitasoy,fortified
Soy drink,creamy original,vitasoy
Soy drink,lush chocolate,vitasoy,fortified
Soy drink,so good

Foods from 5 d WDR assigned to “milk and milk products”
Soy drink,so good essential,sanitarium
Soy drink,so good lite
Soy milk fluid (for recipe analysis) composite
Yoghurt,asst fruits & flavour,red fat,swt
Yoghurt,asst fruits & flavours,sweetened
Yoghurt,asst fruits,low fat,sweetened
Yoghurt,berry,low fat,art sweetened
Yoghurt,cyclops
Yoghurt,dewinkel,greek
Yoghurt,fresh and fruit dessert
Yoghurt,fresh and fruity,lite
Yoghurt,fresh and fruity,natural
Yoghurt,fresh and fruity,regular
Yoghurt,fresh and fruity,vanilla
Yoghurt,greek style
Yoghurt,greek style,freshnfruity
Yoghurt,greek style,yoplait
Yoghurt,greek,dewinkel
Yoghurt,meadowfresh,lite
Yoghurt,plain,low fat,unsweetened
Yoghurt,plain,reduced fat,sweetened
Yoghurt,plain,unsweetened
Yoghurt,puhoi valley
Yoghurt,soy
Yoghurt,strawberry,low fat
Yoghurt,symbio,flavored
Yoghurt,yoplait lite asst frt,low f,swt

9. Breastmilk

Foods from 5 d WDR assigned to “breastmilk”
Milk,human,mature

10. Toddler milk and infant formula

Foods from 5 d WDR assigned to “toddler milk and infant formula”
Infant formula, Heinz Nurture Follow-on stage 2
Infant formula, Karicare De-Lact
Infant formula, Karicare Gold + stage 2
Infant formula, Karicare immunocare
Infant formula, Neocate LCP
Infant formula, S-26 Gold Progress stage 2
Infant formula, S-26 Original Progress stage 2
Infant formula,follow-on,prepared
Infant formula,modified,prepared
Infant formula,soy,prepared
Infant milk, Heinz Nurture Gold Toddler stage 3
Infant milk, Karicare Gold Toddler stage 3
Infant milk, S-26 Gold Toddler stage 3
Infant milk, toddler milk composite (incl.Nutracare toddler formula)
Infant milk, Watties Toddler milk (Nuture Toddler Milk Drink 3)
Toddler formula prepared

11. Spreads

Foods from 5 d WDR assigned to "spreads"
Butter (regular,salted- for recipe analysis)
Butter,salted
Butter,spreadable,fernleaf-semisoft
Butter,unsalted,mainland
Dairy blend,butter canola
Margarine
Margarine spread pro-activ,ul flora,fort a&d
Margarine spread,mono canola,70% fat
Margarine spread,proactiv,flora,fortified a&d
Margarine,meadowlea original
Margarine,mono canola,50% fat,summer gold lite
Margarine,mono canola,70% fat,summer gold
Margarine,mono canola,light,50% fat
Margarine,mono olive bld,75% fat,olivani
Margarine,mono,55% fat,olivani lite
Margarine,mono,55% fat,olivio bertolli light
Margarine,mono,70% fat,olivio bertolli classico
Margarine,poly,50% fat,flora light
Margarine,poly,60% fat,sunrise
Margarine,poly,65% fat,flora original
Margarine,poly,70% fat
Margarine,poly,70% fat,reduced salt
Margarine,reduced fat
Table spread,canola

12. Cakes, biscuits, puddings, confectionary, sweet snacks, sweet cereals

Foods from 5 d WDR assigned to "cakes, biscuits, puddings, confectionary, sweet snacks, sweet cereals"
All bran,wheat flakes,honey almond,kelloggs
Banana cake,nz recipe (nzr)
Berry berry nice,hubbards
Biscotti,chocolate
Biscuit,afghan (chocolate coated)
Biscuit,anzac,home-made (butter)
Biscuit,basic,nz recipe
Biscuit,bran,commercial fat
Biscuit,chocolate base,digestive/wheat
Biscuit,chocolate base,thins
Biscuit,chocolate chip,homemade (butter)
Biscuit,chocolate coated
Biscuit,chocolate coated,mallowpuff
Biscuit,chocolate coated,toffee pop
Biscuit,chocolate cream
Biscuit,cookie,chocolate chip
Biscuit,flat fruit
Biscuit,flavoured biscuit & cream/creme filling,no topping
Biscuit,fruit finger
Biscuit,fruit,digestive
Biscuit,gingernut
Biscuit,gingernut,homemade (butter)
Biscuit,gluten/wheat free,chocolate chip,no topping
Biscuit,gluten/wheat free,plain,no topping
Biscuit,iced,hundred&thousands
Biscuit,krispie
Biscuit,layered,cream,chocolate coated
Biscuit,malt
Biscuit,multi-layer crm filled choc coat
Biscuit,oatcake

