



Dietary assessment in children and adolescents: issues and recommendations

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Abstract

The assessment of dietary intake in children and adolescents is of great interest for different purposes. The characteristics of each developmental stage and associated cognitive abilities are two factors that influence the ability of children to provide valid and reliable information on food consumption. The ability to remember, limitations of vocabulary or the ability to identify different foods are some of the relevant aspects. In addition, often parents or caregivers provide surrogate information and their degree of knowledge depends on the time they spend with the child and on whether they share meals. As children grow they become more independent and increasingly spend more time away from their parents. Children also have limitations to recognize food models and photographs and associate them with different amounts of food consumed. On the other hand, often children and adolescents perceive long interviews or self-administered questionnaires they as long and boring. The use of new technologies is contributing to the development of new tools adapting dietary assessment the methods to the cognitive abilities of children, introducing gaming environments and narrative structures that attract their interest and improve the quality of information they report..

(*Nutr Hosp* 2015;31(Supl. 3):76-83)

DOI:10.3305/nh.2015.31.sup3.8755

Key words: *Children adolescents. Food habits. Dietary assessment. New technology.*

EVALUACIÓN DE LA INGESTA EN NIÑOS Y ADOLESCENTES: PROBLEMAS Y RECOMENDACIONES

Resumen

El análisis de la ingesta alimentaria en niños y adolescentes es de gran interés con diferentes fines. Las características propias de cada etapa del desarrollo evolutivo y las capacidades cognitivas en cada edad son dos factores que influyen sobre la capacidad de los niños para proporcionar información válida y fiable sobre el consumo de alimentos. La capacidad de recordar, limitaciones de vocabulario o la capacidad para identificar distintos alimentos son algunos de los aspectos relevantes. Además a menudo son los padres o cuidadores quienes facilitan la información y su grado de conocimiento depende del tiempo que pasen con el niño y si comparten las comidas. A medida que crecen los niños son más independientes y cada vez pasan más tiempo sin sus padres. Los niños también tienen limitaciones a la hora de reconocer modelos de alimentos y asociarlos con diferentes cantidades. Por otro lado, las entrevistas largas o los cuestionarios auto-administrados les resultan largos y aburridos. El uso de las nuevas tecnologías están favoreciendo el desarrollo de nuevas herramientas que permiten adaptar los métodos de análisis de la ingesta a la capacidad cognitiva de los niños, introduciendo componentes lúdicos y narrativos que atraigan su interés y mejoren la calidad de la información..

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DOI:10.3305/nh.2015.31.sup3.8755

Palabras clave: *Niños adolescentes. Hábitos alimentarios. Análisis de la ingesta. Nuevas tecnologías.*

Abbreviations

BMI :Body Mass Index.
 EGFCD: Expert Group on Food Consumption Data.
 EU: European Union.
 EFSA: European Food Safety Authority.
 EPIC: European Prospective Investigation into Cancer and Nutrition.
 EU Menu: What’s on the Menu in Europe.
 FFQs: Food Frequency Questionnaires.
 IDEFICS: Identification and Prevention of Dietary- and Lifestyle-induced Health Effects in Children and Infants.
 PANCAKE: Pilot study for the Assessment of Nutrient intake and food Consumption Among Kids in Europe.
 RFPM: Remote Food Photography Method.

Introduction

Accurate assessment of food and beverage consumption in children and adolescents is central to mo-

nitor trends. Often it is also required for epidemiological and clinical research on the associations between diet and health. It is essential as well to identify predictors and outcomes of children’s diets, identify targets for intervention, understanding behaviour change processes, plan policies and to develop and evaluate interventions.

Dietary assessment is always a challenge and previous research suggests that collecting reliable and accurate dietary data from children and adolescents can be difficult. The 24-hour recall, dietary records, dietary histories, Food Frequency Questionnaires (FFQs), brief instruments, observations of children’s diets and mixed instruments such as a dietary record-assisted 24-hour recall have all been used to assess children’s intakes.

