



Evaluation of the Relative Validity and Test–Retest Reliability of a 15-Item Beverage Intake Questionnaire in Children and Adolescents

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ABSTRACT

Background Added sugar intake, in the form of sugar-sweetened beverages (SSBs), may contribute to weight gain and obesity development in children and adolescents. A valid and reliable brief beverage intake assessment tool for children and adolescents could facilitate research in this area.

Objective The purpose of this investigation was to evaluate the relative validity and test–retest reliability of a 15-item beverage intake questionnaire (BEVQ) for assessing usual beverage intake in children and adolescents.

Design This cross-sectional investigation included four study visits within a 2- to 3-week time period.

Participants/setting Participants (333 enrolled; 98% completion rate) were children aged 6 to 11 years and adolescents aged 12 to 18 years recruited from the New River Valley, VA, region from January 2014 to September 2015. Study visits included assessment of height/weight, health history, and four 24-hour dietary recalls (24HRs). The BEVQ was completed at two visits (BEVQ 1, BEVQ 2).

Main outcome measures To evaluate relative validity, BEVQ 1 was compared with habitual beverage intake determined by the averaged 24HR. To evaluate test–retest reliability, BEVQ 1 was compared with BEVQ 2.

Statistical analyses performed Analyses included descriptive statistics, independent sample *t* tests, χ^2 tests, one-way analysis of variance, paired sample *t* tests, and correlational analyses.

Results In the full sample, self-reported water and total SSB intake were not different between BEVQ 1 and 24HR (mean differences 0 ± 1 fl oz and 0 ± 1 fl oz, respectively; both *P* values >0.05). Reported intake across all beverage categories was significantly correlated between BEVQ 1 and BEVQ 2 ($P < 0.001$). In children ($n = 126$), reported intake of milk and energy (in kilocalories) for total beverages was not different (all *P* values >0.05) between BEVQ 1 and 24HR (mean differences: whole milk = 3 ± 4 kcal, reduced-fat milk = 9 ± 5 kcal, and fat-free milk = 7 ± 6 kcal, which is 7 ± 15 total beverage kilocalories). In adolescents ($n = 200$), water and SSB kilocalories were not different (both *P* values >0.05) between BEVQ 1 and 24HR (mean differences: -1 ± 1 fl oz and 12 ± 9 kcal, respectively).

Conclusions A 15-item BEVQ provides results that are similar relative to multiple 24HRs for determining habitual milk and total beverage intake in children, and water and SSB intake in adolescents. The 15-item BEVQ is a reliable indicator of habitual beverage intake in both children and adolescents. Future studies could explore whether adjustments to BEVQ beverage categories, portion size, and format could improve the tool's ability to measure beverage intake in young populations.

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RECENT ESTIMATES IN THE UNITED STATES INDICATE that 17.4% of children aged 6 to 11 years and 20.6% of adolescents aged 12 to 19 years are obese.¹ Childhood obesity is associated with serious long-term health consequences, including an increased risk for

cardiovascular disease, type 2 diabetes, stroke, and different types of cancers.²⁻⁶

Added sugars (AS), defined as syrups and sugars that are added to foods during food processing, are a major source of excess energy in the US diet.⁷ The primary dietary source of

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AS in both children and adolescents is sugar-sweetened beverages (SSBs), which are calorically sweetened drinks such as energy or sports drinks, sweetened juice drinks (excluding 100% fruit juice), sugar-sweetened carbonated beverages, and vitamin water drinks.^{8,9} The 2015-2020 Dietary Guidelines for Americans recommend that in all age groups, no more than 10% of total daily energy should come from AS.¹⁰ However, children and adolescents are exceeding this recommendation by 5% and 7%, respectively.¹⁰

SSB consumption is associated with increases in weight and body mass index in children and adolescents,¹¹⁻¹³ and water is recommended as an alternative to consuming SSBs in children and adolescents to reduce energy intake.¹⁴⁻¹⁷ Although recent consumption patterns suggest that a reduction in SSB intake has occurred among US children and adolescents, this population segment still exceeds intake recommendations.^{18,19}

