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Review Article
Methodological Considerations for the Design of Food Frequency Questionnaires for Toddlers

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Abstract

The study was designed to provide literature overview on methodology to develop a Food frequency questionnaire (FFQ) for toddlers. Articles were retrieved from 1997 to March, 2016 with predetermined inclusion and exclusion criteria. In this study, 24 modified and 13 newly developed FFQs were included. Developing an FFQ for toddler was often performed by modifying elements of adult FFQ such as food lists, portion size and frequency of consumption. Food records/recall were commonly reported for reliability check, but none was reported for validity assessment. It is important to understand the new FFQ's specific objective with respect to toddler's dietary data collection.

Key words: Methodology, food frequency questionnaire, food and beverage list, toddlers, dietary data collection, dietary assessment tools, eating habits, balanced diet

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Food frequency questionnaires (FFQ) are dietary assessment tools which are designed to retrospectively assess habitual dietary intake over a specific reference period[1]. It has increasingly been used for dietary assessment in epidemiological research due to its practical advantages, such as relative low cost and respondent burden, along with a relative ease of administration and data analyses[2]. It can also be used to assess dietary intake by having a semi-quantitative FFQ (SQFFQ).

Toddlerhood, defined as children aged 12-36 months, is an important period of life when growth is rapid and organ, motor and cognitive abilities are still under development. Energy and nutrient requirements of these children are relatively higher to their body size. In addition, nutritional deficiencies at this age might have long-lasting effects on health[3,4]. Eating habits are also being developed during this stage and it may be a challenging task to maintain a balanced diet for toddlers while transitioning from an infant diet to family food[5]. Insights into dietary patterns and food intake during toddlerhood may be used for the development of healthy eating habits. A robust dietary assessment tools such as an FFQ could be used to provide these insights.

There is limited information on the methodological considerations for designing an FFQ especially for toddlers. Thus, it is aimed, through a literature review, to provide an evidence-based review of the principal elements and steps required to develop an FFQ for this particular age group.

MATERIALS AND METHODS

Electronic scientific databases PubMed, High Wire, Science Direct, Google Scholar, Pro Quest and Cambridge Journals were searched from 1997 to March, 2016 using the following key words: "Food frequency questionnaire", "development", "developing", "toddler", "children", "pre-school children", "dietary assessment", "nutritional status", "validation", "validity", "food intake", "portion size estimation" and "food portion". Titles and abstracts of publications in English only were scanned to assess relevance (Fig. 1).

Exclusion criteria were, no information on methods to develop an FFQ, study population was beyond toddlerhood (older than 3 years of age) and non-English publications.