Developmental, cognitive, social and behavioural characteristics of respondents have an influence, but also the observer needs special requirements and attributes. Hence, in addition to the systematic error and bias inherent to each method of dietary assessment, peculiarities in the population group make their reporting of food intake prone to additional error. However,

Table I
 Issues to consider in the assessment of dietary intakes of children and adolescents

Cognitive Ability	Lower literacy skills Limited attention span Limited concept of time Limited memory – subconscious memory lapses across all or selected dietary items such as snacks Limited knowledge of food, food preparation, measurement Lack of familiarity with components of mixed dishes and added ingredients Portion size estimation Frequency of consumption estimation
Surrogate reporting	Parents Caregivers Combination
Social desirability	Under reporting – Over reporting Weight status of the child Weight status of the parents
Dietary Habits	Variable food habits - more structured in childhood than in adolescence More in-home eating (childhood) More out-of-home eating (adolescence) Parental influence important in childhood Peer influence important in adolescence
Other considerations	Body image concerns and dieting behaviours Lack of co-operation and motivation (adolescence) A conscious/subconscious need for social approval

research on the magnitude and direction of bias is limited. Validation studies using biomarkers of energy intake such as doubly labelled water have provided an insight¹. Research on cognitive processes involved in dietary recall and estimation of portion size has informed interesting developments and projects based on the new technologies that can reduce bias and improve the accuracy of reports on children's diets².

Children dietary assessment often rely on respondents self-reported intakes, either by children them self, by parents, by caregivers or a combination. The accuracy of these self-reports may be compromised because of cognitive factors, such as children's memory of food intake and retrieval of information, their ability to estimate the size of portions consumed, ability to identify foods, knowledge of food names, etc.¹. Social desirability such as reporting in line with perceived norms also influences self-reports³, as well as study factors, such as taking part in an intervention study focusing on healthy dietary habits. Reporting about diet itself may also modify eating habits. Table I displays a number of issues that should be considered when deciding the suitable dietary assessment method to use in children.

Cognitive abilities and reporting dietary intake

Dietary assessment techniques often require the respondent to remember many details about their food intake at different points in the past, including the names of the foods and beverages consumed, type, preparation, time of consumption, place, eating occasion, weekday, but also they have to remember and estimate the amount of food consumed, and when doing so, they are asked to relate their memory to pictures, models or household measures. These are complex tasks that require attention for the whole duration of the interview and certain literacy and writing skills. Researchers have identified these abilities as an adequately developed concept of time, a good memory and attention span, and knowledge of the names of foods⁴, but the level of development of such abilities depends on the developmental stage and varies between children.

Research on this regard suggests that children between 0-7 years probably need a proxy reporter or observer. Between ages 8-10 years some children may need assistance. It is not clear how well can report 11-13 year-olds, and many of those aged 14 years + can probably provide self-reports. Thus parents or caregivers are often used as proxy reporters of their children's dietary intake, particularly needed for details about the types and quantities of food consumed, because of children's more limited food vocabularies^{1,5}. The age at which a child becomes an accurate self-reporter of his own dietary intake has been estimated to be approximately 12 years, although this varies by dietary assessment method, with a transition period between ages 8 -12 years, but there is no recommen-

dations on who is the most appropriate reporter of dietary intake for children in this age range⁶. From the age of about 7-8 years there is a fairly rapid increase in the ability of children to participate in unassisted recall, but only for food eaten in the immediate past and for no longer than the previous 24 hours. Even in that case it is likely that older children can remember better weekday food intake than more irregular eating patterns, weekend days or events^{1,7}.

