

# Assessing Beverage Intake in Children and Adolescents: State of the Science, Recommendations, and Resources for Evaluation

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## Acknowledgements

This work was supported by Healthy Eating Research, a national program of the Robert Wood Johnson Foundation. Peer review was provided by Dan Taber, PhD, Science by Design; and Amy Yaroch, PhD, Gretchen Swanson Center for Nutrition.



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## I. Introduction and Background

### Beverage Consumption is Important for Children's Health and Development

Beverage consumption is an important contributor to the health and well-being of children and adolescents. Beverages can either promote good health and development, or impede it. For example, consumption of sugar-sweetened-beverages (SSBs) such as sodas, sports drinks, and fruit drinks increases youth's risk of obesity,<sup>1-3</sup> dental caries,<sup>4</sup> and metabolic syndrome.<sup>5</sup> Similarly, adolescents who consume energy drinks report lower self-rated health, are more likely to have behavioral and academic problems,<sup>6</sup> and have an increased risk of poor mental health, obesity, tooth decay, type 2 diabetes, and risk-seeking behaviors.<sup>7</sup> On the other hand, drinking water improves children's cognitive functioning,<sup>8-11</sup> may help to limit weight gain<sup>12,13</sup> and, if fluoridated, may help prevent dental caries.<sup>14,15</sup> Consumption of low-fat or fat-free milk is also recommended, as it facilitates proper bone development.<sup>16,17</sup>

Because beverage consumption contributes to children's health and developmental outcomes, researchers, policymakers, and practitioners are interested in monitoring children's beverage consumption. Monitoring beverage intake helps both to assess general trends over time, and to estimate changes in consumption in response to specific interventions, such as educational campaigns or environmental or policy changes targeting beverage consumption.

A variety of methods exist to assess children's beverage consumption, most of which can be categorized into one of five major types: recalls, diaries, questionnaires and screeners, observations, and direct measurements (see Table 1). Each of these methods has been used for assessing beverage intake in children. In addition, each has its own unique advantages and limitations, and no one technique will be ideal in all settings.<sup>18,19</sup> In addition to tradeoffs among methods, measuring beverage intake in children presents additional challenges, as children have more variable diets than adults and tend to have greater difficulty accurately reporting their dietary behaviors.<sup>19-22</sup>

For these reasons, individuals interested in assessing children's beverage intake need guidance: they need to know what types of methods are available, to learn the basics of how to implement those methods, and to understand some of the tradeoffs involved in using each method. Additionally, because each method brings its own limitations, consumers of the scientific literature also need to know what methods are being used to assess beverage intake in children; this information paints a picture of the strengths and limitations of recent research. This report attempts to address these two goals. Specifically, we aim to:

1. Describe types of available methods, including their advantages and limitations
2. Provide resources and references for evaluators hoping to measure beverage intake among children
3. Describe the recent state-of-the-science in assessing beverage intake in children

There are other excellent resources available to assist researchers in selecting a dietary assessment method.<sup>23,24</sup> However, none of these resources focus specifically on beverage intake, and, in general, their focus is on self-reported measures, rather than on a larger set of assessment options including objective measures.

### Methods Used to Develop the Report

This report draws on three main sources. First, others have written extensively on dietary assessment, and we both reference this work and encourage readers looking for more detail to review these resources directly. Resources we found particularly useful include textbooks edited by Willett<sup>25</sup> and by Hu<sup>26</sup> as well as a chapter of Nutrition in the Prevention and Treatment of Disease by Thompson and Subar.<sup>19</sup> We also drew on a number of review articles, including by Burrows and colleagues,<sup>27</sup> McPherson and colleagues,<sup>28</sup> Serdula, Alexander, Scanlon & Bowman,<sup>29</sup> Livingstone and colleagues,<sup>30,31</sup> and Rutishauser.<sup>32</sup>

Second, we conducted a systematic review of peer-reviewed literature from 2007-2017 to identify recent studies that assess beverage intake in children and adolescents.<sup>33</sup> This review allowed us to determine what methods are commonly used to assess children's beverage intake, as well as which assessment methods have been validated and in what populations. Additionally, the review yielded a repository of specific tools (e.g., questionnaires) researchers have used to assess children's beverage intake, many of which are detailed below.

Finally, this report draws on our searches of the grey literature, including government manuals and reports, online versions of questionnaires or other measurement tools, websites for commercial products that can assist with measuring children's intake, and online databases of measurement tools (e.g., the National Collaborative on Childhood Obesity Research [NCCOR] Measures Registry).

The report contains three main sections. First, we provide a brief overview of general considerations for measuring beverage intake in children and adolescents, with resources for readers looking for additional detail. Second, we review five main types of assessment methods, including a description of how to implement the method, recommendations for use or best practices, advantages and disadvantages, and specific resources and references to help researchers wishing to implement these methods. Rather than providing a completely comprehensive review of all available methods, or all features of those methods, we hope that this section provides a useful starting point for researchers and evaluators as they select an assessment technique. Finally, we provide a short summary of findings from the review, focusing on the state-of-the-science of assessing children's beverage intake.

## II. General Considerations

### Introduction

In this section, we briefly describe several key issues to consider when assessing beverage intake in children and adolescents. For readers seeking more detailed information, we recommend resources such as the National Cancer Institute's Dietary Assessment Primer<sup>24</sup> and the National Collaborative on Childhood Obesity Research's Measures Registry User Guide: Individual Diet.<sup>23</sup>

### Determining the Beverage Intake Variable of Interest

When selecting a beverage intake assessment method, a first step is to clearly define exactly what type of beverage intake is of interest. We focus on two beverage intake variables that researchers may be interested in measuring:

- Long-term, usual intake of one or more beverage category. For example, a researcher interested in bone health might wish to estimate children's usual intake of milk. Long-term usual intake is typically of most interest to public health practitioners and researchers, as usual beverage intake is what is most relevant to the development of important conditions such as obesity, diabetes, and tooth decay.
- Recent or acute intake of one or more beverage category. For example, a physician may wish to assess a child's recent intake of beverages that could explain a patient's gastrointestinal illness. Recent intake is relevant for the development of acute conditions such as allergic reactions, gastrointestinal illness, or migraines.

As discussed in Section III, some assessment methods query individual's usual intake, while others ask about recent intake (e.g., beverages consumed yesterday). Because individual dietary intake varies considerably day-to-day, assessing recent (acute) intake will rarely reflect an individual's usual intake. When researchers use measures that capture recent intake, such as recalls, diaries, and observations, they cannot assume participants' responses represent their long-term intake. If long-term intake is of interest, researchers have two options. First, in most cases, usual intake at the group-level (rather than the individual-level) can be estimated by averaging recent intake from a representative sample.<sup>25</sup> For example, mean usual intake of fruit juice among children in the U.S. can be estimated by calculating the mean intake of fruit juice on a 24-hour recall collected on a representative sample of American children.<sup>24</sup> A second approach is to use an assessment method that queries long-term intake, such as a frequency questionnaire that asks participants to report their usual beverage intake. Whatever the approach used, this consideration is especially important for beverage consumption, as many categories of beverages are consumed episodically,<sup>34-37</sup> and thus individual intake has greater day-to-day variation than intake of ubiquitously consumed dietary components (e.g., macronutrients).

### Self-Report vs. Objective Measures

Another key consideration is whether to measure children's beverage intake using a self-report measure, such as a questionnaire or recall, or an objective measure such as observation or direct measurement. (Other objective measures of dietary intake include biomarkers; however, to our knowledge, no biomarkers have been identified specifically for assessing beverage intake). Self-reported measures are common in dietary research, and some argue that they may be the only feasible approach to assessing usual intake in community-dwelling individuals.<sup>23</sup> Self-reported methods do have some benefits. For example, self-reported data can be collected by phone or online from children across a wide geographic area without researchers needing to visit data collection sites. Additionally, self-reported measures can query children's usual intake, whereas objective measures such as observations and direct measurements of weight and volume typically assess recent intake (e.g., a single meal or single day). Additionally, retrospective measures like recalls do not

cause children to change their behaviors, whereas children who know they are being observed may change their beverage consumption habits as a result.

Despite these benefits, self-report measures have a number of key limitations. A key issue is that self-reported measures are prone to bias: participants often systematically misreport aspects of their dietary intake, including their beverage intake. Children may misestimate portion size,<sup>30</sup> fail to report items they did consume or report consuming items they did not have,<sup>38,39</sup> be unable to accurately report details about items they did not purchase or prepare, have cognitive difficulty estimating usual intake, or misreport intake because they are unmotivated or because of social desirability bias.<sup>23</sup> Misreporting often varies with participant characteristics, such as obesity status, gender, age, race/ethnicity, and socioeconomic status.<sup>40</sup> In turn, systematic bias in beverage intake data can lead to biased estimates of usual intake and of the relationship between beverage intake and other exposures or outcomes of interest. Concerns about the validity of self-reported dietary intake have led some to suggest that their use be abandoned all-together in favor of objective methods.<sup>41</sup> Further, while currently available objective measures are resource-intensive, they may be more feasible to implement with youth than with adults because youth spend a significant portion of their time in formal institutions such as childcare facilities and schools – locations where objective measures may be easier to collect because in many cases, everyone eats at similar times in one or a few locations, and because standardized meals are often served. Emerging technologies, such as digital photography and image recognition, may increase the feasibility of collecting objective dietary intake data from large or community-based samples, but more work is needed to develop and validate these methods.<sup>41</sup>

### Age Range

Another issue to consider when assessing beverage intake in children and adolescents is the age range of the target population, as age can influence both children's cognitive ability to self-report their intake as well as their motivation to report accurately. Young children (<7 or 8 years) are unlikely to be able to accurately recall their recent dietary intake and cannot accurately report usual consumption frequency.<sup>30,42</sup> Thus, researchers wishing to assess beverage intake in this age group must either rely on proxy report or use objective methods (observation, direct measurement). Typically, proxies are the child's parent or caregiver. Some studies have found that parents are able to accurately report what their child consumes at home.<sup>27,30,42</sup> However, proxy-report may be influenced by the same sources of errors as self-report in general, including that proxies may have difficulty remembering what was consumed, struggle to estimate portion size, or misreport due to social desirability bias.<sup>23</sup> Unfortunately, misreporting may be related to both the proxy's and the child's characteristics. For example, researchers have found that parents' degree of over- or under-reporting on 24-hour recalls of their children's (ages 2-9 years) intake is related to both the child's actual body mass index as well as the proxy's perception of the child's weight.<sup>43</sup> Further, many young children spend a substantial portion of their day in childcare facilities or schools, and parents and caregivers may not know what their child consumed while away-from-home.