Foods from 5 d WDR assigned to “cakes, biscuits, puddings, confectionary, sweet snacks, sweet cereals”
Biscuit,oaty fruit,low fat
Biscuit,plain,cream
Biscuit,plain,digestive
Biscuit,semi-sweet
Biscuit,shortbread,homemade
Biscuit,shortbread,retail
Biscuit,shrewsbury
Biscuit,wafer,raspberry,cream filled
Biscuit,wafers,chocolate & vanilla
Biscuits,arrowroot
Bread,sweet bun/roll,chelsea bun,icing,no filling
Bun,bath/chelsea (nzr)
Bun,iced
Bun,spiced
Cake, almond cake
Cake,apple cake
Cake,banana,not iced
Cake,carrot,no icing
Cake,carrot,regular icing
Cake,cheesecake
Cake,chocolate,butter icing
Cake,chocolate,rich,no icing/topping,no filling
Cake,chocolate,standard
Cake,chocolate,standard,icing and chocolate chips
Cake,chocolate,standard,icing,no filling
Cake,chocolate,uniced
Cake,cupcake,chocolate,iced topping
Cake,cupcake,plain,iced topping
Cake,cupcake,plain,no icing
Cake,fancy,iced
Cake,fruitcake,plain,retail
Cake,fruitcake,rich,with icing
Cake,gateaux/layered,chocolate,berry fruit filling,cream topping
Cake,gateaux/layered,chocolate,cream filling,cream topping
Cake,gingerbread
Cake,madeira
Cake,plain buttercake
Cake,rock cake
Cake,sponge,1 layer,no topping
Cake,sponge,2 layers,cream (& jam) filling
Cake,sponge,2 layers,icing topping,cream (& jam) filling
Cake,sponge,high fat
Cake,sponge,plain
Cake,sponge,victoria,butter iced
Cake,sultana,not iced
Candy coated chocolate
Caramel,chocolate coated,bar
Cereal soft bar,frt filled,twisted,flvr
Cereal soft bar,mother earth,whmeal,frt
Cereal soft bar,muesli,frt filled,flvr
Cereal soft bar,uncle tobys,whmeal,frt
Cereal soft bar,wholemeal,frt,asstd flavour
Cereal,muesli,untoasted/natural,pre-sweetened,homemade,with dried fruit and niuts
Cheerios,nestle
Chelsea bun
Chocolate bar,milk
Chocolate bar,plain
Chocolate,cadbury dairy milk
Chocolate,cadbury energy
Chocolate,cadbury fruit & nut
Chocolate,cadburys,peppermint

Foods from 5 d WDR assigned to “cakes, biscuits, puddings, confectionary, sweet snacks, sweet cereals”

Chocolate,cadury,moro,bar
Chocolate,chips/morsels,white and dark
Chocolate,dark
Chocolate,egg,hollow-dark/milk choc
Chocolate,egg,marshmallow
Chocolate,nestle,smartie
Chocolate,plain/solid,milk/white mix
Chocolate,white
Coco pops crunchieschoc chip,kelloggs
Coco pops,kelloggs
Cocoapuffs,homebrand
Coconut ice
Cone,wafer,mcdonalds
Cook island coconut buns
Cookie,peanut brownie
Cream,whipping,light,uht
Cream,whipping,uht
Creamed rice
Croissant
Crunchie bar,cadbury
Crunchy nut corn flakes,kelloggs
Doughnut,ring
Dumplings,boiled
Eclairs w/choc. icing & cream filling
French toast
Fruit bar,strawberry
Fruit bar,wholemeal,assorted flavours
Fruit gums
Fruit leather,apricot
Fruity bix,apricot,sanitarium
Fudge,chocolate
Hard candy chupa chups,asstd flavours
Honey bumbles,hubbards
Ice cream,creamy,fruit ripple
Ice cream,fruit ripple
Ice cream,hokey pokey
Ice cream,in a cone,cream freeze/soft serve,other extras (chocolate)
Ice cream,in a cone,rich,choc bits
Ice cream,maple walnut,premium
Ice cream,paddle pop,assorted flavours
Ice cream,paddle pop,chocolate flavour
Ice cream,rich,cookies and chocolate pieces
Ice cream,standard,chocolate chips
Ice cream,stick/bar,rocky road
Ice cream,vanilla,economy
Ice cream,vanilla,low fat
Ice cream,vanilla,standard
Iceblock,lemonade quencher
Icing,regular icing
Jelly,made up,regular,plain
Jelly,made up,regular,with fruit
Jelly,made with water (nzr)
Jelly,made with whole milk (nzr)
Jellybeans,jaybees,pascall
Lamington,raspberry
Lemon curd
Liquorice
Loaf,with fruit (sweet)
Lollies,hard (boiled/sugary)
Lollies,jelly/gum,plain
Lolly cake