Self-reporting on dietary intake involve understanding what information is being asked for, and searching for and evaluating the retrieved information before providing a response. Errors can emerge because the respondent is unable to complete the task but also because the observer provided inappropriate cues. Errors associated with children's recall of food intake includes both, under-reporting (missing foods), over-reporting (phantom foods/intrusions) and limited memory -subconscious memory lapses across all or selected dietary items such as snacks and incorrect identification of foods because of a limited knowledge about foods⁸. Baxter et al. found that reporting accuracy in children was related to their age/sex Body Mass Index (BMI) percentile, with greater underreporting among the obese. Moore et al reported that episodic memory, classroom behaviour, attitudes, socioeconomic status, and total items consumed were associated with bias in questionnaire self reports⁹. In addition, distractions may interfere as well. Certain foods such as main course items may be recalled more easily than less common foods or side dishes and additions to foods⁸. Children often have limited knowledge of food, food preparation and are not familiar with components of mixed dishes and added ingredients.

A validation study investigating the effects of retention interval - the elapsed time between to-be-reported meals and the interview- on children's accuracy for reporting school-meal intake during 24-hour dietary recalls in fourth grade students, analyzed food-item-level for omission rates (percentage of observed but unreported items), intrusion rates (percentage of reported but unobserved items), and total inaccuracy (combined reporting errors for items and amounts). Researchers found that children's accuracy for reporting school-meal intake was better for prior- 24-hour recalls than previous-day recalls, best for prior- 24-hour recalls obtained in the afternoon and evening, and worst for previous-day recalls obtained in the afternoon and evening¹⁰.

Children are able to answer many questions that are directly relevant to them, but to date little is known about the cognitive constraints on children's ability to retrieve dietary information. Baranowski et al. suggested a model that categorizes the processes involved into attention, perception, organization, retention, retrieval and response formulation. Further development of the model includes the following retrieval strategies during children dietary self-report¹¹: visual imagery (appearance of the food); usual practice (familiarity

with eating the food); behaviour chaining (association with preferred food or favourite activity during a meal or day); and preference (favourite food).

It is not clear whether children under 10 years could accurately answer a FFQ covering a period longer than 1 day, since this requires abilities such as conceptualize frequency. This involves averaging and abstraction skills children of that age are not able to cope with^{1,12}. In addition, FFQs require capacity to concentrate and attention throughout the whole questionnaire. It has been suggested that to complete an FFQ, children need to be >12 years old. However, it is uncertain when a child is between eight and 12 years old as to who, parent or child, should be asked to report child intake, considering factors such as increasing child independence, cognitive abilities and increased consumption of food and drinks outside the home outside of parental control¹³. Overall, the consensus seems to be that the characteristics of different age groups call for the use of different assessment approaches¹⁴.

Adapting FFQs for children need to consider a number of issues. Regarding the food list, children are more likely to interpret questions literally, impairing their ability to report accurately about composite foods. Time intervals are another issue. Concept of the past can make estimating frequency of food use during a specific time period more problematic. Time periods may need to be fixed by meaningful start and end points and may need to be shorter, as children typically have more changeable food patterns. Children tend to respond affirmatively to authoritatively phrased questions, or if unsure of the question, do not have an opinion or are disinterested, thereby reducing accuracy of information provided. Words that are consistent with a child's understanding of a given situation need to be used. Probes may need to be more specific. The structure of the questionnaire requires some careful attention. Easier questions on topics of interest must be asked first, followed by more difficult or more threatening questions^{15, 16}.

Surrogate reporting of children's dietary intake

Although parents of preschool children may provide accurate reports of their children's food consumption, reports appear to be no more valid than children's self-reports once children reach school age. However, young children may spend part of the day with child minders or away from home in care centres.

School age children become more independent. They often have lunch and snacks at school, to some extent decide on their own choices on what they eat or even shop limited items by themselves. In addition, they often do not share meals with their parents, who may not be responsible either for preparing the food, but delegate the task on someone else who may be required to provide additional information on what children eat¹⁷.

Results from studies comparing the results of direct observations of children's food intake with 24-hour recall by parents, suggest that parents can be reliable reporters of their children's food intake in the home setting, but less reliable reporters of their children's food intake out of home¹⁷.

Some children aged 10 years and older would perceive assistance from parents or teachers as an intrusion, and would like to complete the dietary assessment by themselves¹.