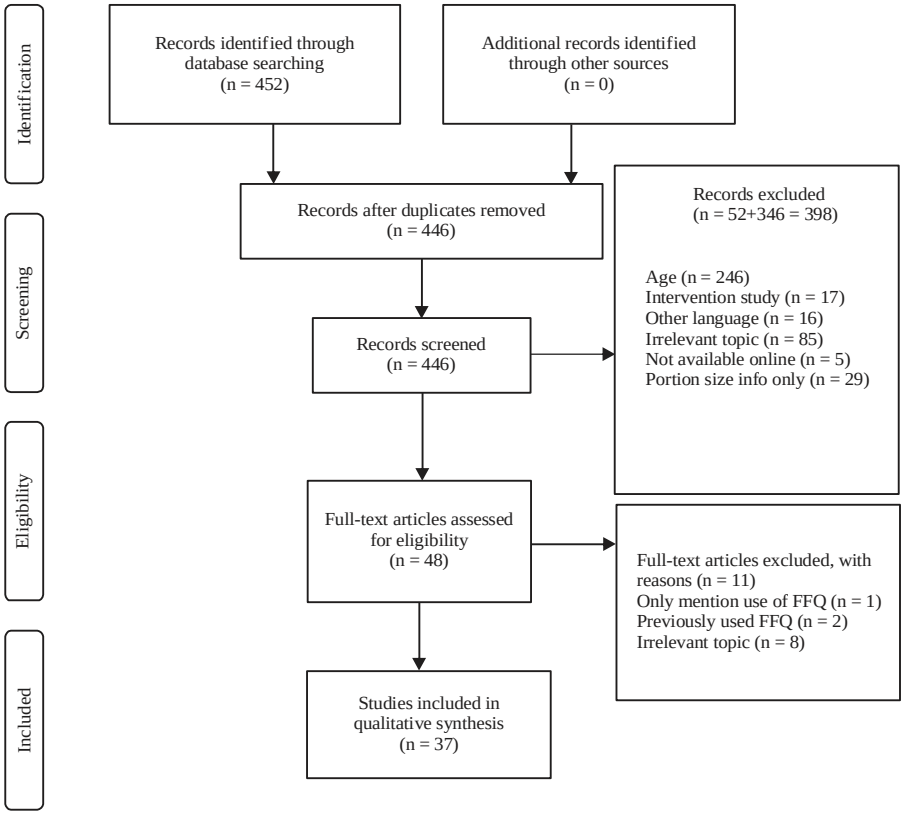

Fig. 1: Flowchart of the review methodology

Further searches of the reference lists of the included articles were conducted to retrieve relevant articles that were not captured in the earlier search.

RESULTS

A total of 452 articles were identified through database search. After exclusion of articles according to the exclusion criteria, 34 studies were included in this review which consists of 24 studies describing modified FFQs and 10 for newly developed ones.

The stages of developing an FFQ were identified as: conducting assessment based on study's objective, constructing its elements which include food and beverage list, frequency of consumption categories, portion size estimation and cultural considerations, testing for its validity and reliability.

Modified FFQ: Only one of the 24 included studies, which stated modification of an FFQ, fulfilled all elements of the development stages to construct this dietary assessment (Table 1). The objective of the modified FFQs varied from assessing dietary patterns to investigating the accuracy of other questionnaires. Most of the modifications were made from an adult-version by adapting the food lists and portion size.

There were several methods reported to adapt the food list. These included updating the list from previous dietary studies or surveys, shortening the questionnaires, inclusion of commonly-consumed food for this age group based on other data sources, or inquiry about specific-nutrient nutrient-rich food such as fluoride in accordance to the objective of the study.

For adjusting the frequency of consumption, only 7 studies reported the methodology which includes previously conducted dietary surveys and assessment studies. The adaptations for the food list were reported based on original FFQ, previous dietary surveys and questionnaires or appropriateness within the reference time period for the FFQ i.e. frequency of intake of a particular food in a day or a week or a month. Food photographs and food models were the most commonly reported methods to develop portion size. Other reported methods for portion size were modification from food pyramids, household utensils or making an average serving size from established guidelines.

Multiple-days food recalls and food records were the most reported techniques to validate the modified FFQs. Other methods included weighing food records, 2-days food diaries and blood markers. The latter included erythrocyte membrane composition, hemoglobin and serum ferritin to validate iron intake. Only 7 studies reported repeatability checks at an interval between 10-15 days.

Newly developed FFQ: Only one out of 13 studies fulfilled all elements to construct the FFQ (Table 2). Four studies did not report the methods to develop the food list. The most common reported dietary assessment methods to develop the FFQ food list were 24 h food recall and food diaries. None of the retrieved studies reported methods to develop frequency of consumptions.

There were no consistent methods reported in developing portion size. Consumer research, the use of household utensils, food photographs, digital scales and general knowledge were reported.

There were no consistent dietary assessment methods reported in validity assessment which were performed in, 9 out of 13 studies. Multiple-day recalls or records and serum retinol were reported as methods to assess validity of the questionnaires. Only 3 studies reported repeatability assessments conducted within 1-2 weeks interval.

