

Validity and Reliability of the BEVQ-15 in Children and Adolescents

Catelyn E Hill

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Brenda M Davy  
Valisa E Hedrick  
Jyoti T Savla

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### ABSTRACT

The prevalence of children and adolescents who are considered overweight or obese has grown drastically in the United States. Childhood overweight and obesity is associated with serious long-term health consequences, including an increased risk for cardiovascular disease, type 2 diabetes, strokes, and different types of cancers. Added sugar intake (AS), in the form of sugar-sweetened beverages (SSB), may contribute to weight gain and obesity development in children and adolescents. Due to the negative health implications of SSB consumption, a valid and reliable brief beverage intake assessment tool is needed for children and adolescents to advance research in this area. The BEVQ-15 food frequency questionnaire has been validated as a tool to assess habitual beverage intake in adults. By validating this tool in youth, there will be a rapid, feasibly administered method to assess beverage intake in children and adolescents. The purpose of this investigation was to determine the comparative validity and test-retest reliability of the BEVQ-15 for assessing usual beverage intake in children and adolescents. Participants (n=326) completed four laboratory sessions, which included providing demographic information, assessment of height/weight, and four record-assisted 24 hour dietary recalls (24HR) from January 2014-September 2015. The BEVQ was completed at 2 sessions (BEVQ1, BEVQ2). Validity was assessed by comparing beverage intake from dietary recalls (24HR) to the BEVQ1; reliability was assessed by comparing BEVQ responses at two sessions (BEVQ1, BEVQ2). Data analysis included descriptive statistics, paired sample t-tests, independent sample t-tests, and chi-squared test, and one-way ANOVA tests. Comparisons of validity and reliability were also made within two subsets; children (aged 6-11) and adolescents (aged 12-18). In the full sample, self-reported water and total sugar-sweetened beverage intake (in fl oz and kcal) were not different between BEVQ1 and 24HR. Responses between BEVQ1 and BEVQ2 were not different in intake (fl oz) or energy (kcal) for water, milk, and total sugar-sweetened beverages. In children, milk and energy (kcal) for total beverages were not different between BEVQ1 and 24HR. No differences were reported between BEVQ1 and BEVQ2 across beverage categories. In adolescents, water and energy (kcal) for total-sugar sweetened beverages were not different between BEVQ1 and 24HR. No differences were reported between BEVQ1 and BEVQ2 with the exception of sweetened juice drinks and total beverages. Overall, these results demonstrate that the BEVQ-15 appears to be a valid and reliable tool to assess habitual water and total SSB intake in children and adolescents. This tool could further epidemiological and clinical research examining the impact of SSB intake, as well as intake of other beverages, on health.

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## General Audience ABSTRACT

More than one-third of children and adolescents are considered overweight or obese. Childhood overweight and obesity is associated with serious long-term health consequences, including an increased risk for cardiovascular disease, type 2 diabetes, strokes, and different types of cancers. Added sugars (AS), defined as syrups and sugars that are added to foods during food processing, are a major source of excess energy in children and adolescent's diets. The primary source of AS in both children and adolescents is in the form of sugar-sweetened beverages (SSB). SSB are calorically-sweetened drinks such as energy or sports drinks, fruit juice (excluding 100% fruit juice), sodas, and vitamin water drinks. Added sugar intake, in the form SSB, may contribute to weight gain and obesity development in children and adolescents. Due to the negative health effects of SSB, a tool is needed to assess SSB intake in children and adolescents. Although there are assessment tools that are used to assess dietary intake in adolescents, there is no tool that addresses beverage intake, specifically SSB intake. A food frequency questionnaire (FFQ), which is a tool used by participants to report how often and how much of a certain food or beverage they usually consume during the week, could be used to advance research addressing beverage intake patterns in children and adolescents. The BEVQ-15 FFQ tool has been validated as a tool to assess habitual intake in adults. By validating this tool in youth, there will be a rapid, feasibly administered method to assess beverage intake in children and adolescents. Results from this study demonstrated that the BEVQ-15 appears to be a valid and reliable tool to assess habitual beverage intake in children and adolescents for water and total SSB. This tool could further epidemiological and clinical research examining the impact of SSB intake, as well as intake of other beverages, on health.