As children get older, they become increasingly able to report their own intake. For example, population-based surveys such as the National Health and Nutrition Examination Survey ask elementary school-age children (6-11 years) to report their own intake with the

assistance of a parent or caregiver.<sup>44</sup> However, children in this age range can only accurately report their intake over very short periods, e.g., the previous meal.<sup>21,30</sup> Once youth reach adolescence (age 12 or older), they are generally considered capable of self-reporting their own dietary intake.<sup>42</sup> However, adolescents may still struggle to accurately self-report their beverage intake depending on their literacy level, attention span, capacity for abstract reasoning, and motivation.<sup>31,42</sup> Further, adolescents, like adults, struggle to accurately estimate portion size.<sup>23,30,31,42</sup>

### III. Assessment Methods

#### Introduction

In this section, we begin by providing an overview of each method, as well as key advantages, limitations, and resources related to these methods (Table 1). Next, we provide additional details on recommendations for implementing each method. This information is not meant to be exhaustive, but to provide an introduction to the major methods for assessing beverage intake in children and adolescents, as well as considerations for using these methods. We give special attention to resources for assessing beverage intake with questionnaires or screeners, as this method typically requires the fewer resources to implement, and thus may be feasible to conduct in a variety of evaluation settings (though note the limitations of self-report measured discussed above). Table 2 provides a compilation of available questionnaires for assessing beverage intake in children, as well as brief descriptions of their properties (e.g., validity, reliability, types of beverage intake assessed).

Table 1. Overview of Beverage Consumption Assessment Methods Reviewed

Method	Description	Advantages	Limitations	Resources
Recalls	Respondent reports all beverages consumed over the referent period (usually the preceding 24 hours or preceding day). Respondents generally give detailed information on items consumed, including product descriptions (e.g., low-fat vs. high fat milk, sweetened or unsweetened coffee) and amount consumed. Multiple passes may be used to increase accuracy and completeness. Recalls can be interviewer- or self-administered.	<ul style="list-style-type: none"> <li>• Allow for precise estimation of an individual’s recent consumption</li> <li>• Can estimate usual intake at the group-level</li> <li>• Low literacy if interviewer-administered</li> <li>• Less challenging for participants because of short referent period (usually 24 hours)</li> <li>• Do not cause participants to change their behavior</li> <li>• Open-ended, so can be used across diverse populations</li> </ul>	<ul style="list-style-type: none"> <li>• Self-report measure; participants may not report accurately, and misreporting may be associated with participant characteristics<sup>27,28</sup></li> <li>• Young children cannot accurately recall their own intake; proxy-report will be needed for young children</li> <li>• Unless multiple recalls are collected, data may not represent an individual’s usual beverage consumption</li> <li>• Beverages consumed may need to be coded (e.g., categorized into groups) before analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Procedure manuals for national studies provide details on administering 24-hour recalls with the multi-pass method: <a href="https://perma.cc/T5TW-R293">https://perma.cc/T5TW-R293</a></li> <li>• Multiple-pass, interviewer-administered recalls can be collected via commercial software (e.g., the Nutrition Data System for Research [NDSR]<sup>45</sup>)</li> <li>• The National Cancer Institute offers the ASA-24, free software for collecting self-administered multiple pass 24-hour recalls in English or Spanish: <a href="https://perma.cc/WJ4W-KAUU">https://perma.cc/WJ4W-KAUU</a>. <a href="#">The ASA-24</a></li> </ul>
Diary	Respondent records, in real time, all beverages consumed, including product descriptions and the amount consumed. Typically conducted over one or more days. Respondents may also weigh items consumed to report portion sizes with greater accuracy. Can be completed on paper or electronically.	<ul style="list-style-type: none"> <li>• Allow for precise estimation of an individual’s recent consumption; if several days are collected, may provide a picture of usual consumption for that time of year</li> <li>• Real-time reporting may increase accuracy and detail of reports</li> <li>• Weighed diaries accurately reflect portion size</li> </ul>	<ul style="list-style-type: none"> <li>• Self-reported measure; participants tend to underreport intake. Under-reporting may be related to participants’ characteristics (e.g., body mass index, sex, socioeconomic status)<sup>19,27,28</sup> and may be worse for older compared to younger children.<sup>46</sup></li> <li>• Unless multiple diaries are collected, diaries may not represent an individual’s usual dietary intake</li> <li>• Respondents must be highly literate. Young children cannot complete on their own.</li> <li>• High participant burden</li> <li>• Recording consumption in real-time may change participants’ dietary behaviors</li> <li>• Beverages consumed may need to be coded prior to analysis</li> </ul>	<ul style="list-style-type: none"> <li>• The NDSR software (see also above) can be used to collect and analyze diary data.<sup>45</sup></li> <li>• The National Heart, Lung, and Blood Institute offers printable diaries (<a href="https://perma.cc/Y3YD-YTLY">https://perma.cc/Y3YD-YTLY</a>), though these are not specifically designed for children nor for research purposes.</li> </ul>



## ASSESSING BEVERAGE INTAKE IN CHILDREN AND ADOLESCENTS

Method	Description	Advantages	Limitations	Resources
Questionnaires and screeners	Respondent indicates usual frequency of consumption of specific beverages, sometimes over a specific referent period (e.g., last week, month, or year). Questionnaires assess a finite of beverages using pre-specified response categories (e.g., times per day, per week, or per month). In some questionnaires, usual portion size is also assessed. Brief measures (sometimes called 'screeners') focus on assessing consumption of one or a small number items (e.g., sugar-sweetened beverages). Can be interviewer- or self-administered.	<ul style="list-style-type: none"> <li>• Can estimate respondents' usual beverage intake over longer periods</li> <li>• Less resource intensive to administer than other methods</li> <li>• Focused questionnaires and screeners have low respondent burden</li> <li>• Do not cause participants to change their behavior</li> <li>• Lower data processing costs compared to diaries or recalls.</li> </ul>	<ul style="list-style-type: none"> <li>• More measurement error than other methods (less detail about beverages, less accurate portion size estimation)</li> <li>• Can be cognitively challenging; may be difficult for respondents, particularly younger children, to estimate their usual intake</li> <li>• Closed ended; need to be detailed to respondent population or could miss consumption of key beverage categories</li> <li>• Most suitable for ranking individual consumption relative to others, not for estimating precise intake</li> </ul>	See Table 2
Observation	Researchers observe and visually estimate beverage consumption, generally using standardized forms. Typically used to estimate consumption during a single meal or snack.	<ul style="list-style-type: none"> <li>• Does not rely on self-report, reducing measurement error and bias</li> <li>• Because researcher collects data (rather than participants self-reporting), measure is appropriate for low-literacy populations</li> <li>• Low respondent burden</li> <li>• Relatively precise estimation of recent intake</li> <li>• Can be used with children of any age, since does not depend on their cognitive abilities; avoids use of proxy-report for young children</li> </ul>	<ul style="list-style-type: none"> <li>• May be more resource-intensive than self-reported measures</li> <li>• Unless multiple observations are conducted, data may not represent an individual's usual dietary intake</li> <li>• Require staff to visit the locations where children are observed, limiting geographic scope</li> <li>• Observers need extensive training prior to data collection</li> <li>• Difficult to visually estimate consumption of beverages consumed in opaque containers (e.g., milk or juice cartons, opaque cups or bottles, cans)</li> </ul>	<ul style="list-style-type: none"> <li>• Ball, Benjamin, and Ward (2007) describe a widely-used, reliable, and validated procedure for observing children's food and beverage intake in child care settings.<sup>47</sup></li> <li>• Hanks and colleagues<sup>48</sup> and the Food and Brand Lab's website describe the popular and validated 'quarter-waste' method for visual estimation: <a href="https://foodpsychology.cornell.edu/discoveries/quarter-waste-method">https://foodpsychology.cornell.edu/discoveries/quarter-waste-method</a>.</li> <li>• Kenney and colleagues<sup>49</sup> describe a similar procedure that estimates amount wasted in thirds rather than quarters.</li> <li>• Grummon and colleagues provide an observation form for estimating middle school students' beverage consumption during school lunch time.<sup>50</sup></li> </ul>

## ASSESSING BEVERAGE INTAKE IN CHILDREN AND ADOLESCENTS

Method	Description	Advantages	Limitations	Resources
Direct measurement of weight or volume	Researchers collect direct measurements of weight or volume of beverages consumed by participants. Often done using 'plate waste' methods, in which the researcher measures weight or volume of beverages before they are served, then measures the weight or volume of any leftover items; consumption is estimated as the difference in these two measures. Often used in settings where children are served similar items or standardized meals (e.g., childcare or school meal settings).	<ul style="list-style-type: none"> <li>• Does not rely on self-report, reducing measurement error and bias</li> <li>• Provides accurate estimation of recent intake; if spills and trades are accounted for, can be more accurate than observations</li> <li>• Provides detailed information on types and amounts of beverages consumed</li> <li>• Can be conducted without children's knowledge they are being measured, reducing the potential for behavior change in response to measurement</li> <li>• Can be used with children of any age, since does not depend on their cognitive abilities; avoids use of proxy-report for young children</li> </ul>	<ul style="list-style-type: none"> <li>• Resource-intensive, particularly if individual intake is tracked</li> <li>• Trained research staff, scales/measuring equipment, and space to conduct measurements are needed</li> <li>• Multiple days of measurements must be collected to capture usual intake</li> <li>• Investigators must visit the sites where data is collected, limiting geographic scope</li> <li>• May not be feasible in settings where children are not eating standardized meals</li> <li>• Difficult to link consumption to an individual unless trays or cups are marked</li> </ul>	<ul style="list-style-type: none"> <li>• The Smarter Lunchroom Movement provides a step-by-step guide to assessing children's intake using direct measurements in school cafeterias, as well as free spreadsheets for collecting data: <a href="https://www.smarterlunchroom.org/scorecard-tools/measuring-consumption-smarter-lunchroom-tray-waste">https://www.smarterlunchroom.org/scorecard-tools/measuring-consumption-smarter-lunchroom-tray-waste</a>.</li> <li>• The USDA also provides a brief, non-technical description of 'plate waste' measurement techniques, though note that this document focuses on estimating the percentage of foods/beverages children waste (do not eat) rather than the amount they consume: <a href="https://www.ers.usda.gov/webdocs/publications/43131/31216_efan02009.pdf?v=41423">https://www.ers.usda.gov/webdocs/publications/43131/31216_efan02009.pdf?v=41423</a>.</li> </ul>

### A. Recalls

#### Recommendations for Use

Use a ‘multiple pass’ method. Standard practice, used by major nutrition surveillance surveys such as the National Health and Nutrition Examination Survey (NHANES), is to administer recalls using a multi-pass method in which the respondent reviews her intake more than once in order to capture information about consumption of foods or beverages the respondent may have forgotten on earlier passes. Beverages are often forgotten in a first pass, so using multiple passes is especially important for researchers interested in beverage intake. The United States Department of Agriculture (USDA) Automated Multiple Pass is considered the “gold standard” multi-pass method. In this method, the follow steps are taken:

1. The respondent gives a “quick list” of foods and beverages consumed during the referent period, without taking questions from the interviewer
2. The interviewer probes for consumption of 9 foods and beverages individuals often forget to report
3. The interviewer probes for the time of each eating occasion,
4. The interviewer probes for more detailed information about each item consumed (e.g., asking for portion size, preparation methods), and
5. The interviewer and respondent engage in a final review, with the interviewer asking questions about any reported items not yet reviewed.<sup>51</sup>

**Interviewer-administered vs. self-administered recalls.** Recalls are often interviewer-administered (either in person or by phone), and some recommend this as best practice, as interviewers can improve the accuracy and richness of the data by probing for additional details and forgotten items.<sup>19</sup> Interviewer-administered recalls are also appropriate for low-literacy populations.<sup>52,53</sup> Interviewers should be trained before collecting data to ensure they probe correctly and consistently. However, recalls can also be self-administered. For example, the National Cancer Institute developed a free, online tool for self-administered recalls, the Automated Self-Administered 24-hour Recall (ASA 24).<sup>54</sup> These systems may reduce the cost of collecting recall data.