DISCUSSION

From undertaking this review, the process of constructing an FFQ are: an assessment stage of characteristics of population and time interval, followed by selecting and developing the elements such as food lists, frequency of consumption and portion sizes is similar with the one suggested by an earlier review[6].

Modifying an FFQ from an existing questionnaire based on the objectives of the new study could save time and resources. Many studies have adopted adult FFQs for a younger population by modifying the food lists, reducing the portion sizes and frequency of intake[6]. These adaptations undertaken without validity checking could change the accuracy of the dietary assessment tools and could lead to over or under estimation of nutrient intake.

The food and beverage list is the backbone of the FFQ and directly influenced the quality of FFQ outcome measures. It is essential that the list consisted items that are truly representative of the toddler's dietary pattern in a given population. The number of food varied from 30-130 items in the food lists. Although "24 h food recall" was the most commonly used method to build the food list, there were several ways of building food lists reported in this review which could create further concern as these methods might not be validated. Focus groups and interviews could also be considered, because directly speaking to parents or primary

Table 1: Overview of studies with modified FFQ

Authors	Study details (sample size, year of study, country of study)	Original FFQ	Objective of the new FFQ	Modification of the FFQ	Methods to develop food lists	Methods to develop frequency of consumption	Methods to develop portion size	Methods to validate new FFQ	Repeatability check
Mills *et al.*[16]	n = 160, 1-2 years Kiwi toddlers	EAT FFQ was adapted from FFQ for Southampton Women's Survey	To evaluate the relative validity and reproducibility of dietary patterns from an FFQ developed for toddlers aged 12-24 months	Food list was updated using results from other studies	Adapted from original FFQ	Watson *et al.*[18] was used to determine portion size of kiwi food list	Watson *et al.*[18] was used to determine frequency	5 days weighted food record	Yes 5 weeks apart
Voortman *et al.*[19]	n = 3629, The Netherlands	SQFFQ[20]	To develop and evaluate a diet score that measures overall diet quality in preschool children and to examine the sociodemographic and lifestyle determinants of this score	Food list was updated using Dutch national food consumption survey	Adapted from original FFQ[20]	Adopted from the survey and converted into grams per day	Converted into grams per day from Dutch National Food Consumption Survey	Three 24 h recalls with n = 32	No
Jarman *et al.*[8]	n = 892, 3 years old British toddlers	FFQ for Southampton Women's Survey	To evaluate the use of an administered eighty-item FFQ to assess nutrient intake and diet quality in 3-years-old children	Food list, portion size, frequency options were updates	Dietary intake data collected from original FFQ	Review of dietary intake data collected from a nationally representative sample	Food photographs and household utensils	2 days weighed food diary	No
Klohe *et al.*[10]	n = 77, 1-3 years old Hispanic, African-American, White children	Adult version that has been previously validated in a sample of Hispanic, African-American and white low-income mothers from the same area	To develop and validate the FFQ for children 1-3 years of age	Age-appropriate food items and portion sizes that were applicable to 1- to 3-years-old children	Adapted from health habits and history questionnaire	Health habit and history questionnaire	Thrams and Pipes and food pyramid	24 h food recalls and 2 day diaries. Reliability were significant for all nine food categories	No
Flood *et al.*[17]	n = 77, 2-5 years old Australian children	Based upon New South Wales Government's Population Health Survey	To determine the reliability and validity of a short FFQ to assess the dietary habits of young children aged 2-5 years	FFQ was shortened to 17 items. Questions were associated with food and beverage items that are associated with health, designed to assess usual intake	NSW Government's Population Health Survey	No change from original FFQ	No change from original FFQ	3 days food record	Yes 2 weeks apart