There has been substantial controversy over proposed policies (eg, taxation) related to beverages, due in part to a limited evidence base linking AS and SSBs to adverse health outcomes. Research challenges include the resource-intensive nature of many dietary assessment methods and the reliance on self-reported dietary intake assessment methods. Children have a limited ability to estimate portion sizes, and parents may not be a reliable source for assisting children in estimating dietary intake.^{20,21} Compared with diet diaries, 24-hour dietary recalls (24HRs) and food frequency questionnaires (FFQs) may be less burdensome for adolescents.^{20,21} Self-reporting is known to present over- and under-reporting issues in both children and adolescents.²²⁻²⁴ However, 24HRs can provide more accurate measures of dietary intake when conducted on nonconsecutive days.²⁵⁻²⁷ In addition, four 24HRs, paired with an FFQ and food and beverage recording booklet, improve self-reporting in children and adolescents.^{25,26}

The beverage intake questionnaire (BEVQ) is a validated 15-item tool used to estimate habitual beverage intake over the past month across 15 beverage categories.²⁸⁻³⁰ This brief assessment tool provides an estimate of total beverage and SSB intake, along with milk, water, and other beverages. The purpose of this investigation is to evaluate the relative validity and test-retest reliability of the 15-item BEVQ for assessing usual short-term beverage intake in children and adolescents.

MATERIALS AND METHODS

Subjects and Design

Children and adolescents (N=333) were enrolled in this cross-sectional investigation. The only eligibility criteria were age between 6 and 18 years and willingness to complete all study visits. Enrollment was conducted so as to include a somewhat balanced sample across sexes. Participants were recruited from the New River Valley, VA, area from January 2014 to September 2015, using newspaper and print advertisements posted in Montgomery County grocery stores, worksites, community centers, fitness centers, and e-mail announcements on listservs of local community parent's groups and Virginia Tech employees. The Virginia Tech Institutional Review Board approved the study protocol and all participants provided written informed consent or child assent. Consent forms and a food recording booklet were sent

via e-mail to potential participants after the initial telephone screening. Participants received verbal instructions to complete the food recording booklet before the first scheduled study visit. Written consent was obtained in person at the first study visit. Parental consent was obtained for participants younger than age 18 years. Participants aged 18 years are permitted to consent themselves without parental consent. Participants were compensated \$50 for completing all study visits.

Protocol

To evaluate the relative validity and reliability of the BEVQ (Figure 1, available online at www.jandonline.org), participants completed four study visits within a 2- to 3-week period, in a randomly assigned visit sequence. Randomly assigned study visit sequences were utilized to minimize changes in dietary consumption (ie, beverage intake) due to questions asked at each visit (Figure 2).³¹

At the first study visit, demographic information was collected, including the participant's date of birth, grade in school, and health history. Height was measured in centimeters without shoes, using a wall-mounted stadiometer (Seca version 216). Weight was assessed without shoes using a digital scale (Scale-Tronix version 5002). BMI, BMI-for-age percentile (underweight: <5th percentile, normal weight: 5th to 84th percentile, overweight: 85th to <95th percentile, and obese: ≥95th percentile),^{32,33} and estimated energy requirements were calculated for each participant.³⁴

A record-assisted (ie, food and beverage recording booklet) 24HR was administered at each of the four study visits (Figure 2). A food and beverage recording booklet was provided at the end of each of the first three visits for the following study visit. When participants were provided with the food and beverage recording booklet, they were instructed to record their intake on the day before their next study visit, which was used as a memory aid when administering the 24HR.^{25,26,35,36} For each participant, 24HRs were obtained on nonconsecutive days that included 1 weekend day and 3 weekdays because adolescents and children are more likely to consume foods containing added sugar on the weekends compared with weekdays.²⁶ Younger children may need assistance from parents or caregivers in recalling their dietary intake, whereas older children may be able to report their dietary intake without assistance.³⁶ Therefore, parents were allowed to assist their children with the 24HR when they were present. Trained research assistants administered 24HRs to help prompt participants when recalling their dietary intake, and the multiple-pass method was used.³⁷ Food models, measuring cups, and food diagrams were used to help study participants estimate portion sizes. 24HRs were analyzed using Nutrition Data System for Research version 2013.³⁸ All research assistants were trained in the use of this software³⁸ before the onset of the study and supervised by the senior investigator who has completed training with the software developer.³⁹

Sequence 1 participants (Figure 2) completed the BEVQ at the first and third study visits, whereas Sequence 2 participants completed the BEVQ at the second and fourth study visits. The BEVQ was self-administered, but research assistants were present to help participants complete the questionnaire when needed. Respondents are asked to report

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