**Portion size.** Providing respondents with training can help them better estimate portion size, but training is time- and resource-intensive.<sup>30</sup> Booklets explaining portion sizes, or with visual props may help respondents more accurately estimate portion size, though there is debate about whether they are useful for younger children and adolescents.<sup>31</sup>

**Day of the week.** Day of the week can affect what participants eat and drink. Ideally, investigators collect data on consumption during each day of the week in roughly equal proportions.<sup>55</sup> When more than one day of intake is collected from the same participant, it is standard practice to collect one weekday and one weekend day.

**Proxy vs. self-report.** Children over age 12 are generally able to recall their intake over the past day;<sup>31</sup> younger children (ages 8 or 9) may only be able to recall over shorter periods, such as a single meal.<sup>21,30</sup> In general, it is recommended that a proxy report on behalf of children under the age of 10, typically with the child present.<sup>55</sup>

### B. Diaries

#### Recommendations for Use

**Number of days of data collection.** Collecting more than one day is recommended if the investigator wishes to approximate 'usual' consumption. However, respondents may become fatigued if they are asked to complete the diary over too long a period, and consequently report less accurately later in the data collection period. Collecting more than 4 days of diary is discouraged.<sup>19,56</sup>

**Training respondents and reviewing records.** Respondents need to be trained in how to complete the diary and given instructions on the amount of detail the investigator wishes to collect. In some studies, investigators review the first day of the diary with the participants before the participant completes additional days, providing feedback or clarification. When possible, it is recommended that a trained interviewer review the entire diary with the respondent to collect any missing details.

**Modifications.** For investigators interested specifically in beverage consumption, and not in consumption of foods, diaries could be modified to ask respondents to report on their beverage consumption only. Additionally, some diaries use a "checklist" form in which participants check each item they consume from a pre-specified list. Researchers interested in intake of beverages generally, or of specific beverage types, could employ this method, rather than asking participants to record all foods and beverages they consume.

### C. Questionnaires and Screeners

#### Recommendations for Use

**Portion size.** Some frequency questionnaires capture portion size. This information can be captured either by asking respondents for their usual portion size in separate questions, or by indicating a standard portion size in the question itself and asking participants how many of these defined servings they typically consume during the specified period. When portion size is assessed, investigators can compute a quantitative or semi-quantitative estimate of total consumption of a particular beverage type or types over the referent period. When portion size is not captured, investigators must either rely on frequency information alone (e.g., use 'times consumed per day' in analyses) or make an assumption about the portion size usually consumed by participants in their sample.

Some researchers recommend using questionnaires without asking respondents to report serving sizes, as this may reduce participant burden.<sup>19,55</sup> However, others recommend asking respondents to report their usual portion size, as this may improve the accuracy of the questionnaire.<sup>19,57</sup>

**Beverage categories to assess.** Unlike recalls and diaries, in which participants can report all items they consume, questionnaires capture intake only for the pre-specified list of items. Thus, it is crucial to ensure this list is appropriate for use in the target population. When possible, investigators should pilot test their questionnaires with members of the target population and/or with others familiar with measuring intake in this population.

It is difficult to assess consumption for items consumed both as single items and in mixtures. While this issue is often more problematic for assessing foods than beverages,

investigators should consider whether mixed beverages are commonly consumed in their target population (e.g., juice diluted with water, coffee with milk added). If mixed beverages are of interest, the investigator can either: (a) ask the respondent to estimate intake of each component individually (e.g., separately estimate juice and water intake), which may be challenging for respondents to do, or (b) could ask separate questions about each item, which could cause some respondents to double count intake of some beverages.<sup>19</sup>

**Time frame.** Frequency questionnaires differ in the time frame, or referent period, over which intake is assessed. Some questionnaires and screeners ask about recent actual intake. For example, the Youth Risk Behavior Survey (YRBS) asks respondents about their beverage intake over the past 7 days.<sup>58</sup> Other questionnaires assess usual or habitual intake over a longer period; for example, the Block Questionnaire for Ages 2-7 asks about a child's usual eating and drinking habits in the past 6 months.<sup>59</sup>

Longer referent periods are difficult for children. Specifically, research finds that while children can report their dietary intake more accurately over very short referent (a recent meal, past 24 hours), they may not be accurate when reporting over longer referent periods.<sup>21,30</sup> Additionally, while usual beverage consumption is often of interest, it is more cognitively complex –even for adults – to remember and estimate one's usual consumption over a longer period than it is to report consumption at a recent meal or over the past day.

### D. Observation

#### Recommendations for Use

**Training.** Observers should be trained prior to data collection to ensure consistent and accurate reporting. Training typically includes practice visually estimating portion size, watching unobtrusively, and using any standardized forms correctly. Investigators might wish to "certify" their data collectors before collecting study data. For example, Ball and colleagues report certification procedures for data collectors observing meals in child care settings.<sup>47</sup> Some studies also employ quality control checks during data collection periods in which observation forms are reviewed by a member of the research team (see, e.g., Harnack and colleagues<sup>60</sup>), or the same child/children are observed by multiple researchers and agreement among observers is calculated.

**Observer-to-child ratio.** When possible, each observer should be matched 1:1 with a child to observe. However, this is often not feasible. Studies suggest that observers can accurately observe up to 3 children at a time<sup>47,61</sup> and some studies ask observers to observe even more children at a time (e.g., Kenney and colleagues<sup>49</sup> conducted a study in which a single data collector recorded intake for up to 35 children at a time).

**More than one observer.** Because different observers may record child's intake differently, it may be helpful to establish that observers are consistent with one another. To do this, more than one researcher must observe the same child/children, and estimates of intake are compared across the observers, for example using agreement statistics such as Cohen's kappa<sup>62</sup> or Krippendorff's alpha.<sup>63</sup> A Cohen's kappa of 0.61-0.80 is considered 'substantial agreement' and 0.81-0.99 is considered 'almost perfect agreement';<sup>62</sup> depending on research needs, either cutoff might be used when establishing inter-rater consistency.

Krippendorff suggests that  $\alpha > 0.80$  demonstrates adequate inter-rater reliability in many settings.<sup>64</sup>

**Conducting the observation.** Observers should attempt to watch children unobtrusively. While children will often know or notice they are being observed, observers should not talk or interact with children.

**Number of observations.** Investigators wishing to assess usual intake may wish to collect multiple observations, as children's intake can vary greatly from one meal to the next, or one day to the next, and thus one assessment may not reflect children's usual consumption patterns. Single observations can be used to estimate group-level average intake across the sample, but should not be used to predict health outcomes.<sup>28</sup>

**Portion size.** Portion size can be estimated in various ways. For estimating beverage intake, observers might record the number of ounces they observe the child consuming based on starting/ending amounts observed, or based on number of sips they observe the child taking.<sup>50</sup> Another popular method is the 'quarter-waste' method in which researchers estimate consumption in quarters of the starting amount. Hanks and colleagues<sup>48</sup> found that the quarter-waste method correlated well with weighed estimates of intake for beverages (range of correlation coefficients for beverages: 0.67 to 0.93), and performed better than the half-waste method. A similar method was validated by Kenney and colleagues,<sup>49</sup> who found that visual estimates of children's consumption in four categories (0% or 'none', 33% or 'some', 66% or 'most', and 100% or 'all') produce accurate estimates of total beverage servings consumed (correlation coefficient = 0.92), though this method performed less well for estimating water consumption specifically (correlation coefficient = 0.48).

### E. Direct Measurement of Weight or Volume

#### Recommendations for Use

**Individual vs. aggregate intake.** Direct measurement can be used to assess individual's intake or aggregate intake of a group (e.g., a classroom). To assess individual intake, each child's starting and ending amount of each beverage must be measured and recorded. Investigators must therefore devise a system to pair each child's starting and ending amounts, for example, by placing ID numbers on each child's tray or cup. To assess aggregate intake, the total starting amount is calculated by weighing/measuring each type of item served and multiplying this measurement by the number of times this item was served. Individuals' beverage leftovers are combined, often separated by beverage type (e.g., orange juice leftovers are combined separately from milk leftovers) and the aggregated leftovers are measured. Investigators then estimate the total amount consumed by all children by subtracting the amount leftover from the starting amounts. Mean individual intake can be calculated by dividing this total amount consumed by the number of children at the meal.

**Assess only edible portions consumed.** Only the edible portion of beverages should be 'counted' toward estimates of total amount consumed. In practice, this means that if a researcher weighs a pre-meal beverage while it is still in its serving container, the investigator must either also weigh leftovers in the serving container (so that the weight of the container is 'differenced out' when calculating total amount consumed). Or, the weight of an empty container must be measured and this weight subtracted from the starting weight.

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**Stay out of sight.** Whenever possible, children should be unaware that their intake is being monitored, so that they are less likely to change their consumption in response to being measured. Investigators might choose to mark children's trays or cups unobtrusively (e.g., a sticker underneath the tray), and might also weigh/measure beverages in a separate room, out of children's sight.

**Account for spills and trades.** To increase accuracy, investigators should (unobtrusively) observe children during the meal and record (a) when children take additional servings of any items of interest (and, if individual intake is being assessed, which children take additional servings and how many each takes) and (b) whether any beverages are spilled, and if so, about how much was spilled. Spills should be subtracted from estimates of total amount consumed. Additionally, for investigators wishing to measure individual intake, observers should record if individual children swap or trade any beverage items.

### F. Resources for Assessing Children's Beverage Intake Using Questionnaires and Screeners

Questionnaires and screeners are often less resource intensive than the other types of beverage intake assessment methods, and thus many investigators are interested in using these instruments. Table 2 provides a number of resources for assessing children's beverage intake using questionnaires and screeners, including information on time-to-complete the questionnaire/screener, literacy level required, types of beverages assessed, languages available, validity and/or reliability information, and recent (past ten years) examples of the instruments' use or validation in low-income and/or minority populations.


This table is not meant to be an exhaustive list of all available questionnaires and screeners, but rather illustrative of a number of options available for researchers. We have included in this table all of the questionnaires and screeners that we identified in our systematic review as having recently published (2007-2017) primary data on criterion validity (correlation with a "gold-standard" method) and/or reliability.