Table 1: Continued

Authors	Study details (sample size, year of study, country of study)	Original FFQ	Objective of the new FFQ	Modification of the FFQ	Methods to develop food lists	Methods to develop frequency of consumption	Methods to develop portion size	Methods to validate new FFQ	Repeatability check
D'Ambrosio *et al.*[21]	n = 22, toddles from Low-German speaking Mennonites	Based upon childrens nutrition questionnaire (CNQ) of Harvard School of Public Health	To develop, validate and test the reliability of a culturally sensitive, SQFFQ for for assessing mean dietary intakes in toddlers. A secondary objective was to evaluate nutrient intakes	Focus group to determine commonly consumed cultural foods	Focus group	Food records/recall were commonly reported for reliability check. Validity assessment was rarely conducted	Food records/ recall were commonly reported for reliability check. Validity assessment was rarely conducted	Multiple 24 h recall	Yes, within 30 days interval in same population (n = 14)
Rankin *et al.*[22]	n = 753, 11 and ½ years American children	Bases upon FFQ from Iowa Flouride study Marshall *et al.*[23]	To determine the relative validity of a quantitative FFQ in assessing dietary fluoride intakes	FFQ focused on capturing the major dietary categories of fluoride exposures in the children	Not mentioned	No change from original FFQ	No change from original FFQ	3 days estimated food and beverage diary	Yes, n = 320, 7-10 days apart
Miziara *et al.*[24]	n = 348, Children between 2-6 years of age in Brazil	FFQ by Colluci *et al.*[25]	To validate fluroide intake among children 2-6 years of age	To include "others" category which consists food and drinks available in Brazilian market and have been reported to be rich in Fluoride and to include fluoride intake from dentifrice	Adapted from original FFQ	No change from original FFQ	Using food pyramid	Not available	Yes, within 15 days interval in other population
Orton *et al.*[14]	n = 404, 1-11 years old American children	Willett questionnaire[15]	To assess the validity of SQFFQ by comparing dietary intake of omega-3 and omega-6 PUFAs in youth aged 1-11 years	Child portion size were determined and specific question regarding fat intake were included	Adapted from Willet[15]	No change from original FFQ	Commonly used unit size of foods	Erythrocyte membrane composition	No
Williams *et al.*[13]	n = 148, 8-26 months Caucasian and Chinese background children	Ontario Health Survey, the Harvard Eating Survey for Children, the National Health and Nutrition Examination Survey III	A FFQ was developed and tested for assessing iron nutrition in infants	Ontario health survey food list was modified to include Chinese food items	A 3 days food record as well as health surveys	No change from original FFQ	Food pictures, three-dimensional models, measuring utensils and common foods and serving dishes were used	A 3 day food record and measures of iron status of haemoglobin (Hgb), ferritin and transferrin receptor (sTfR)	No

Table 1: Continued

Authors	Study details (sample size, year of study, country of study)	Original FFQ	Objective of the new FFQ	Modification of the FFQ	Methods to develop food lists	Methods to develop frequency of consumption	Methods to develop portion size	Methods to validate new FFQ	Repeatability check
Blum *et al.*[26]	Food records/recall were commonly reported for reliability check. Validity assessment was rarely conducted	Havard FFQ	To assess the validity of the Harvard Service Food Frequency Questionnaire (HFFQ) in the diet assessment of children 1-5 years	Consultation with local nutritionists and dieticians	Adapted from original FFQ	No change from original FFQ	National data (CSFII) and age appropriate portion sizes	24 h recall	No
Horodynski *et al.*[27]	n = 399, African American and non-Hispanic white children	Block *et al.*[28]	Food records/recall were commonly reported for reliability check. Validity assessment was rarely conducted	Food records/recall were commonly reported for reliability check. Validity assessment was rarely conducted	Adapted from Block FFQ	Not mentioned	Not mentioned	Not validated	No
Englberger[29]	n = 65, Kosrae and Pohnpei	Based upon the Keller International (HKI) Food Frequency Method	To assess dietary intake of vitamin A in pre school chidlren	FFQ was changed to include data on caretaker intake. Separate food Item categories were created for banana and breadfruit at different maturity stages	Adapted from The Helen Keller International (HKI) Food Frequency Method	Not mentioned	Not mentioned	Not validated	No
Kiefte-de Jong *et al.*[20]	n = 2420, 14 months The Netherlands	Feunekes *et al.*[30] FFQ for adults to estimates intake of fat and cholesterol	To identify common dietary patterns in toddlers and to explore parental and child indicators of these dietary patterns	Inclusion of foods frequently consumed during the second year of life according to a National Dutch food consumption survey	Adapted from original FFQ (Feunekes *et al.*[30])	Not mentioned	Standarised household utensils	Not validated	No
Kristiansen *et al.*[31]	n = 300, 2 years old Norwegian children	Based on National Dietary Survey Norway, 1999[31] {Kristiansen, 2013 #27}	To explore the comparability of data obtained at two time points by a semi-quantitative FFQ	Sequences of frequency options and ranges modified. Additional sub question about assortment in groceries. Addition of photographs in he booklet. Food composition data base updated inclusion of dietary fiber	Adapted from 1999 SQFFQ version	Not mentioned	Not mentioned	Not validated	No