Foods from 5 d WDR assigned to “cakes, biscuits, puddings, confectionary, sweet snacks, sweet cereals”
M&ms,crispy
Marshmallows,pink and white
Meringue
Meringue,regular,plain
Milk,sweetened,condensed,whole
Muesli bar
Muesli bar,apricot
Muesli bar,blueberry & apple
Muesli bar,chocolate chip
Muesli bar,chocolate coated,snacker
Muesli bar,chocolate coated,wrapps
Muesli bar,magic muesli,asst flavours
Muesli bar,mixed fruit
Muesli bar,yoghurt coated,assorted
Muesli,natural fruit & five grains,sanitarium
Muesli,natural,sanitarium
Muesli,toasted,sweetened
Muffin,apple
Muffin,banana
Muffin,banana and chocolate chip
Muffin,berry
Muffin,berry,jam filling
Muffin,blueberry
Muffin,bran
Muffin,bran,with fruit/vege,low fat
Muffin,bran,with fruit/vege,regular
Muffin,chocolate
Muffin,chocolate
Muffin,chocolate,chocolate chip topping
Muffin,lemon
Muffin,savoury,cheese
Muffin,savoury,cheese & bacon/ham
Muffin,savoury,cheese & vegetables
Muffin,sweet,plain
Nut bar ANS08 recipe 6 cereal & nut bar no chocolate nature valley crunchy bars
Nutri-grain,kelloggs
Oat temptations,app/s/h,uncle tobys
Pancake,dessert
Pancake,plain
Pancakes,plain,with butter
Pancakes,plain,with butter/margarine blend
Pascall party pack
Pastries,pain au chocolat (filled pastry),chocolate
Pastry,choux,cooked
Pastry,danish,
Pastry,fillo
Pastry,flaky,cooked
Pastry,puff,cooked
Pavlova
Pavlova,unfilled,homemade
Pie,fruit,two crust
Pinky bar,cadbury
Popcorn,candied
Pudding,crumble,berry
Pudding,instant
Pudding,rice
Pudding,rice,homemade
Pudding,self-saucing,chocolate
Pudding,yorkshire
Rice bar,rice bubbles treats
Rocky road,slice

Foods from 5 d WDR assigned to “cakes, biscuits, puddings, confectionary, sweet snacks, sweet cereals”
Rusks,teething rusks,Heinz
Scone,cheese
Scone,plain
Scones,white,pinwheel (w/brown sugar)
Scones,white,plain
Scones,white,with cheese
Scones,white,with dried fruit (dates)
Shortbread,homemade
Slice,apricot slice
Slice,brownie,with nuts
Slice,brownie,without nuts
Sultana bran,kelloggs
Tart,fruit mince,one crust
Tart,jam
Tart,lemon curd
Topping,real fruit-based,sweetened,sugar
Very fruitful flakes,hubbards
Waffles,plain

13. Sweet drinks

Foods from 5 d WDR assigned to “sweet drinks”
Cordial concentrate,syrup,lime
Cordial,blackcurrant syrup,barkers
Drink flavour,assorted,powder,raro
Drink flavour,raspberry,powder
Drink,blackcurrant,concentrate,ribena
Ice block
Ribena,bought ready-to-drink,blackcurrant
Soft drink,lemonade
Soft drink,orange flavour