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### Table 2. Questionnaires Assessing Beverage Intake in American Children and Adolescents


#### Key & Notes:



The questionnaires included here are organized by the age range they were developed to assess, sorted from youngest to oldest based on the lower end of the age range (e.g., a survey used among children ages 3-12 years is listed before one used with ages 5-8 years). Grade levels are used in place of ages as needed. This table is meant to provide a resource for researchers looking to assess beverage intake in a particular population (e.g., a certain age group, literacy level, racial/ethnic background, or income level), using a particular language, with specific properties (e.g., validated), or focused on particular beverage categories. Each row describes a different questionnaire or screener; columns describe key features of that instrument.

 = Criterion validity and/or any type of reliability has been assessed for this questionnaire. Does not mean that validity/reliability were adequate, only that these properties have been assessed and reported on for this questionnaire. See validity and reliability columns for additional details.

 = Questionnaire has been used and/or validated in a racially diverse sample




 = Questionnaire has been used and/or validated in a lower-income sample

 = Literacy level assessed, and questionnaire is appropriate for as 8<sup>th</sup> grade reading level or lower



Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
California Health Interview Survey (CHIS), adult respondent   	Questions can be found here: <a href="http://healthpolicy.ucla.edu/chis/design/Pages/questionnairesEnglish.aspx">http://healthpolicy.ucla.edu/chis/design/Pages/questionnairesEnglish.aspx</a> (English)  and here: <a href="http://healthpolicy.ucla.edu/chis/design/Pages/Questionnaires%20(Translated).aspx">http://healthpolicy.ucla.edu/chis/design/Pages/Questionnaires%20(Translated).aspx</a> (Translated)	Proxy report of child's (ages: 0-11 years) consumption of beverages (number of bottles, cans) 'yesterday.'	~15 minutes for all items about child; <sup>65</sup> beverage items should take < 5 minutes	Not reported	Not reported for beverage intake	Not reported for beverage intake	<ul style="list-style-type: none"> <li>English</li> <li>Spanish</li> <li>Cantonese</li> <li>Mandarin</li> <li>Korean</li> <li>Vietnamese</li> <li>Tagalog</li> </ul>	<ul style="list-style-type: none"> <li>Developed for use in large samples of Californians that would include minorities and low-income households.</li> </ul>	<ul style="list-style-type: none"> <li>Soda (non-diet)</li> <li>Sweetened fruit drinks, sports and energy drinks</li> </ul>




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Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
Self-Administered Questionnaire for assessing water intake and intake of other beverages 	See Gorelick et al. (2008). <sup>66</sup>	Developed by to assess water exposure (including usual water consumption) among emergency department patients. <sup>66</sup> Proxy reports on child's (ages: 0-18 years) consumption (yes/no) of beverages during the child's current illness.	Not reported	Appropriate for use in lower-literacy populations: Flesch-Kincaid score was 5.3 (~5 <sup>th</sup> grade reading level). <sup>66</sup>	Not reported	In parents of children presenting at an emergency department (n = 94), next-day test-retest reliability was adequate (kappa > 0.40) for items related to usual water consumption and for recent consumption of tap water, bottled water, juice, milk, infant formula, soda, sports drinks, and electrolyte drinks. Inter-rater agreement among caregivers of the same child was adequate for these beverage categories, except for juice (kappa = 0.16). <sup>66</sup>	<ul style="list-style-type: none"> <li>English</li> </ul>	Validation: <ul style="list-style-type: none"> <li>Reliability was assessed in a relatively diverse sample of parents (63% white, 19% African American, 11% mixed race, and 12% Latino).<sup>66</sup></li> </ul>	<ul style="list-style-type: none"> <li>Usual water consumption</li> <li>Consumption of the following beverages during the child's current illness:               <ul style="list-style-type: none"> <li>Tap water</li> <li>Bottled water</li> <li>Juice</li> <li>Milk</li> <li>Infant formula</li> <li>Soda</li> <li>Sports drinks</li> <li>Electrolyte drinks</li> </ul> </li> </ul>
Food Frequency Questionnaire (FFQ) for 1-3-year-old children from tri-ethnic, low-income families 	Developed by Klohe et al. (2005) <sup>67</sup> for use with low-income white, Hispanic, and African American children. <sup>67</sup>	Proxy reports child's (ages: 1-3 years) usual intake (frequency and qualitative portion size) of foods and beverages using 191 items.	Not reported	Not reported	In a sample of 52 parents, most children (94%) were classified in the same or within one quartile for servings per day of sweetened beverages by the FFQ and a 3-day diary. Response to the FFQ significantly correlated with 3-day diaries for consumption of orange juice, apple juice, sweetened beverages, reduced-fat milk, and whole milk. <sup>67</sup>	In a sample of 25 parents, 2-week test-retest reliability for sugar-sweetened beverage consumption was 0.74. <sup>67</sup> Inter-rater reliability among 2 caregivers/parents reporting on the same child's intake ranged from kappa = 0.16 (juice) to 1.00 (sports drinks).	English	Validation: <ul style="list-style-type: none"> <li>Validated among white, Hispanic, and African American low-income mothers (all were participants in the Special Supplemental Nutrition Assistance Program for Women, Infants, and Children [WIC] with incomes &lt; 200% of the Federal Poverty Level).<sup>67</sup></li> </ul>	<ul style="list-style-type: none"> <li>Sweetened beverages (sodas, ades, and sweetened teas)</li> <li>Orange juice</li> <li>Apple juice</li> <li>Reduced-fat milk</li> <li>Whole milk</li> </ul>
Food Frequency Questionnaire for children of Mexican descent 	Developed by Vera-Becerra et al. (2016) for use measuring food acculturation among children of Mexican descent. <sup>68</sup>	Proxy reports child's (ages: 1-6 years) frequency of consumption of 30 items.	Not reported	Not reported	In Mexican-descent children ages 1-6 years from the U.S. and Mexico, responses to the questionnaire were significantly correlated with consumption reported on a 24-hour recall for whole milk, low-fat milk, soda, fruit drinks, and 100% juice (both fresh and canned). <sup>68</sup>	Not reported	Spanish	Validation: <ul style="list-style-type: none"> <li>Validated in a sample of Mexican-origin children in urban areas of the U.S. as well as urban and rural areas of Mexico.<sup>68</sup></li> </ul>	<ul style="list-style-type: none"> <li>Whole milk</li> <li>Low-fat milk</li> <li>Soda</li> <li>Fruit drink/aquas frescas</li> <li>100% juice (fresh)</li> <li>100% juice (canned)</li> </ul>



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Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
<p>Child Food and Beverage Intake Questionnaire (CFBIQ) (embedded within the LA County Women, Infants, and Children [WIC] Survey)</p> 	<p>Items can be found in Koleilat and Whaley (2016)<sup>69</sup> and at the Los Angeles County WIC Data website: <a href="http://lawicdata.org/survey/">http://lawicdata.org/survey/</a></p>	<p>Proxy reports child's (grades: preschool) usual intake of beverages. Some items capture frequency only; other are semi-quantitative.<sup>69</sup></p>	<p>3 minutes<sup>69</sup></p>	<p>Not reported</p>	<p>Validated against three 24-hour recalls with WIC participants with children ages 2-4 years (n = 70). Correlation coefficients between CFBIQ and 24-hour recalls were significant for milk, chocolate/sweetened milk, fruit drinks, 100% fruit juice, sweetened drinks and total sugar-sweetened beverages (composite of fruit drinks sodas, and sweetened drinks). CFBIQ did not correlate significantly with 24-hour recall estimates of soda consumption.<sup>69</sup></p>	<p>In a sample of 70 WIC participants with children ages 2-4-years, test-retest reliability was adequate for all beverage categories assessed (range of ICCs = 0.48-0.87).<sup>69</sup></p>	<ul style="list-style-type: none"> <li>English</li> <li>Spanish</li> </ul>	<p>Validation:</p> <ul style="list-style-type: none"> <li>Validity and reliability testing was conducted in a low-income sample (all respondents were WIC participants).<sup>69</sup> Additionally, the items are meant to be fielded to all WIC participants, which would include parents of diverse racial/ethnic backgrounds.</li> </ul>	<ul style="list-style-type: none"> <li>Milk</li> <li>Chocolate or sweetened milk</li> <li>100% fruit juice</li> <li>Fruit drinks</li> <li>Sweetened drinks (e.g., Sunny Delight)</li> <li>Regular sodas</li> </ul>
<p>Block Kids Questionnaire for Ages 2-7</p> 	<p>Available from Nutrition-Quest.<sup>59</sup></p>	<p>Proxy reports on 90 items assessing child's (ages: 2-7) usual intake (frequency and portion size) over the past 6 months.</p>	<p>~30 minutes for the full questionnaire<sup>59</sup></p>	<p>Not reported</p>	<p>None reported</p>	<p>None reported</p>	<p>English</p>	<p>Use:</p> <ul style="list-style-type: none"> <li>Hare et al. (2012) used in a primarily African-American sample with about 50% of households earning &lt;\$30,000/year.<sup>70</sup></li> </ul>	<ul style="list-style-type: none"> <li>Sweetened (sugary) beverages</li> <li>Fruit juice</li> </ul>





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Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
Block Food Screeners for Ages 2-17 	Available from Nutrition-Quest. <sup>59</sup>	Proxy or child reports on child's (ages: 2-17 years) consumption of items 'yesterday' or 'last week' (depending on version)	10-12 minutes for the full screener	Approximately 3 <sup>rd</sup> grade reading level <sup>71</sup>	Validated for use in 10-17-year-old children for assessing fruit/fruit juice, vegetables, potatoes, whole grains, saturated fat, meat/poultry/fish, dairy, legumes, sugar, and average daily glycemic index and load. <sup>72</sup> Mulasi-Pokhriyal et al. (2013): used in a sample of Hmong-American children ages 9-18, but found that it did not validly capture milk intake compared to a 24-hour recall. <sup>73</sup> No other studies of validity for assessing beverage intake reported.	None reported	<ul style="list-style-type: none"> <li>English, Spanish ('last week' version only)</li> </ul>	Use: <ul style="list-style-type: none"> <li>Colorado Longitudinal Eating and Physical Activity (LEAP) study used screener in a white &amp; Hispanic low-income sample of caregivers of preschoolers.<sup>71</sup></li> <li>Kolker et al. (2007): used in a sample of low-income parents of African American children ages 3-5 years living in the Detroit, MI area.<sup>74</sup></li> </ul> Validation: <ul style="list-style-type: none"> <li>Mulasi-Pokhriyal et al. (2013): used in a sample of Hmong-American children ages 9-18, but found that it did not validly capture milk intake compared to a 24-hour recall.<sup>73</sup></li> </ul>	<ul style="list-style-type: none"> <li>Sweetened (sugary) beverages</li> <li>Milk</li> </ul>