Table 1: Continued

Authors	Study details (sample size, year of study, country of study)	Original FFQ	Objective of the new FFQ	Modification of the FFQ	Methods to develop food lists	Methods to develop frequency of consumption	Methods to develop portion size	Methods to validate new FFQ	Repeatability check
Marriott *et al.*[32]	n = 50, 1 year old British children	FFQ was adapted for multi-ethnic population of Bradford	To evaluate the relative validity of an FFQ for assessing nutrient intakes in these infants	To include additional food items and frequency of consumption using focus group and 24 h recall	Dietary survey, 24 h recalls	Food list/frequency option/portion size was based upon review of data from a UK survey, 24 h recalls and food diaries of 12-months old preterm infants	-	4 days weighed diary	No
Kwok *et al.*[33]	n = 29, 2-5 years old Hong Kong toddlers	Based on Woo *et al.*[34]	To assess nutrient intakes of young picky-eating Hong Kong children	Portion sizes were modified according to toddler's intake	Adapted from Original FFQ (Woo *et al.*[34])	Not mentioned	Food models	3 days estimated food records	Yes, 14 days apart
Levy *et al.*[35]	n = 398, 2-6 years old Brazilian children	Modified FFQ developed by Colucci *et al.*[25]	To estimate their FI and (ii) to provide additional validity to the questionnaire by comparing the results obtained with those found previously in a uoridated municipality	Inclusion of a category of Brazilian foods and beverages named 'others	Adapted from Colucci *et al.*[25]	None	Not mentioned	No	No
Parrish *et al.*[36]	n = 68	Willett questionnaire[15]	To assess validation of a FFQ in children 1-3 years of age	None	Adapted from original FFQ	No change from original FFQ	No change from original FFQ	Multiple 24 h recall and nutrient bio markers	No
Bel-Serrat *et al.*[37]	Food records/recall were commonly reported for reliability check. Validity assessment was rarely conducted	Suling *et al.*[38]	To assess eating behaviors associated with risk of overweight, obesity and general health in children	None	Adapted from original FFQ	Not mentioned	Not mentioned	Two 24 h dietary recalls	No
Bell *et al.*[1]	n = 493, 24 months Australian toddlers	Based upon information from recent dietary intake data of Australian toddlers	To develop a simple tool that assesses toddlers' dietary risk and investigates its reliability and validity	None	Dietary data of Australian toddlers, the Australian Dietary Guidelines Modelling System and the Australian Dietary guidelines	Based on the appropriateness of categories for a 1-week period of intake	Based upon average serving size mentioned in Australian Dietary Guidelines Modelling System	3 days estimated food records	Yes, n = 111, 3.2 weeks apart