14. Hot chips, roast potato and kumara

Foods from 5 d WDR assigned to “hot chips, roast potato and kumara”
Potato,baked/roasted/microwaved (plain),peeled,with oil - other (polyunstaturated)
Potato,baked/roasted/microwaved (plain),peeled,with oil - peanut,olive,canola,ricebran (monounstaturated)
Potato,fried(not chips),peeled,with butter
Potato,fried(not chips),peeled,with default ANS08 fat
Potato,fries,independant shop all (2009)
Potato,fries,independant shops,straight cut (2009)
Potato,fries,kfc(2009)
Potato,fries,mcdonalds(2009)
Potato,frozen/ fries,chunky,canola oil,bkd
Potato,frozen/ fries,chunky,polyunsat,bkd
Potato,frozen/ fries,crinkle,beef fat,bkd
Potato,frozen/ fries,crinkle,polyunsat,bkd
Potato,frozen/ fries,shoest,polyunsat,bkd
Potato,frozen/ fries,straight,canola,bkd
Potato,frozen/ fries,straight,polyunsat,bkd
Potato,frozen/ wedges,canola oil,baked
Potato,frozen/ wedges,coated,beef fat,bkd
Potato,hash brown,homecooked,baked/roasted,with no fat
Potato,hashbrown,mcdonalds
Potato,hot chips (homecooked),straight (thick),from fresh,baked,with oil - peanut,olive,canola,ricebran (monounstaturated)

15. Savoury snacks

Foods from 5 d WDR assigned to “savoury snacks”
Banana,chips,deep fried
Biscuit,plain,water
Bread sticks,cheesy,toddler,Heinz
Cheese spread&crispbread,asst flavour,u.tby
Corn chips,cheese flavour
Corn snacks,cheese flavour
Cracker,assorted flavours
Cracker,cheese
Cracker,cream
Cracker,crispbread,asstd flavour,arnotts
Cracker,crispbread,puffed & toasted
Cracker,crispbread,rye
Cracker,high fat
Cracker,meal mates,griffins
Cracker,rice,bbq flavours,baked
Cracker,rice/prawn
Cracker,ryvita,assorted flavours
Cracker,salada,arnotts
Cracker,sesame
Cracker,snax,griffins
Cracker,supreme
Cracker,water,arnotts
Cracker,wholemeal and sesame
Cracker,wholemeal,medium fat
Crackers,cream,reduced fat,huntley & palmers
Cream,standard
Crispbread,corn,original,arnotts
Cruskits,lite,arnotts
Noodles,chickpea,fried (bombay mix)
Noodles,inst,oriental flavour,prep w/water
Noodles,instant (2 minute),regular,boiled,drained
Noodles,instant (2 minute),regular,boiled,not drained
Noodles,instant,beef flavour
Noodles,instant,chicken flavour
Potato chips,krispa
Potato crisps,chicken
Potato crisps,flavoured
Potato crisps,kettle,salted
Potato crisps,lites
Potato crisps,low salt,flavoured
Potato crisps,natural,eta
Potato crisps,plain
Potato crisps,salt and vinegar
Potato crisps,salt&vinegar,pringles
Potato crisps,slims,eta
Potato straws,salt and vinegar
Pretzels
Pretzels,
Rice cracker,plain,composite
Rice cracker,seaweed,fantastic
Rice cracker,seaweed,pams
Rice cracker,seaweed,sakata
Snacks,sweet potato chips
Soy chips,crisps,salted

16. Nutritive drinks

Foods from 5 d WDR assigned to “nutritive drinks”
Chocolate,drinking,powder
Juice concentrate,app&orange,fresh up
Juice concentrate,apple,unsw,fresh up
Juice concentrate,apple&mango,fresh up
Juice drink,orange,golden circle
Juice,apple & blkcur,golden circle
Juice,apple and mango,unsw,fresh up
Juice,apple and orange,unsw,fresh up
Juice,apple,old fashd,unsw,fresh up
Juice,apple,unsweetened,fresh up
Juice,apple&blackcurrant,fresh up
Juice,apple&mango,golden circle
Juice,crisp apple,fresh up
Juice,orange & apple,unsw,just juice
Juice,orange & mango,just juice
Juice,orange,golden circle
Juice,orange,mccoy
Juice,orange,unsw,citrus tree
Juice,orange,unsweetened
Juice,pineapple
Juice,pineapple,golden circle
Juice,tropical with apple base
Just juice bubbles tropical
Milk shake,chocolate flavour,mcdonalds
Milk shake,no flavouring,mcdonalds
Milkshake,ready-to-drink,with milkshake powder
Milo,powder,fortified
Milo,powder,old record
Nesquik,powder
Orange,juice,freshly extracted