## ASSESSING BEVERAGE INTAKE IN CHILDREN AND ADOLESCENTS

Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
Beverage Intake Questionnaire for Hispanic Preschool-aged Children (BEVQ-PS) 	See Lora et al. (2016). <sup>75</sup>	Proxy reports on child's (ages: 3-5 years) intake (frequency, portion size) of beverages during the past month.	3-5 minutes <sup>75</sup>	Lora et al. (2016) report that mothers found the BEVQ-PS easy to understand, but that mothers preferred the questionnaire read aloud to them. Literacy level was not explicitly reported.	In mothers of preschool children (n = 109), correlations between BEVQ-PS and 4-day food diaries were significant for water, juice drinks, whole milk, and sweetened carbonated drinks, and total sugar-sweetened beverages but were not significant for fruit juice, reduced-fat milk, low-fat/fat-free milk, flavored milk, diet carbonated drinks, tea with or without artificial sweetener, sports drinks, total beverage intake. <sup>75</sup>	In mothers of preschool children (n = 109), 1-week test-retest reliability was significant for all beverage categories except tea with or without artificial sweetener and flavored milk. Test-retest reliability was also significant for total sugar-sweetened beverages and total beverage grams and calories. <sup>75</sup>	<ul style="list-style-type: none"> <li>English</li> <li>Spanish</li> </ul>	Validation: <ul style="list-style-type: none"> <li>Validity and reliability assessed among low-income Hispanic mothers.<sup>75</sup></li> </ul>	<ul style="list-style-type: none"> <li>Water</li> <li>100% fruit juice</li> <li>Sweetened juice beverage/fruit drink</li> <li>Whole milk</li> <li>Reduced fat milk</li> <li>Low fat/fat-free milk</li> <li>Flavored milk</li> <li>Sweetened carbonated drinks or soda</li> <li>Diet carbonated drinks, diet soda, or artificially sweetened drinks</li> <li>Sweetened tea</li> <li>Tea with or without artificial sweetener</li> <li>Sports drinks</li> <li>Total sugar-sweetened beverages</li> <li>Total beverages</li> </ul>
Healthy Children, Healthy Family Behavior Checklist (HCHF-BC) 	Developed by Dickin et al. (2012) to evaluate a behavioral intervention for children in New York State. <sup>76</sup>	Proxy reports on child's (ages: 3-11 years) usual consumption (frequency) of soda.	5-10 minutes for full questionnaire. <sup>76</sup>	Field testing and cognitive interviewing conducted to ensure understanding, but literacy level not explicitly reported. <sup>76</sup>	Among parents (n = 66) across New York state, the soda item on the HCHF-BC correlated significantly with the Food Behavior Checklist <sup>77</sup> and with the Child Food Frequency Questionnaire. <sup>78</sup>	In a sample of primarily white parents (n = 38), 2-week test-retest reliability averaged 0.83 across all items on the checklist (reliability of soda item not reported separately). <sup>76</sup>	<ul style="list-style-type: none"> <li>English</li> <li>Spanish</li> </ul>	Use: <ul style="list-style-type: none"> <li>Field tested in a diverse sample (two-thirds non-White).<sup>76</sup></li> </ul> Validation: <ul style="list-style-type: none"> <li>Validity assessed in diverse sample (27% Latino, 30% African American).<sup>76</sup></li> </ul>	<ul style="list-style-type: none"> <li>Soda</li> </ul>



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Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
Parent questionnaires for the Early Childhood Longitudinal Study Birth Cohort and Kindergarten Cohort 	Questionnaires vary by wave. Instruments available here: <a href="https://nces.ed.gov/ecls/birthinstruments.asp">https://nces.ed.gov/ecls/birthinstruments.asp</a> and here: <a href="https://nces.ed.gov/ecls/kingergarten.asp">https://nces.ed.gov/ecls/kingergarten.asp</a>	Proxy report of children's (grades: preschool, kindergarten) frequency of consuming beverages (3 items) during the past 7 days.	<5 minutes	Not reported	Not reported	Not reported	English	<ul style="list-style-type: none"> <li>Developed for use in nationally representative samples that would include minorities and low-income households.</li> </ul>	<ul style="list-style-type: none"> <li>Milk (frequency and type)</li> <li>100% juice</li> <li>Soda, sports drinks, or fruit drinks</li> </ul>
EMPOWER questionnaire 	See Knowlden (2015a and 2015b) <sup>79,80</sup>	Proxy reports on child's (ages: 4-6 years) consumption (total glasses) of sugar-free beverages 'yesterday.'	Not reported	Not reported	Not reported	2-week test-retest reliability correlation coefficient of 0.71 for child's consumption of sugar-free beverages. <sup>79,80</sup>	English	None reported	<ul style="list-style-type: none"> <li>Sugar-free beverages</li> </ul>
Iowa Fluoride Study Targeted Nutrient Questionnaire 	See Marshall et al. (2008). <sup>81</sup>	Proxy reports (with child input as appropriate) on child's (ages: ~8-9 years) consumption (any consumption, number of servings) during the past week of foods and beverages related to bone health.	Not reported	Not reported	In a primarily white sample (n = 223), correlation coefficients with 3-day food diaries completed 4 to 9 months before the questionnaire were statistically significant for all beverage categories (range: 0.252 to 0.572). <sup>81</sup>	Not reported	English	None reported	<ul style="list-style-type: none"> <li>Total milk</li> <li>100% juice</li> <li>Juice drinks</li> <li>Soda</li> <li>Water</li> </ul>
Food Behavior Checklist Modified for Children (FBC-MC) 	Branscum et al. (2010) <sup>82</sup> describes the development of the checklist and gives sample items.	Children (ages: 8-10 years) self-report consumption of 14 food and beverage categories (yes/no)	<5 minutes	Not reported	Experts assessed face validity and construct validity; <sup>82</sup> criterion-related validity not reported.	Not reported	English	<ul style="list-style-type: none"> <li>Branscum et al. (2010) developed the checklist for use in a low-income, majority-minority sample.<sup>82</sup></li> </ul>	<ul style="list-style-type: none"> <li>Milk</li> <li>Sugar-sweetened beverages</li> </ul>




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Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
Block Questionnaire for Ages 8-17 	Available from Nutrition-Quest. <sup>59</sup>	Children (ages: 8-17 years) self-report their usual intake (frequency, portion size) of 77 items over the previous six months.	Approximately 25 minutes to complete the full questionnaire <sup>59</sup>	Not reported	One study found good correlations between the questionnaire and a 3-day diary in children ages 6-10 years for milk, 100% juice, fruit drinks, and soda. <sup>83</sup> Another study found that correlation with 24-hour recall was lower, only 0.11, for assessing intake of 100% juice in children 10-17 years. <sup>84</sup>	Adequate reliability for assessing intake of 100% juice in children 10-17 years. <sup>84</sup>	<ul style="list-style-type: none"> <li>English</li> <li>Spanish</li> </ul>	Use: <ul style="list-style-type: none"> <li>Smith and Fila use in a Native American sample.<sup>85</sup></li> <li>Wright (2015) used in a diverse sample in the Boston area.<sup>86</sup></li> <li>Detroit Dental Health Project used with low-income African American children ages 0-5 years.<sup>87</sup></li> <li>Texas Childhood Obesity Research Demonstration Study (TX-CORD) used Hispanic Block Questionnaire in a diverse sample of children ages 2-12 years.<sup>88</sup></li> </ul>	<ul style="list-style-type: none"> <li>Milk</li> <li>100% juice</li> <li>Fruit drinks</li> <li>Soda</li> </ul>
4 <sup>th</sup> grade version, School Physical Activity and Nutrition (SPAN) Survey 	The full SPAN questionnaire can be found here: <a href="https://sph.uth.edu/research/centers/dell/projects/ct.htm?project=3037edaa-201e-492a-b42f-f0208ccf8b29">https://sph.uth.edu/research/centers/dell/projects/ct.htm?project=3037edaa-201e-492a-b42f-f0208ccf8b29</a>	Children (grades: 4 <sup>th</sup> ) self-report their frequency of consumption of foods and beverages 'yesterday.' Does not assess portion size.	20-45 minutes to administer the all SPAN items, <sup>89</sup> beverage questions <5 minutes.	Estimated to have a 4 <sup>th</sup> grade reading level. <sup>89</sup>	In fourth-graders, SPAN responses correlate adequately with 24-hour recall for sodas/soft drinks, 100% fruit juice, fruit-flavored drinks and sports drinks, and milk (correlation coefficients all 0.41-0.56). <sup>90</sup>	2-hour test-retest reliability was good for the two beverage categories assessed (milk, fruit juice) in a sample of 9- and 10-year-old students. <sup>91</sup>	<ul style="list-style-type: none"> <li>English</li> <li>Spanish</li> </ul>	Use: <ul style="list-style-type: none"> <li>Evans et al. (2016) used SPAN items in a primarily minority and low-income sample.<sup>92</sup></li> <li>Developed for use in schools across Texas which would include minority and low-income participants. Also used in the Massachusetts Childhood Obesity Research Demonstration (CORD) study, focused on low-income communities.<sup>93</sup></li> </ul> Validation: <ul style="list-style-type: none"> <li>Reliability and validity assessed in two diverse samples.<sup>90,91</sup></li> </ul>	<ul style="list-style-type: none"> <li>Milk (including milk on cereal and drinks made with milk)</li> <li>Fruit juice</li> <li>Fruit-flavored drinks or sports drinks</li> <li>Regular soda</li> <li>Diet soda</li> </ul>