Questions have also been raised about the bias that parents may provide to their child's report of intake^{1,18}. A Finnish study showed that parents were more likely to report health behaviours in line with recommended and desired behaviours than children do¹⁹. However, a recall where the mother and/or father assists and cooperate with the child may yield better estimates than the child or parent alone²⁰. The parents can assist by prompting children, adding food details and assist with practical issues connected to reporting.

Burrows et al compared and validated 8-11 years children versus parents reporting of children's energy intake using food frequency questionnaires versus food records. They concluded that children were the most accurate reporters when compared to their parents, with fathers more accurate than mothers. They also found that estimates of energy intake based on 4-day weighted food records were approximately equal to the child report FFQ¹³.

For preschool-aged children, information is obtained from surrogates, usually the primary caretaker. A "consensus" recall method, in which the child and parents report as a group on a 24-hour recall, has been shown to give more accurate information than a recall from either parent or child alone²¹. Tips for interviewers to maximize data accuracy have been suggested.

In the Identification and Prevention of Dietary- and Lifestyle-induced Health Effects in Children and Infants study (IDEFICs), two proxy-reported 24-hour recalls from 4-10 year old children were found to be a valid instrument to assess energy intake on group level but not on the individual level²².

Portion size

Early studies suggested that young children cannot estimate portion size accurately, even when prompted with visual aids¹. However, older children and adolescents also experience difficulty in reporting portion size. Overall, in the majority of studies that have used quantification tools such as household measures and graduated food models, little attention has been paid to how well such aids work with children¹. Estimating the amount of food consumed is a complex cognitive task difficult for many children^{11, 23}. It requires that children can recognize and describe food quantities in terms of proportions or whole units. It also assumes that children can think abstractly about food and understand

the meaning of generic food models of different volumes and dimensions, or food photographs. Children younger than 10–11 years old are very unlikely to be able to efficiently perform these abstraction tasks. The accuracy of children's estimates of portion size using age-appropriate photographs, sensitive to the cognitive abilities of children, has shown not to be different from that of adults in a study by Foster et al.²⁴.

Foster et al. demonstrated that children are able to use portion size assessment tools to estimate portion size as young as 4–6 years old, although precision and accuracy of estimates improved with age using different tools²⁴. Conservation is the ability to recognise that a size or quantity remains the same when the appearance of the object changes. The ability to conserve develops at about 7 years of age. Additionally, children need to be able to report foods actually consumed, rather than that served, which requires reporting leftovers, thus portion sizes suitable for estimation of leftovers may be required as well. Foster et al tested different measurement aids with children and found photographs and an interactive tool to perform better than food models. Baranowski et al found that multiple smaller food images in progressively larger amounts on the same screen enabled children to more quickly report food portion size than larger single-portion pictures presented one at a time. The presence or absence of visual cues such as a tablecloth and cutlery in images did not influence accuracy of portion size²⁵.

Dietary habits of children and adolescents

Food habits of children are more structured than in adolescence. Children more often eat at home while adolescents often do it out-of-home. Parental influence is important in childhood, while peer influence is important in adolescence.

In adolescence eating habits are rapidly changing and unstructured eating is common (snacks, meal skipping), with high levels of restrained eating.

Additional considerations regarding adolescence include body image concerns and dieting behaviours²⁶.

Social desirability

Children may under-report or over-report some dietary habits because they may perceive their own practices, or what they report as own practice, are either socially undesirable or desirable, respectively. Socially desirable responses are more frequent in younger than in older children²⁷. Interviewer administered 24 hour recall, where children and/or parents are sitting in front of an interviewer, have shown to provide social desirability biases^{28,29}. This may not occur to the same extent when reporting in private.

The association between dieting and weight consciousness with misreporting is the most frequent and

consistent. Parental obesity status and/or the extent to which parents perceive that information about their child's diet is a reflection of their child's weight may also compromise reporting accuracy¹. It has been suggested that a small part of the inaccuracy of children's self-reports is deliberate and might be due to social desirability⁴.