Table 1: Continued

Authors	Study details (sample size, year of study, country of study)	Original FFQ	Objective of the new FFQ	Modification of the FFQ	Methods to develop food lists	Methods to develop frequency of consumption	Methods to develop portion size	Methods to validate new FFQ	Repeatability check
Vereecken *et al.*[39]	n = 216, Belgian-Flemish preschool children	Previously developed FFQ for preschool children (Huybrechts *et al.*[7]).	To investigate the relative validity of a FFQ developed for use in a biennial longitudinal study	None	Adapted from original FFQ	No change from original FFQ	No change from original FFQ-common standard measures	Young Children's Nutrition Assessment on the Web (YCNA-W). An online dietary assessment tool for three non-consecutive days. (Vereecken *et al.*[40])	No
Sofianou-Katsoulis *et al.*[41]	n = 33, 3-7 years old	Maternal Peanut FFQ Fox *et al.*[42]	Food records/recall were commonly reported for reliability check. Validity assessment was rarely conducted	Food records/ recall were commonly reported for reliability check. Validity assessment was rarely conducted	Predefined list of food items commonly consumed by families living in the United Kingdom	Not mentioned	Food records/ recall were commonly reported for reliability check. Validity assessment was rarely conducted	7 day food diary	No
Morino *et al.*[43]	n = 201, 1-3 years old Italian toddlers	Originally designed based upon suggestions from family pediatricians, the user-requirements of European nutrition experts and evidence from state-of the-art literature	To investigate the accuracy and reliability of the NutricheQ Questionnaire in the identification of toddlers with the risk of inadequate intake of micro- and macronutrients	None	Based on suggestions from family pediatricians, the users-requirements of European nutrition experts and evidence from state-of the-art literature	No change from original FFQ	Not mentioned	3 days weighted food record	Yes, 10-15 days apart. Additional n = 50

Table 2: Overview of studies with newly developed FFQ

Authors	Study details (sample size, year of study, country of study)	Objective of the new FFQ	Methods to develop food lists	Methods to develop frequency of consumption	Methods to develop portion size	Methods to validate new FFQ	Repeatability check
Koleilat and Whaley[44]	n = 70, 2-4 years old English and Spanish speaking American children	To examine the test retest reliability and validity of a 10-items Child Food and Beverage Intake Questionnaire designed to assess fruits, vegetables and sweetened foods and beverages intake	Dietary survey	Not mentioned	Not mentioned	Three 24 h recalls	Yes, 2 weeks apart
Rice *et al.*[45]	n = 371, 12-36 months Irish toddlers	To develop and test the validity of a parent administered questionnaire as a means of evaluating dietary risk in young children	Stage I: healthcare and consumer research, an initial literature review; Stage II; Focus group and pilot testing; Stage III: Validation study	Stage I: healthcare and consumer research, an initial literature review; Stage II; Focus group and pilot testing; Stage III: Validation	Stage I: healthcare and consumer research, an initial literature review, Stage II; Focus group and pilot testing, Stage III: Validation study	Irish National Preschool Nutrition Survey 7-days-record	No No
Escobar *et al.*[11]	n = 342, 7-36 months Spanish children	To develop and validate tools (food frequency questionnaires, FFQs) for the assessment of gluten consumption	24 h recall	study 24 h recalls collecting prospectively information on the most frequent gluten-containing food	Household utensils, standard serving size	(2DR)	
Sharma *et al.*[46]	n = 84, 0-24 months American infants toddlers	To characterize food and nutrient intake and develop a population-specific food list to be used as a comprehensive dietary assessment tool	Weekend and weekdays 24 h recalls for food list and frequency	Weekend and weekdays 24 h recalls for food list and frequency	Portion sizes were recorded using digital scale but not listed on the draft FFQ because of the difficulty in collecting accurate portion size	Not validated	No
Sochacka-Tatara and Pac[47]	n = 143, 3 years old Polish children	To assess the relative validity of a semi quantitative FFQ which measures the usual dietary intake of 3-years-old children	Data from general knowledge on dietary habits in pre-school children and data from previous surveys	Not mentioned	General knowledge on dietary habits in pre-school children and data from previous surveys	25 h recalls for 3 consecutive days	No
Corsini *et al.*[48]	n = 175, 18-24 months Australian toddlers	To assess the validity of Toddler Snack Food Feeding Questionnaire designed to measure parental feeding practices used to manage toddlers' access to and consumption of snack foods	Mothers were interviewed	Mothers were interviewed	Mothers were interviewed	Child feeding questionnaire	Yes, n = 60, 1 week apart