## ASSESSING BEVERAGE INTAKE IN CHILDREN AND ADOLESCENTS



Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
Food, Health, Choices Questionnaire (FHC-Q)  	Developed by Gray et al. (2016) for use with 4 <sup>th</sup> - and 5 <sup>th</sup> -graders in New York City public schools. <sup>94</sup>	Children (grades: 4 <sup>th</sup> and 5 <sup>th</sup> ) self-report on their energy-balance-related behaviors, including consumption (frequency, portion size) of sugar-sweetened beverages during the past week.	Not reported	Cognitive tests conducted to ensure understanding, but literacy level not explicitly reported. <sup>94</sup>	Correlation coefficients in elementary school students (n=66) between the FHC-Q and the Beverage and Snack Questionnaire <sup>95</sup> were significant for fruit drinks, sodas, sports drinks, and flavored water (range: 0.26-0.72). <sup>94</sup>	2-week test-retest reliability in elementary school students (n=155) for combined sugar-sweetened beverage items was high (range: 0.77-0.86, depending on mode of administration). <sup>94</sup>	<ul style="list-style-type: none"> <li>English</li> </ul>	Validation: <ul style="list-style-type: none"> <li>Validity and reliability assessed in schools that were primarily minority (27% African American, 69% Hispanic) and low-income (98% eligible for free or reduced price lunch).<sup>96</sup></li> </ul>	<ul style="list-style-type: none"> <li>Fruit drinks or sweetened iced teas</li> <li>Sodas</li> <li>Sports drinks</li> <li>Flavored waters</li> </ul>
Youth Adolescent Food Frequency Questionnaire (YAQ)  	Documents for administering the YAQ can be found here: <a href="https://regepi.bwh.harvard.edu/health">https://regepi.bwh.harvard.edu/health</a>	Assesses child's (ages: 9-17 years) consumption (frequency, portion size) of foods and beverages over the past year.	20-30 minutes for full YAQ	Not reported	Good validity against 24-hour recall for assessing energy and nutrient intakes in a sample of mostly white/Caucasian 9-17 years. <sup>97</sup> A study of African American and Hispanic middle school students found lower validity vs. diaries for energy, fat, fruit, juice, and vegetables (no other beverage categories assessed). <sup>98</sup>	Rockett and colleagues report 1-year test-retest correlation of 0.57 for soda and 0.56 for milk. <sup>99</sup> In a sample of African American and Hispanic middle school students, Cullen and Zakeri report 3-week test-retest correlation of 0.37 for juice. <sup>98</sup>	<ul style="list-style-type: none"> <li>English; see Elder (2014) for use in a Spanish-speaking population</li> </ul>	Use: <ul style="list-style-type: none"> <li>The YAQ was used by Project Eating Among Teens (EAT), which followed a racially and economically diverse sample of teens attending school in the Minneapolis/St. Paul, MN area.<sup>100-102</sup></li> <li>Elder et al. used beverage items from the YAQ in the me Muevo study of children 5-8 years, 41% of whom were Latino<sup>103</sup></li> </ul> Validation: <ul style="list-style-type: none"> <li>Cullen and Zakeri found good reliability but only modest validity in a sample of African American and Hispanic middle school students.<sup>98</sup></li> </ul>	<ul style="list-style-type: none"> <li>Diet soda</li> <li>Soda (non-diet)</li> <li>Sweetened tea and fruit drinks</li> <li>Sports drinks</li> <li>Sugar-free or low-calorie energy drinks</li> <li>Regular energy drinks</li> <li>Smoothies</li> <li>Milkshakes</li> <li>Hot tea with caffeine</li> <li>Decaffeinated coffee</li> <li>Regular coffee</li> <li>Coffee drinks (with nonfat or whole milk; iced)</li> <li>Water</li> <li>Beer</li> <li>Wine or wine coolers</li> <li>Liquor</li> </ul>

## ASSESSING BEVERAGE INTAKE IN CHILDREN AND ADOLESCENTS



Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
Child questionnaires for the Early Childhood Longitudinal Study Kindergarten Cohort 	Questions about beverage intake are similar in both the 5 <sup>th</sup> and 8 <sup>th</sup> grade surveys, and can be found here: <a href="https://nces.ed.gov/ecls/pdf/fifthgrade/childfoodconsumption.pdf">https://nces.ed.gov/ecls/pdf/fifthgrade/childfoodconsumption.pdf</a>	Child (grades: 5 <sup>th</sup> grade, 8 <sup>th</sup> grade) self-reports frequency of consuming beverages (3 items) during past 7 days.	<5 minutes	Not reported	Not reported	Not reported	<ul style="list-style-type: none"> <li>English</li> </ul>	Use: <ul style="list-style-type: none"> <li>Developed for use in nationally representative samples that would include minorities and low-income households.</li> </ul>	<ul style="list-style-type: none"> <li>Milk (frequency and type)</li> <li>100% juice</li> <li>Soda, sports drinks, or fruit drinks</li> </ul>
5-a-Day Food Frequency Questionnaires 	Items shown in Di Noia (2009). <sup>104</sup>	Children (ages: 10-14 years) self-report their usual intake (frequency) of fruit, juice, and vegetables during the past month	<5 minutes	Not reported	Juice intake as reported on the questionnaire was weakly but not significantly correlated with direct observations of intake during a summer camp meal ( $r=0.15$ and $p > 0.05$ ). Participants underestimated their intake on the questionnaire compared to observations. <sup>104</sup>	Not reported	<ul style="list-style-type: none"> <li>English</li> </ul>	Validation: <ul style="list-style-type: none"> <li>Validity assessed among African American adolescents, but note that correlation between questionnaire and observation was low and not significant.<sup>104</sup></li> </ul>	<ul style="list-style-type: none"> <li>100% fruit juice</li> </ul>
SEARCH FFQ for children with type 1 diabetes 	Questionnaire described by Liese et al. (2015). <sup>105</sup>	Adapted from the Block FFQ for youth with type 1 diabetes. Child (ages 10-24) self-report consumption (frequency, portion size) during past week.	Not reported	Not reported	Good validity for assessing sugar-sweetened beverage and fruit drink intake against 24-hour recall in 10-24 year olds with type 1 diabetes. <sup>105</sup>	Good 1-month test-retest reliability for assessing sugar-sweetened beverage and fruit drinks intake against 24-hour recall in 10-24 year olds with type 1 diabetes. <sup>105</sup>	<ul style="list-style-type: none"> <li>English</li> </ul>	Use: <ul style="list-style-type: none"> <li>SEARCH study in which the FFQ was fielded included a sample that was about 27% non-White.<sup>106</sup></li> </ul> Validation: <ul style="list-style-type: none"> <li>Validation conducted in a sample with 15% African American and 11% other minority children.<sup>105</sup></li> </ul>	<ul style="list-style-type: none"> <li>Sugar-sweetened beverages and fruit-flavored drinks</li> </ul>





## ASSESSING BEVERAGE INTAKE IN CHILDREN AND ADOLESCENTS

Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
<p>Screener to assess fast food and beverage intake in adolescents</p> 	Items can be found in Nelson & Lytle (2009). <sup>107</sup>	Adolescents (ages: 11-18 years) self-report consumption of beverages during past month. Assess frequency for: regular soda, diet soda, sports drinks, other sweetened beverages, milk, and coffee drinks. Assess amount for: regular soda, diet soda, and water.	<10 minutes	Not reported	<p>Nelson and Lytle<sup>107</sup> validated against three 24-hour recalls in primarily white adolescents. Correlation coefficients frequency of consumption of regular soft drinks, sports drinks, and milk were significant; range: 0.25-0.38. Correlation for other sweetened beverages was 0.11 (p = 0.11). Validity could not be assessed for diet soft drinks or coffee drinks. Correlations for amount of regular soft drinks and water consumed were significant (range 0.19-0.20). Others examined validity in a sample of 35 female Latinas aged 14-17 years in East Los Angeles, CA. Compared to 3-day diet records, kappa statistics (κ's) for individual beverage categories ranged from 0.01 to 0.18; none were significant.<sup>108</sup></p>	<ul style="list-style-type: none"> <li>In a primarily white sample, Nelson &amp; Lytle<sup>107</sup> report 1- to 2-week test-retest reliability correlation coefficients for frequency of beverage consumption were significant for all beverage categories (range: 0.63-0.84). Kappa statistics or amount of regular soft drink, diet soft drink, and water consumption were significant (range: 0.59-0.73).</li> <li>In 35 Latina adolescents,<sup>108</sup> 1-week test-retest reliability correlation coefficients for frequency of consumption of regular soda, diet soda, sports drinks, sweetened beverages, milk, and coffee drinks ranged from 0.53 to 0.71 (all p's &lt; 0.05). Reliability for amount of regular soda, diet soda, and water consumed had κ's between 0.44-0.61 (p's &lt; 0.01).</li> </ul>	<ul style="list-style-type: none"> <li>English</li> </ul>	<p>Validation:</p> <ul style="list-style-type: none"> <li>Modified version of the screener was found to be reliable but not valid for assessing beverage intake in a sample of 35 Latina females ages 14-17 in East Los Angeles, CA.<sup>108</sup></li> </ul>	<ul style="list-style-type: none"> <li>Regular soda</li> <li>Diet soda</li> <li>Sports drinks</li> <li>Other sweetened beverages</li> <li>Milk</li> <li>Coffee drinks</li> <li>Water</li> </ul>
<p>Single item for assessing milk consumption</p> 	Item is described by Mays (2011) <sup>109</sup>	Adolescents and young adults (ages: 11-21 years) self-report on their frequency of milk consumption using a single item.	<1 minute	Not reported	In a sample of survivors of childhood cancer ages 11-21 (n = 75), correlation coefficient between the milk item and total dietary calcium as assessed via a food frequency question was 0.31. <sup>109</sup>	Not reported	<ul style="list-style-type: none"> <li>English</li> </ul>	None reported	<ul style="list-style-type: none"> <li>Milk</li> </ul>



## ASSESSING BEVERAGE INTAKE IN CHILDREN AND ADOLESCENTS

Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
10-item Food Frequency Questionnaire for assessing water intake 	Developed and used by Baranowski et al. (2010) to assess water intake in middle school students in 7 sites across the U.S. <sup>110</sup>	Children (grades: middle school) self-report consumption of water (glasses) with breakfast, lunch, dinner, for a snack after school, and at others times, on school days vs. non-school days.	<5 minutes	Cognitive interviewing suggested middle schoolers can understand items, but literacy level not explicitly reported. <sup>110</sup>	In a sample of 6 <sup>th</sup> grade students, mean intake of water reported on the FFQ was higher than reported in a 24-hour recall; no other validation information provided. <sup>110</sup>	In a sample of 6 <sup>th</sup> grade students, internal consistency of the 10 water consumption items was high (ICC = 0.85).	<ul style="list-style-type: none"> <li>English</li> </ul>	Validation: <ul style="list-style-type: none"> <li>Development and validation occurred in a diverse sample of middle schoolers from 7 sites in the U.S.; ~50% Hispanic/Latino and ~25% African American.<sup>110</sup></li> </ul>	Water
EatWalk Survey 	Developed to evaluate an intervention for New York City middle school students. <sup>111,112</sup> Items can be found in Contento (2010). <sup>111</sup>	Children (grades: middle school) self-report their consumption (frequency, portion size) of water and sweetened beverages during the past week. <sup>112</sup>	Not reported	Cognitive interviewing conducted to improve clarity, but literacy level not explicitly reported. <sup>111</sup>	Contento and colleagues <sup>111,112</sup> validated the EatWalk survey against the original Block instrument and against 24-hour recalls (n = 60). Agreement within 1 standard deviation ranged from 54% to 75%. Correlations between EatWalk responses and 24-hour recalls ranged from 0.30 to 0.60.	In a sample of 27 middle school students, test-retest reliability correlations ranged from 0.30-.80 for all items on EatWalk survey, with most between 0.40-0.60 (reliability for beverage items not reported separately).	<ul style="list-style-type: none"> <li>English</li> </ul>	Use: <ul style="list-style-type: none"> <li>Used in a diverse, low-income sample of New York City middle school students (~ 25% African American, ~70% Latino, ~78% eligible for free or reduced price lunch).</li> </ul> Validation: <ul style="list-style-type: none"> <li>Authors report that reliability and validity testing occurred in sample with diverse racial/ethnic backgrounds.<sup>111</sup></li> </ul>	<ul style="list-style-type: none"> <li>Water</li> <li>Sweetened beverages</li> </ul>