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## Chapter 1

### 1.1 Introduction

The prevalence of overweight and obesity has grown drastically among children and adolescents in the United States<sup>1,2</sup>. Currently, the most widely used method to assess bodyweight in children and adolescents is through BMI (body mass index) calculations<sup>3,4</sup>. Specifically, BMI-for-age growth charts are used to determine the percentile for height and weight where children and adolescents lie<sup>5</sup>. These growth charts take into account a child's growth and development, as well as age and sex, to determine their BMI percentile<sup>6</sup>. A child is considered overweight with a BMI-for-age percentile between the 85<sup>th</sup> and 94<sup>th</sup> percentile<sup>5,7,8</sup>, and considered obese with a BMI-for-age percentile at or above the 95<sup>th</sup> percentile<sup>5,7,8</sup>. As of 2012, an estimated 34.2% of children ages 6-11 were considered overweight or obese<sup>1,2</sup>. Similarly, an estimated 34.5% of adolescents ages 12-19 were considered overweight or obese<sup>1,2</sup>. Finally, 17.7% of children ages 6-11 and 20.5% of adolescents ages 12-19 were considered obese<sup>1,2</sup>.

Childhood overweight and obesity is associated with long-term health consequences, including an increased risk for high cholesterol or high blood pressure, which are both risk factors for cardiovascular disease<sup>9-11</sup>. Obese adolescents are more likely to develop prediabetes, which increases their risk for developing type 2 diabetes later in life<sup>12</sup>. Overweight and obesity can also lead to sleep apnea and bone and joint problems in both children and adolescents<sup>10</sup>. Children and adolescents who are obese at a young age are more likely to become obese adults, which can lead to adverse health outcomes such as heart disease, type 2 diabetes, strokes, and different types of cancers<sup>10,11,13,14</sup>.

## 1.2 National Health Recommendations

Efforts have been put in place to decrease the number of children and adolescents who are considered overweight and obese in the United States. A goal of Healthy People 2020 is to promote optimal health and reduce chronic health conditions, such as obesity, through healthy diets and maintenance of healthy body weights<sup>15</sup>. Healthy People 2020 plans to reach this goal through a number of different objectives. Specifically, there is a focus toward reducing the proportion of children and adolescents who are considered obese<sup>15</sup>. Healthy People 2020 aims for only 15.7% of children ages 6-11 to be considered obese and for only 16.1% of adolescents ages 12-19 to be considered obese<sup>15</sup>. In both of these age groups, this will be a 10% improvement of those considered obese compared to data collected between 2005-2008<sup>15</sup>. Healthy People 2020 also aims to increase access to healthier food options, by increasing the proportion of schools that do not sell or offer sugar-sweetened beverages (SSB) for students<sup>15</sup>. SSB are calorically sweetened drinks such as energy or sports drinks, fruit juice (excluding 100% fruit juice), sodas, and vitamin water drinks<sup>16</sup>. In 2006, 9.3% of schools did not sell or offer SSB for students<sup>15</sup>. A target of Healthy People 2020 is for 21.6% of schools to not sell or offer SSB for students<sup>15</sup>.

Concern about childhood and adolescent obesity has generated reform in school nutrition programs over the past decade. In particular, the Academy of Pediatrics states that high-energy, low-nutrient beverages contribute substantial calories, with little nutritional value, in the school system<sup>17</sup>. In 2004, the Academy of Pediatrics recommended that schools replace SSB with water, milk, or 100% fruit or vegetable juice<sup>17</sup>. These recommendations have helped reduce the availability of SSB in schools;



however, children still have access to these beverages through other students, parents, and staff. The Academy of Pediatrics support a position that promotes nutrient-rich foods that are within calorie guidelines to help balance the sweetened drinks brought and sold in schools<sup>17</sup>. Their policy states that a positive emphasis on nutritional value, portion sizes, variety, and an improvement in quality of food will be more effective than advocating for the elimination of added sugars<sup>17</sup>.