Table 2: Continued

Authors	Study details (sample size, year of study, country of study)	Objective of the new FFQ	Methods to develop food lists	Methods to develop frequency of consumption	Methods to develop portion size	Methods to validate new FFQ	Repeatability check
Kobayashi *et al.*[49]	n = 621, 3-11 years Chinese children	To develop a FFQ to assess the regular dietary intake of Japanese children	Weighed dietary record	Food records/recall were commonly reported for reliability check. Validity assessment was rarely conducted	Food records/recall were commonly reported for reliability check. Validity assessment was rarely conducted	Not validated	No
Andersen *et al.*[50]	n = 178, 2 years old Norwegian children	To assess the validity of a SFFQ applied in a large nation-wide survey among 2-years-old children and to examine the validity of the SFFQ in relation to different background parameters	Dietary survey, general knowledge and nation-wide surveys	To include frequency options, more food items, photos in the booklet. To use of a different food composition database to include energy intake from dietary fibre	Dietary surveys and general knowledge	7 days weighed food records	No
Marshall *et al.*[23]	n = 240, 6 months-5 years old American children	To determine the relative validity of a quantitative beverage frequency questionnaire in assessing beverage, calcium and vitamin D intakes	Not mentioned	Not mentioned	Not mentioned	3 days estimated food diaries	No
Metcalf *et al.*[51]	n = 117, 1-14 years old Kiwi toddlers	To evaluate the repeatability of a children's food frequency questionnaire (FFQ) by gender, ethnicity and age group	24 h diet records	Developed from 24 h diet record	National food guidelines, commonly used serving sizes	Not validated	Yes, 2 weeks apart
Humphrey *et al.*[52]	n = 265, 1-7.5 years Indonesian children	To see if a FFQ or 24 h yielded estimated dietary vitamin A intakes most closely associated with vitamin A status	Food records/recall were commonly reported for reliability check. Validity assessment was rarely conducted	Food records/recall were commonly reported for reliability check. Validity assessment was rarely conducted	Usual serving size was measured in a pilot study	Not validated	No
Sloan *et al.*[12]	n = 723, 1-5 years old Philippines Guatemala and Tanzanian children	To examine the validity of a simple, inexpensive FFQ to identify areas with a high prevalence of vitamin A deficiency	Guided group discussions were held with the interviewers and local nutritionists and brief market surveys	Not mentioned	Not mentioned	Serum retinol levels	No

care givers gave good insight into the eating patterns and habits of toddlers, all the types of foods and drinks consumed, the portion sizes of these foods and beverages and common utensils, cups, plates and bowls used. While food items were the focus of an FFQ, it is also important to consider beverages other than water. With the rise in the prevalence of childhood obesity, the consumption of beverages other than water could potentially contribute largely to overall nutrient intake of a small child, or displace the intake of nutritious foods.

The next step in developing FFQ is to construct the frequency of consumption. It is well-recognized that toddlers eat relatively tiny amounts, but more frequently than adults. Therefore, frequency categories should accurately capture their pattern of food and drink intake, especially for items consumed more than once a day[7]. In this review, there were no consistent methods reported to construct the frequency of consumption in modified FFQs and none was reported in the newly developed ones. As frequency of consumption is one of the key elements of FFQ, it is quite concerning that this element seemed not to be given adequate attention.