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Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
Beverage and Snack Questionnaire (BSQ)  	Development is described by Neuhouser et al. (2012). <sup>95</sup> Items can be found here: <a href="https://sharedresources.fredhutch.org/sites/default/files/SnackQSample.pdf">https://sharedresources.fredhutch.org/sites/default/files/SnackQSample.pdf</a>  See also a modified version here: <a href="http://sharedresources.fredhutch.org/sites/default/files/BSQ2_Sample.pdf">http://sharedresources.fredhutch.org/sites/default/files/BSQ2_Sample.pdf</a>	Children (grades: middle school) self-report consumption (frequency only) of 19 items (9 beverages) at and away from school during past week.	<10 minutes	Not reported	In a sample of 7 <sup>th</sup> graders, Neuhouser et al. reported an average correlation coefficient of 0.70-0.71 between the BSQ and a 4-day diary for beverages (range 0.56-0.87). <sup>95</sup>	In a sample of 7 <sup>th</sup> graders, Neuhouser et al. reported an average 2-week test-retest reliability of 0.74-0.77 for beverages in a sample of middle school students (range 0.65-0.89). <sup>95</sup> Majumdar (2013) used modified BSQ with low-income African American and Hispanic middle school students in New York City. <sup>113</sup> Correlations between the modified BSQ and two previously-validated FFQs ranged from 0.1 to 0.8 (most between 0.6 and 0.9). Test-retest reliability correlations of 0.3 to 0.8.	<ul style="list-style-type: none"> <li>English</li> </ul>	Use: <ul style="list-style-type: none"> <li>Johnson et al. (2009) used in a diverse sample of middle school students in Washington state.<sup>114</sup></li> <li>Chi et al. (2015) adapted for use in a Yup'ik Native Alaskans.<sup>115</sup></li> <li>Validation assessed in diverse sample of 7<sup>th</sup> grade students in Seattle, WA.<sup>95</sup></li> <li>Majumdar (2013) assess validity and reliability among African American and Hispanic students.<sup>113</sup></li> </ul>	Original version assesses: <ul style="list-style-type: none"> <li>100% juice</li> <li>Fruit drinks</li> <li>Sports drinks</li> <li>Flavored waters</li> <li>Regular soda</li> <li>Diet soda</li> <li>Energy drinks</li> <li>1% or nonfat milk</li> <li>2% or whole milk</li> </ul> Modified version also assesses: <ul style="list-style-type: none"> <li>Water</li> <li>Flavored milks</li> <li>Sweetened coffee and tea drinks</li> </ul>
Snack Foods Eaten at School and Home  	Described in Schwartz et al. (2009) <sup>116</sup>	Children (grades: middle school) self-report consumption (frequency) of snack foods and beverages. <sup>116</sup>	Not reported	Not reported	Correlations with items on the School-Based Nutrition Monitoring Questionnaire (SBNMQ <sup>89</sup> ) were all statistically significant for items regarding consumption at home ( $r=0.1-0.38$ , all $p's < .05$ ) and at school ( $r=0.12-0.30$ , all $p's < .05$ ). <sup>116</sup>	Not assessed	<ul style="list-style-type: none"> <li>English</li> </ul>	Use: <ul style="list-style-type: none"> <li>Schwartz et al. (2009)<sup>116</sup> used in schools that were 50-63% white, 8-21% African American, ~24% Hispanic, 3-4% Asian, and ~1% American Indian. About one-third of students were eligible for free and reduced price lunch.</li> </ul>	<ul style="list-style-type: none"> <li>Soda</li> <li>Fruit drinks</li> <li>Sport drinks</li> <li>Water</li> <li>100% fruit juice</li> </ul>




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Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
Food frequency questionnaire to assess food behaviors of middle school students  	Described by Wordell (2012) <sup>117</sup>	Children (grades: middle school) self-report consumption (number of servings per day) of beverages in and outside of school during previous week.	5-7 minutes <sup>117</sup>	Not reported	Not reported	Report that reliability was adequate (Cronbach's $\alpha$ 's range: 0.55 to 0.79) but do not provide further details on reliability testing (e.g., type of reliability assessed). <sup>117</sup>	<ul style="list-style-type: none"> <li>English</li> </ul>	Use: <ul style="list-style-type: none"> <li>Wordell et al. (2012)<sup>117</sup> fielded this instrument in six middle schools in the Midwest; schools were &gt;90% white and half had a large proportion (&gt;70%) of students eligible for free- and reduced price lunch.</li> </ul>	<ul style="list-style-type: none"> <li>100% fruit juice</li> <li>Milk</li> <li>Sweetened beverages</li> <li>Energy drinks</li> </ul>
California Health Interview Survey (CHIS), adolescent respondent  	Full CHIS interview questions can be found here: <a href="http://healthpolicy.ucla.edu/chis/design/Pages/questionnairesEnglish.aspx">http://healthpolicy.ucla.edu/chis/design/Pages/questionnairesEnglish.aspx</a> (English)  and here: <a href="http://healthpolicy.ucla.edu/chis/design/Pages/Questionnaires%20(Translated).aspx">http://healthpolicy.ucla.edu/chis/design/Pages/Questionnaires%20(Translated).aspx</a> (Translated)	Children (ages: 12-18 years) self-report consumption of beverages (number of bottles, cans) 'yesterday.'	Full survey ~20 minutes; <sup>65</sup> beverage items should take < 5 minutes	Not reported	Not reported	Not reported for beverage intake	<ul style="list-style-type: none"> <li>English</li> <li>Spanish</li> <li>Cantonese</li> <li>Mandarin</li> <li>Korean</li> <li>Vietnamese</li> <li>Tagalog</li> </ul>	<ul style="list-style-type: none"> <li>Developed for use in large samples of Californians that would include minorities and low-income households.</li> </ul>	<ul style="list-style-type: none"> <li>Soda (non-diet)</li> <li>Sweetened fruit drinks, sports and energy drinks</li> <li>Water</li> </ul>

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Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
Questionnaire to assess Soy Consumption 	Described by Segovia-Siapco et al. (2014) <sup>118</sup>	Children (ages: 12-18 years) self-report consumption (frequency) of soy-containing foods and beverages during the past 6 months.	Not reported	Segovia-Siapco et al. (2014) <sup>118</sup> pilot-tested with adolescent girls to ensure participants could understand the items, but literacy level not explicitly reported.	In a subsample (n=70), average corrected correlation coefficient with 6 days of food diaries for intake of all soy-containing foods/beverages combined was 0.63 (p>0.05); correlation for beverages was not reported separately. <sup>118</sup>	Not assessed	<ul style="list-style-type: none"> <li>English</li> </ul>	Use: <ul style="list-style-type: none"> <li>Segovia-Siapco et al. (2014)<sup>118</sup> fielded the survey in a diverse sample (about 55% non-white) of middle and high school students from Michigan and California. Also reported on validation of the items against food diaries, but does not report the demographic characteristics of the validation sample.</li> </ul>	<ul style="list-style-type: none"> <li>Soy beverages</li> </ul>
8 <sup>th</sup> -11 <sup>th</sup> grade version, School Physical Activity and Nutrition (SPAN) Survey 	The full SPAN questionnaire can be found here: <a href="https://sph.uth.edu/research/centers/dell/projects/ct.htm?project=3037edaa-201e-492a-b42f-f0208ccf8b29">https://sph.uth.edu/research/centers/dell/projects/ct.htm?project=3037edaa-201e-492a-b42f-f0208ccf8b29</a>	Children (grades: 8 <sup>th</sup> – 11 <sup>th</sup> ) self-report their frequency of consumption of foods and beverages 'yesterday.' Does not assess portion size.	20-45 minutes to administer the entire SPAN questionnaire; <sup>8</sup> <sup>9</sup> beverage questions <5 minutes.	Estimates to have 5 <sup>th</sup> grade reading level. <sup>89</sup>	In eighth-graders, SPAN responses correlated well for milk and fruit juice (correlation coefficient = 0.68 and 0.40, respectively); other categories were not assessed. <sup>89</sup>	Not assessed in this age group	<ul style="list-style-type: none"> <li>English</li> <li>Spanish</li> </ul>	Use: <ul style="list-style-type: none"> <li>Developed for use in schools across Texas which would include minority and low-income participants. Also used in the Massachusetts Childhood Obesity Research Demonstration (CORD) study, focused on low-income communities.<sup>93</sup></li> <li>Evans et al. (2016) used SPAN items in a primarily minority and low-income sample.<sup>92</sup></li> </ul> Validation: <ul style="list-style-type: none"> <li>Validity and reliability of the 8<sup>th</sup>-11<sup>th</sup> grade questionnaire has also been established in a diverse population.<sup>89</sup></li> </ul>	<ul style="list-style-type: none"> <li>Milk (including milk on cereal and drinks made with milk)</li> <li>Fruit juice</li> <li>Fruit-flavored drinks or sports drinks</li> <li>Regular soda</li> <li>Diet soda</li> <li>Water</li> <li>Coffee, tea, iced tea or coffee drinks</li> </ul>

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Instrument	Source	Description	Time to complete	Readability	Validity	Reliability	Languages	Use or validation in minority or low-income samples	Beverage categories assessed
<p>National Youth Physical Activity and Nutrition Survey (NYPANS) items</p> 	<p>Items described in O'Malley (2014)<sup>119</sup></p>	<p>Adolescents (grades: 9-12<sup>th</sup>) self-report consumption (frequency; amount for milk only) of 9 beverage items during the past week.</p>	<p>Not reported</p>	<p>Appropriate for high school students</p>	<p>In a sample of high school students (n=610), correlation coefficients between NYPANS items and repeated 24-hour recalls were statistically significant for water, juice, coffee/tea, diet soda, non-diet soda and other SSBs (correlations for sports drinks and energy drinks not assessed) and ranged from 0.26 to 0.49 with an average of 0.35 across all beverages.<sup>119</sup></p>	<p>Not assessed specifically for NYPANS, but Brener et al.<sup>58,120</sup> report good 2-week test-retest reliability for similar items used in YRBSS.</p>	<p>English</p>	<p>Validation:</p> <ul style="list-style-type: none"> <li>• Validity assessed in a diverse sample (26% African American, 29% Hispanic, and 37% white). Developed for use in national survey, so meant to be applicable to diverse populations.<sup>119</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Plain water</li> <li>• 100% fruit juice</li> <li>• Coffee/tea</li> <li>• Diet soda</li> <li>• Non-diet soda</li> <li>• Other SSBs</li> <li>• Sports drinks</li> <li>• Energy drinks</li> <li>• Milk</li> </ul>
<p>High school survey, Youth Risk Behavior Surveillance Survey</p> 	<p>Questionnaires can be found here: <a href="https://www.cdc.gov/healthyyouth/data/yrbbs/questionnaires.htm">https://www.cdc.gov/healthyyouth/data/yrbbs/questionnaires.htm</a></p>	<p>Adolescents (grades: 9-12<sup>th</sup>) self-report on consumption of beverages during previous 7 days. Questions about milk, soda, water, and sports drinks are semi-quantitative; juice question assesses frequency only.</p>	<p>&lt;5 minutes</p>	<p>Appropriate for high school students</p>	<p>None reported</p>	<p>Early studies suggest acceptable test-retest reliability over a 2-week period<sup>58</sup></p>	<p>English</p>	<ul style="list-style-type: none"> <li>• Meant for population-based surveys that would include minorities and low-income participants.</li> </ul>	<ul style="list-style-type: none"> <li>• Soda (non-diet)</li> <li>• Milk (including milk on cereal)</li> <li>• Fruit juice</li> <li>• Plain water (national version)</li> <li>• Sports drinks (national version)</li> </ul>
<p>Snack and Beverage Food Frequency Questionnaire (SBFFQ)</p> 	<p>Developed by Haire-Joshu et al. for use evaluating the effectiveness of an intervention among post-partum teenagers (average age: 17.8 years).<sup>121</sup></p>	<p>Adolescent (ages: ~17 years) self-reports consumption (frequency, usual portion size) of high calorie snacks and beverages during the past week.</p>	<p>Not reported</p>	<p>Not reported</p>	<p>Not reported</p>	<ul style="list-style-type: none"> <li>• 2-week test-retest reliability was high for sweetened beverages and water (ICCs = 0.68, 0.71, respectively).<sup>121</sup></li> </ul>	<p>English</p>	<p>Use:</p> <ul style="list-style-type: none"> <li>• Haire-Joshu (2015) used the SBFFQ in a sample with 52% minorities.<sup>121</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Water</li> <li>• Sweetened beverages</li> </ul>

## III. State-of-the-Science: Assessing Beverage Intake in Children and Adolescents

### Introduction

In 2017, we conducted a systematic review of peer-reviewed studies assessing beverage intake in children and adolescents in the United States.<sup>33</sup> The review covered 589 English-language studies published from February 2007 – February 2017, and addressed four key questions. Below, we will briefly describe findings related to each key question. The published manuscript describing the review can also be found online here:

<https://rdcu.be/1WwC>.