30. Foods consumed in 5-d WDRs but not assigned to any of the 16 food groups

Foods from 5 d WDR not assigned to the 16 food groups
Aioli
Allspice,ground
Almonds,dried,blanched
Almonds,raw
Baking powder
Basil,ground
Bay leaf,crumbled
Cashew nuts,raw
Chilli powder
Chocolate hail
Chutney,apple
Chutney,roasted vegetable
Chutney,tomato
Cinnamon,ground
Cocoa,powder
Coconut cream,canned
Coconut,desiccated
Coriander seed
Cumin seed
Curry paste eg rogan josh,butter chicken paste
Curry powder
Dip,reduced cream/soup mix
Dressing,mayonnaise,commercial
Dressing,mayonnaise,reduced fat,comm.

Foods from 5 d WDR not assigned to the 16 food groups
Dressing,potato salad,eta
Flour,cornflour
Flour,plain
Flour,rice,raw
Flour,wheat,white,high grade
Flour,wheat,white,high grade,lower north island
Flour,wheat,white,standard
Flour,wheat,white,standard,lower north island
Flour,wheat,white,standard,south island
Flour,wheat,wholemeal
Flour,wheat,wholemeal,south island
Garlic,fresh,cooked,with default ANS08 fat
Ginger root,raw
Ginger,raw,peeled
Gravy,homemade,fat not skimmed
Gravy,homemade,fat skimmed
Gravy,kfc
Honey
Icing,butter based (all flavours)
Jam,berry frt,asst berries,premium
Jam,berry fruit
Jam,regular (sugar sweetened)
Jam,stone frt,asst frt,premium
Jam,stone fruit
Macadamia nuts,unroasted
Marmite
Mayonnaise
Mayonnaise (nzr)
Mustard powder
Mustard seed,yellow
Mustard,creamed,commercial
Mustard,dijonnaise
Nutella
Oil,avocado
Oil,canola
Oil,composite
Oil,composite monounsaturated (for recipe analysis)
Oil,palm
Oil,rice bran
Oil,sesame
Oil,vegetable,blend,frying
Oil,vegetable,blend,salad & cooking
Olive oil
Oregano,ground
Oxo cubes
Paprika
Parsley,dried
Peanut butter,smth & crh,no sug salt add
Peanut butter,smth & crh,sug add,no salt
Peanut butter,smth&crh,salt add,no sugar
Peanut butter,smth&crh,sugar&salt added
Peanuts,raw
Pepper,black
Pepper,white
Pesto, pesto-style dip (eg lisas chunky)
Pesto,basil,garlic,nuts,retail
Pickle,sweet
Pine nuts,raw
Pumpkin seeds,roasted,salted
Relish,tomato
Rosemary,dried

Foods from 5 d WDR not assigned to the 16 food groups
Salt,iodised,table
Salt,table
Sauce,barbecue
Sauce,brown
Sauce,chilli
Sauce,curry
Sauce,honey and soy
Sauce,indian style,jar/can,low fat(<5%)
Sauce,oyster
Sauce,savoury/asian,basic ingredients,other
Sauce,savoury/asian,squeezy pack,honey soy based
Sauce,simmer,savoury,heated
Sauce,soy
Sauce,stir-fry,jar/bottle/can,thai curry
Sauce,sweet chilli
Sauce,tomato
Sauce,worcestershire
Seeds,flaxseed,usa
Seeds,sunflower,dry roasted,unsalted
Sesame seeds,roasted
Soup,chicken,dried
Soup,creme of chicken,dried
Soup,creme of vegetable,dried
Soup,mushroom,dried
Soup,mushroom,dried,prepared w/water
Soup,tomato,dried
Soup,vegetable,dried,prepared w/water
Stock,chicken/other poultry,liquid
Stock,meat
Stock,vegetable,liquid
Sugar,brown
Sugar,icing
Sugar,raw
Sugar,white
Sunflower seeds,kernel,dried
Syrup,golden
Syrup,maple
Tea,black,infused,weak
Tea,herbal,ready to drink
Thai red curry paste
Thyme,ground
Vegemite,kraft
Vinegar
Vinegar,cider
Walnuts,raw
Water,mineral still (bottled),sweetened/flavoured
Water,municipal
Wheat germ
Wheat germ,north island
Wheat,kibbled,south island
Wine,red,dry
Wine,red,medium
Wine,white,dry
Wine,white,medium
Yeast,bakers,compressed
Yeast,bakers,dried