Another strategy that has been proposed to decrease the prevalence of overweight and obesity in American's is a tax on SSB<sup>18,19</sup>. Previous studies have shown that taxing certain foods has the potential to decrease weight gain<sup>20,21</sup>. Additionally, higher beverage prices may decrease the consumption of the taxed beverage<sup>20,21</sup>. Currently, a number of states in America have a tax on SSB; however, it is not clear is this will impact American's SSB consumption<sup>19</sup>. A tax on SSB could reduce SSB purchases, which could lead to a decrease in overweight and obesity among children<sup>18</sup>.

One major source of excess calories in America's diet, which could lead to an increase in the number of overweight and obese Americans, is added sugars (AS)<sup>22</sup>. AS are defined as syrups and sugars that are added to foods during food processing<sup>22</sup>. The American Heart Association recommends a decrease in AS intake in American diets<sup>22</sup>. The number one source of AS in both children and adolescents is in the form of SSB, such as soda and fruit drinks<sup>23</sup>. The 2015 Dietary Guidelines for Americans recommend that in all age groups, no more than 10% of total daily calories should come from AS<sup>24</sup>. However, both children and adolescents are exceeding this recommendation. National Health and Nutrition Examination Survey (NHANES) data from 2007-2010 indicated that both boys and girls ages 4-8 are exceeding the AS intake maximum recommendation

by an estimated 5%<sup>24</sup>. Additionally, those ages 9-13 and 14-18 are exceeding the maximum recommendation by approximately 7%<sup>24</sup>.

### **1.3 Health Implications of Excess Added Sugar Intake**

Consumption of AS in the form of SSB can lead to many health effects in both children and adolescents, including increased risk for weight gain, obesity, type 2 diabetes, cardiovascular diseases, and dental problems<sup>25-29</sup>. Malik et al., through a systematic review and meta-analysis, found that one daily serving of SSB was associated with an increase in BMI in children, and a reduction in BMI was reported when SSB intake was reduced<sup>30</sup>. Similarly, Ludwig et al. reported a positive relationship with an increase in SSB consumption and BMI and occurrence of obesity in children and adolescents<sup>28</sup>. A systematic literature review was conducted to examine whether SSB intake increased the risk for obesity, which included all ages, genders, and ethnicities<sup>31</sup>. A positive relationship between SSB consumption and adiposity was noted among all age groups<sup>31</sup>. Bigornia et al. also found that in children and adolescents ages 10-13, increased consumption of SSB was associated with increased waist circumference<sup>32</sup>. This study's findings support a recommendation to decrease SSB intake in order to reduce excess weight gain in children and adolescents<sup>32</sup>. Research indicates that SSB intake also leads to increased energy intake<sup>33</sup>. In a randomized controlled trial of adolescents who regularly consumed SSB, a decrease in energy intake was reported after a one-year intervention of replacing SSB with water or artificially sweetened beverages<sup>33</sup>. Although no studies have examined the relationship between SSB consumption and type 2 diabetes in adolescents, studies have shown a positive correlation between SSB intake and type 2 diabetes in adults<sup>33</sup>.

Water has been recommended as an alternative to consuming SSB in children and adolescents<sup>34-37</sup>. Replacing SSB with water would decrease energy intake in children and adolescents, and therefore, could promote obesity prevention<sup>35,36</sup>. An analysis using NHANES data from 2003-2004 found that replacing SSB with water in children and adolescents, could reduce energy intake by 235 kcal/d.<sup>36</sup>

#### **1.4 Dietary Assessment Methods in Children and Adolescents**

A challenge to research in this area is the reliance on self-reported dietary intake assessment methods. Research has shown that children under the age of 12 have a limited ability to estimate and indicate portion sizes<sup>38,39</sup>. Parents may also not be the most reliable source to help their children estimate their dietary intake because they do not see what their children eat away from home<sup>38,39</sup>. Body image issues may also affect a child's willingness to report their dietary intake<sup>39</sup>.

Differences also occur between children and adolescents when reporting dietary intake. Adolescents eating habits are less likely to be supervised by their parents, and they are more likely to use food as a way of self-expression<sup>39</sup>. On the other hand, parents generally monitor their children while they are consuming food, and children tend to eat when they're hungry, rather than eating as a way of expression<sup>39</sup>.