### What assessment methods are used?

We categorized assessment methods into one of five major method types (recall, diary, questionnaire or screener, observation, and direct measurement). We found that questionnaires and screeners were the most commonly-used method in the 589 articles we reviewed, with about two-thirds (65.4%) of articles reviewed using this method. About one-quarter of articles (24.4%) used recalls (nearly always 24-hour recalls). The remaining methods (diaries, observations, and direct measurements) were each used by about 4-5% of studies. About 4% of studies used more than one assessment method (e.g., used both a recall and a questionnaire).

As described in Table 1, questionnaires and screeners have a variety of benefits. However, they are also more prone to measurement error than the other four assessment methods. Future research on children’s beverage intake may wish to shift toward greater use of more precise measures, particularly for assessing associations between beverage intake and health outcomes.<sup>26,55</sup>

### What are the properties of these assessment methods?

#### Recalls, Diaries, and Questionnaires/Screeners

We first examined recalls, diaries, and questionnaires – methods that involve participant-report of intake rather than researcher measurement. Methods that use participant-report can assess children’s intake either by asking the child to self-report his or her own intake, or by asking a proxy (usually a parent or caregiver) to report on the child’s intake. Some studies employ both proxy- and self-report, with older children self-reporting and younger children having a proxy report their intake. We found that for recalls, diaries, and questionnaires used in the reviewed articles, it was slightly more common for children to self-report their intake, with about 65% of measures using self-report. About 40% used proxy-report, and 12% used both proxy- and self-report (e.g., self-report for older children and proxy-report for younger children).

About 13% of articles explicitly reported that the measure they used was available in Spanish, and another 2.5% reported the measure was available in another non-English language such as Cantonese, Mandarin, or Vietnamese. Most (95%) articles did not report

how long it took participants to complete the measure. Among articles that did report time-to-complete, some methods could be completed as quickly as 3 minutes. Only 5% of articles explicitly mentioned that their recall, diary, or questionnaire/screener was appropriate for use in a low-literacy population (see examples in Table 2); the remaining articles did not provide enough information to determine whether they could be used in low-literacy populations.

Slightly more than one-third (37%) of recalls and questionnaires assessed children's beverage consumption 'yesterday', and another 19% assessed children's consumption over the past week or 7 days. It is often considered more difficult to estimate their dietary intake over longer periods compared to shorter periods,<sup>19</sup> and children may have particular difficulty reporting their usual intake compared to their recent intake.<sup>21</sup> Thus, it is encouraging that more than half of the studies we examined assessed children's beverage consumption during a recent period.

### Observations and Direct Measurements

About 4% of the articles we examined used observations to assess children's beverage intake, and another 4% used direct measurements. These methods both capture children's recent intake, typically during a single meal. Because children's intake can vary considerably from meal to meal and day to day, it is sometimes recommended that observations and direct measurements be repeated two or more times (e.g., assess lunch on two separate days) to better reflect children's usual intake. We found that about three-quarters of the studies using observations and direct measurements followed this recommendation and collected two or more measurements.

### Validity and Reliability

We examined whether articles addressed the validity or reliability of the method used to assess children's intake, either by measuring these characteristics directly or by referencing another article that appeared to contain psychometric information. Most articles (71% of those we reviewed) did not address validity, and about 80% did not address reliability. In some instances, this is to be expected. For example, multiple-pass 24-hour recalls are often considered the "gold-standard" for assessing dietary intake, and so we may not expect authors to explicitly mention the validity of this method. Likewise, direct measurements are typically not prone to bias or measurement error. In contrast, validity and reliability may be particularly important to address for questionnaires and screeners, which tend to have more measurement error than the other assessment methods. However, of the articles that used questionnaires or screeners to assess children's beverage intake, 63% did not address the validity of the questionnaire or screener used, and 75% did not address its reliability. These results suggest that future research needs to give more attention to the validity and reliability of the methods used to assess children's beverage intake.

The articles that addressed validity and reliability did so in two ways. Some articles provided a reference to another study that appeared to contain information on the validity or reliability of the assessment method. Of the reviewed articles, 22% provided a reference regarding the validity of the beverage intake assessment method, and 16% provided a reference regarding its reliability. A minority of articles measured and reported on the characteristics of the assessment method in the article itself (i.e., conducted primary data



collection regarding validity and/or reliability). In total, 40 articles measured and reported on validity (7% of the included studies). Only 27 (5%) of articles measured and reported on reliability, most often on test-retest reliability or inter-rater reliability. These results could suggest both that (a) research studies need to more consistently report measures' reliability and validity so that readers can accurately assess study quality, and (b) that more research may be needed to establish the properties of beverage intake assessment methods.

### What types of beverages are examined?

We examined what beverage categories each article examined in their analyses. Reflecting continued interest in sugar-sweetened beverage (SSB) consumption among children and adolescents, we found that the majority of studies – nearly 80% – examined children's SSB intake as either a key exposure or outcome of interest. About one-third of studies examined soda or carbonated soft drinks in particular, and another 13% examined fruit drinks. One in five (20%) of studies examined children's plain water intake. About one-third of studies examined children's intake of milk or milk substitutes such as soy milk, and 31% assess children's consumption of 100% juice. These results broadly (though not perfectly) reflect the beverages that contribute the most to total energy intake in children. For example, using NHANES data from 2005-2010, Drewnowski, Rehm & Constant report that children ages 4-13 years consumed about 350 calories/day from beverages; of these, about 40% were from milk (excluding milk on cereal), 16% from soda, 14% from fruit juice, and 13% from fruit drinks. We also found that about 6% of studies assessed consumption of energy drinks, and 8.5% assessed consumption of sports drinks. While these beverages contribute <10% of beverage calories, consumption of these categories has increased since the late 1990s.<sup>35,37</sup> Perhaps reflecting the growing role energy drinks play in children's diet, we found that studies published later in our review period were more likely to assess energy drinks (linear trend <0.05); however, no such relationship was found for sports drinks.

### What are the characteristics of study populations in which beverage consumption was assessed?

Children's beverage consumption varies considerably with their demographic characteristics.<sup>35,37,122-126</sup> Some methods may be therefore be appropriate and valid for assessing children's beverage consumption in some populations but not others.<sup>127</sup> For this reason, we assessed the characteristics (e.g., age, race/ethnicity, sex) of the participants in the included studies. Studies varied greatly in the demographic characteristics of their participants. For example, the mean age of study samples ranged from 2.0 years to 17.8 years. About half of included studies (53%) included children between the ages of 12 and 18 years, 47% included children ages 6-11 years, and 40% included children between the ages of 2 and 5 years. On average, study samples were relatively balanced in terms of children's sex, with an average of 54% of participants being female; however, some studies included 0% females and others focused exclusively on female participants.

Because racial/ethnic minorities and low-income children are priority populations for many interventions seeking to improve beverage intake, we also examined whether studies included minority or low-income children. We found that nearly all (90%) of studies included

at least some non-white children, though the proportion of participants who were non-white varied greatly across studies. On average, 41% of children in study samples were white, 24% were African American, 26% were Hispanic or Latino, and 4% were Asian or Asian American. Some studies focused on specific populations. For example, 20 articles focused specifically on African American children (i.e., 100% of the study sample were African American),<sup>74,87,104,128-144</sup> 19 focused on Hispanic or Latino children,<sup>68,108,145-161</sup> six focused on Native American, Alaskan Native, or American Indian children,<sup>162-167</sup> and one focused on Asian or Asian-American children.<sup>73</sup>

We used a broad definition of low-income, and considered an article as including low-income children if the sample included any children who: were eligible for or participating in nutrition or other assistance programs (e.g., National School Lunch Program, Supplemental Nutrition Assistance Program), attending a facility that participated in these programs (e.g., a Head Start preschool, a childcare facility participating in the Child and Adult Care Food Program, or a school with more than 50% of its students eligible for free/reduced price meal programs), had a household income less than 185% of the Federal Poverty Level or \$30,000, or whom the authors described as low-income or low socioeconomic status. About half (45%) of articles did not provide enough information to ascertain whether they included low-income children. About 55% of articles reported they included low-income children, and only 0.3% explicitly reported that only higher-income children were included in their sample.

Together, these results suggest that the recent literature is capturing the beverage intake of relatively diverse samples of children. A handful of studies focused on a particular subpopulation of interest, which may be important for establishing that a particular measurement technique is feasible and/or valid for use in this population. We provide additional examples of assessment methods that have been used and/or validated in minority and/or low-income populations in Table 2.

## IV. Conclusions

Promoting healthy beverage intake, particularly among children and adolescents, has emerged in recent years as a policy and research priority. Because different dietary assessment methods are subject to specific and unique limitations that could influence study findings, it is important to understand what assessment methods are available, what properties they have, and what methods are typically used in the scientific literature. This report and our accompanying systematic review begin to address these issues. In general, we found that recent studies reflect the diversity of American children, and that a number of measurement techniques are available for assessing beverage intake in specific populations, such as those with lower-literacy, children of racial/ethnic minority backgrounds, and lower-income children. However, we also found that greater attention to issues of validity, reliability, and measurement error is warranted. Improved measurement techniques will help establish whether progress is being made toward ensuring that all children in the U.S. have healthy beverage consumption habits. Given the important role that beverage intake plays in range of children's health and developmental outcomes, researchers and practitioners from a

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variety of areas should be invested in developing and applying thoughtful measurement techniques for assessing children's beverage consumption.

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