Co-operation of respondent

Engaging children and adolescents in reporting their food intake is particularly challenging, but motivation is essential to gain collaboration which will help overcome some of the difficulties discussed. Assessment tools should facilitate cooperation of children and parents. Some useful characteristics for that purpose are being intuitive, easy and fast to complete, flexible in choices, nonintrusive, engaging, age appropriate and fun. Providing feed-back, and some kind of recognition such as gift or incentive may also be important. Co-operation and motivation is more difficult in adolescence. Although they are more able to report, adolescents may be less interested in giving accurate reports¹⁸.

Other factors

Being part of an intervention study focused on body weight and healthy eating habits, having clinical measurements or blood samples taken as indicators of diet, health or lifestyle diseases may unconsciously change influence dietary behaviour. Reporting food intake may in itself cause reactivity and a change in habits. This is especially a risk with Food diaries and food records. Reporting foods as they are eaten can affect both the types of foods and the amounts consumed, thus leading to under eating in the reporting period¹⁴. Furthermore, completing food records is time consuming, and can be perceived as boring. Using self-administered tools as well as long monotonous face-to-face interviews can result boring and cause fatigue in children that affect dietary information retrieval¹². This may lead to misreporting or alternative eating habits substituting foods which are easier to report³.

Advantages and limitations of different dietary assessment methods in children

Single or repeated 24-hour recalls and food records of varying duration have been widely used in children and adolescents. For school-age children and adolescents, there is no consensus of which dietary assessment method is most accurate. The choice of which instrument to use may depend on the study objectives and study design factors, all of which will influence the appropriateness and feasibility of different approaches¹⁴.

Developmental cognitive issues, problems with memory and information retrieval in children as well as those related to estimation of portion sizes have been discussed above. These issues are particularly relevant for 24 hour recalls and FFQs. In children, previous studies with double-labeled water used as a standard have shown that the food frequency questionnaire overestimates total calorie intake by ;50%,⁸³ whereas repeated 24-hour recalls⁸⁴ and weighed diet records⁸⁵ provide reasonably accurate group mean values for intake, although the values are not accurate on an individual basis³⁰. Generally, correlations between food frequency type instruments and more precise reference instruments have been lower in child and adolescent populations than in adult populations. A web-based food behavioural questionnaire underestimated the intake of middle-school children compared to a multiple-pass 24-hour recall³¹.

It has been suggested that food records using digital pictures may be a valid and feasible method for assessing food intake of preschool children³². Results of a pilot test showed an average 0,96 correlation between estimated weights and actual weights and the digital diet estimates were 5% lower than the actual weights. The Remote Food Photography Method (RFBM), which relies on smartphones to estimate food intake in near real-time in free-living conditions. When using the RFBM, participants capture images of food selection and leftovers using a smartphone and these images are wirelessly transmitted in near real-time to a server for analysis³³.

Systems based on digital photography to be used in school cafeterias have been developed and tested as well. This observation method consists of standardized photography of the food selected before the meal and the plate waste following the meal. Using reference portions of measured quantities of the foods, expert judgment is used to estimate the amount of each food consumed^{34, 35}.

Another approach that has been used with school-age children is a combination instrument, the record assisted 24-hour recall. In this case children record only the names of foods and beverages consumed throughout a 24-hour period. This information serves as a cue for the later 24-hour recall interview.

The European Food Consumption Validation Project provisionally recommended a similar approach -a food recording booklet for foods eaten away from home- for schoolchildren 7-14 years old. Nevertheless, studies examining the validity of this approach have had mixed results

An European Union (EU)-wide standardized food consumption data collection system (EU Menu) was initiated in 2010. The system uses a methodology that enables comparability of data and provides information that is detailed enough for risk assessments that are representative of all countries and regions in the EU. In addition, the data will be useful for nutrition purposes and public health policy makers. The collection of

food consumption data is planned to be carried out as a rolling programme from 2012 to 2017³⁶.