Portion size estimation is necessary for a semi-quantitative FFQ. Ideally, portion sizes should be the true representative amount of food consumed by a toddler. Food photographs were the most commonly reported method in this review. This technique has been considered to minimize memory bias and increase precision. However, the quality of the photograph such as lighting, distance etc were crucial factors in accurately determining portion sizes[8,9]. Other methods included the use of regular household utensils. Although this sounds relatively easy and more economical, there were no common standards for these household utensils. For example, the volume of a child's cup varied from one brand or type to another and the capacity of a child cup was typically much less than a standard cup (250 mL). In this case, the FFQ would require extra information in the form of photographs and measurements for example, placing a ruler next to a cup or bowl to provide scale and to capture the dimensions of utensils, cups, bowls and spoons. This would ensure that the participant and investigator are both referring to the same size or volume to avoid errors in estimation.

Dietary guidelines, national dietary data, or food composition tables could also potentially be used to construct portion sizes[9,10]. For example, a serving size for toddler could be around 1/3 to 1/2 of adults' recommendations. However, this method has been reported to result in poor accuracy of the portion sizes. A dietary guideline could recommend 1 serve of meat but a "serve" may not be understood by the individual completing the questionnaire[7,10,11]. In this review, there were limited information on the accuracy and precision of one method (i.e. food photographs) as compared to the other method (i.e. household utensils) in estimating portion size. There are several methods to develop food portion estimation with various degrees of accuracy and easiness. Use of household utensils is the most common method due to its easy availability.

The final stages of the FFQ development involve testing for validity and repeatability of the draft questionnaire to avoid biased results and inappropriate associations[6]. There is no gold standard for assessed the validity of the FFQ. A newly developed dietary assessment tool can be validated against any other method, taking into account that method's limitations the objective of the study. From the retrieved literature, when validated against weighed food record, the FFQ tended to overestimate nutrient intake among toddlers[8,12,13]. This could be because weighed food records are accurate, since the items that were consumed, were measured. Another possibility is to validate against biomarkers which could be appropriate when only a few nutrients or single nutrient was of interest[12,14]. However, errors could occur due to bioavailability, absorption and metabolism of a particular nutrient. Another possible route reported in the review is to validate against two dietary methods. For example, a combination of 24 h recall and 3 days estimated dietary record for FFQ validation had also been used in past.

Repeatability tests are need to check the results consistency, with the time interval between the two assessments should not exceed 5 weeks due to the greatly varying diet of toddlers[7,10] and to be conducted in separate study population to lighten the participants' burden[6]. A repeatability test with a correlation coefficient range between 0.5-0.7 is considered as acceptable[6,15]. Pre-testing the final questionnaire to the similar target population of the new study is advisable to reduce other potential biases. In this review, there were very limited studies reporting the repeatability check. In more recently published studies, repeatability check were conducted within 1-2 weeks interval which could be an ideal period for toddlers[16,17].

CONCLUSION

Food frequency questionnaires (FFQ) has increasingly been used in epidemiological research due to its practical advantages. The study objective with respect to the dietary data collection is the most important consideration when building a robust FFQ. This review provides evidence-based guidance and considerations when building a suitable FFQ for a study among toddlers.

SIGNIFICANCE STATEMENT

In this study, it is reported on the steps and components required to develop a food frequency questionnaire (FFQ) for toddlers. This is significant because FFQ have increasingly been used for dietary assessment in epidemiological research owning to its practical advantages. Therefore, it must be carefully designed to capture all the dietary information especially for toddler as they have very different dietary patterns and food choices as compared to adults. This narrative could serve as an evidence-based overview on how to develop FFQ for toddlers. This could be useful for clinical nutritionists, dieticians, paediatric healthcare professionals and researchers in clinical settings and applied research.

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