The Expert Group on Food Consumption Data (EGFCD) recommended in 2009 the dietary record including two non-consecutive days the method to be used in to infants, toddlers and other children (from 36 months to 10 years of age). The EGFCD considered that this method facilitates a combination of parents and (various) caretakers in recording the foods and beverages consumed, depending on the location of the child. The group considered that non-respondent bias is probably less of a problem in this population group since response rates in studies among children are generally higher compared to other population groups³⁷.

The Pilot study for the Assessment of Nutrient intake and food Consumption Among Kids in Europe (PANCAKE) project provided tools and protocols for a future harmonised pan-European food consumption survey in infants, toddlers and children, with specific recommendations for further improvement and on the preferred dietary assessment method. The authors recommended to use the two non-consecutive one-day food diaries followed by an EPIC-Soft completion interview with the parent/caretaker as main dietary assessment method. They also advise the use of validated PANCAKE picture books for quantification of portion sizes of consumed foods and recommend to collect additional information with a questionnaire on background characteristics, a food propensity questionnaire, and measurement of height and weight³⁸.

New approaches and technologies to improve accuracy in diet reporting

Formative research on the use of innovative technologies, such as computers, the Internet, personal digital assistants and mobile phones, to obtain information on food consumption is important for the development of these technologies³⁹⁻⁴¹. The many possibilities technologies offer have been used in diverse ways to enhance accuracy, minimize self-report errors and otherwise make it easier to report diet⁴². A number of innovative technology based methods to address the needs for dietary assessment in children have been developed. New technology-based methods, such as disposable cameras, mobile phones with cameras, and smart phones, are being developed for collecting records.

Using web-based technology for dietary assessment offers standardization of the sequence of the questions, can include audiovisual stimuli, provide immediate results, increased flexibility, and easy and fast updating facilities^{9,18,43}. The use of technology to collect dietary intake data is especially engaging to children, adolescents and younger adults who are familiar with the technology in their daily lives. Perceptions of “enjoyable” and “easy to use” are rated highly in many com-

puterized diet programmes. Many adolescents prefer these methods to traditional methods¹⁴.

To be successful, however, any self-completed diet assessment instrument requires some minimum attention, memory, and categorization skills. A useful skill for successfully self-completing a 24-hour diet recall is the ability to identify foods consumed by “browsing” among hierarchically organized food groups or by “searching” (typing in food names). Observers reported that many children relied on pictures of foods (category collages) rather than text to make their selections in the cover-flow method²⁵.

A web-based dietary assessment software system that assess the dietary intake among 8-10 year old children should include motivation factors, and try to motivate the children by the soft-ware's functionality, content, aesthetics and setting²⁵.

Boredom and fatigue affect dietary information retrieval especially when using self-administered instruments with children¹². Theories from media psychology and communication research provide innovative perspectives to address children's motivation and accuracy in dietary assessment. A challenge for entertainment media is to provide an environment that motivates children to accurately complete the dietary assessment task⁴⁴. Innovative strategies for enhancing children's motivation for dietary assessment and for enhancing accuracy of reporting have been suggested. One of the strategies suggested to motivate children to complete a dietary assessment is the use of animated, customisable agents which could guide and interact with children during the process. Embed the assessment process into a video game is another motivating strategy. Control and interactivity are two distinct features of videogames. The challenge is to design such interactivity to minimise adverse reaction to the reporting of dietary intake, for instance by providing non-evaluative feedback periodically during dietary report⁴⁴. A third useful strategy is to add narratives to encourage self-reporting behaviour. Stories could provide intriguing incentives for children who feel encouraged to finish the story. Virtual recreation of intake environment, training sessions interspersed to improve portion estimation and implicit attitudinal measures incorporated in the process as a control or to increase validity have been suggested among the strategies to improve accuracy. Many motivation and accuracy strategies could be combined. For example, a video game with an involving storyline could include multiple accuracy training sessions via a virtual environment. However, more research is needed to operationalise and validate these theoretically useful strategies.

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