Body image issues may also affect a child's willingness to report their dietary intake<sup>39</sup>. Studies show that under-reporting occurs more often among heavier children<sup>40</sup>. Livingstone et al. found that heavier adolescent girls were more likely to under-report energy intake, compared to normal weight girls<sup>41</sup>. These findings were consistent with a study conducted by Bandini et al., which found that obese adolescent males were more

likely to under-report their food intake by 20%, compared to their non-obese counterparts<sup>42</sup>.

Compared to food diaries, 24-hour dietary recalls (24HR) and food frequency questionnaires (FFQ) may be appealing to adolescents since they are a less intrusive approach to assess diet<sup>38,39</sup>. In adolescents, there is no method for dietary assessment that is considered superior<sup>43</sup>. Burrows et al. conducted a study, which found that in adolescents, over-reporting of food intake was associated with 24HR, FFQ, and diet histories<sup>44</sup>. The review suggested that 24HR conducted over at least a 3-day period was the most accurate method to assess total energy intake in children aged 4-11 years. Diet histories were shown as the most accurate estimate for adolescents 16 years and older<sup>44</sup>.

FFQ are used to measure dietary intake through self-reporting measures that ask a participant to report how often and how much of a certain food or beverage they usually consume during the week. FFQ are commonly used in large studies because they require little administration time, and are less of a burden on study participants compared to diet histories<sup>45,46</sup>. FFQ also generally do not require a high literacy level and can be scored quickly compared other dietary assessment methods<sup>46</sup>. However, there are limitations to FFQ. Unlike 24HR, FFQ are a measure of a participant's usual intake over weeks, months, or years<sup>46</sup>. Therefore, it cannot provide information on daily food or beverage intake. FFQ are also not as detailed compared to 24HR, which may lead to inaccurate measurements of key nutrients<sup>46</sup>. FFQ only include a limited list of foods or beverages, so it is more challenging to accurately determine mixed dishes, compared to 24HR and diet histories<sup>46</sup>.

## **1.5 Overcoming Barriers to Evaluating Added Sugar Intake**

One challenge to dietary assessment of AS intake in children and adolescents is that it is most commonly self-reported<sup>47</sup>. Self-reporting is known to present over- and under- reporting issues in both children and adolescents<sup>41,42,48</sup>. 24HR in children and adolescents can provide more accurate measures of dietary intake, especially when conducted on non-consecutive days<sup>44,49-51</sup>. Additionally, four 24HR, paired with a FFQ and food-recording booklet, are shown to improve self-reporting in children and adolescents<sup>49-51</sup>.

Consumption patterns in the United States have shown an increase in SSB among children and adolescents<sup>52,53</sup>. Due to the negative health effects of AS, mainly in the form of SSB, a tool is needed for children and adolescents that addresses beverage intake, specifically SSB intake<sup>25-29</sup>. A valid and reliable beverage intake assessment instrument, i.e. a FFQ, could advance research addressing beverage intake patterns in children and adolescents.

## **1.6 Assessing Habitual Intake in Children and Adolescents: The BEVQ-15**

The Beverage Intake Questionnaire (BEVQ-15) is a 15-item tool used to estimate habitual beverage intake over 15-beverage categories<sup>54-56</sup>. This tool provides an estimate of total beverage and SSB intake (fl oz and kcal). The BEVQ-15 FFQ has been validated as a tool to assess habitual beverage intake in adults<sup>54-56</sup>. Hedrick et al. conducted a study in an adult population that found the BEVQ-15 questionnaire to be a sensitive assessment tool that could be used to assess beverage intake in adult populations<sup>54</sup>. By validating this tool in youth, we will have a rapid, feasibly administered method to assess beverage

intake in both children and adolescents. Establishing the BEVQ-15 as valid, reliable, and sensitive means for assessing habitual beverage intake in youth could further epidemiological and clinical research examining the impact of SSB intake, as well as intake of other beverages, on health.

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## Chapter 2

### 2.1 Abstract

Added sugar intake, in the form of sugar-sweetened beverages (SSB), may contribute to weight gain and obesity development in children and adolescents. Due to the negative health implications of SSB, a valid and reliable brief beverage intake assessment tool is needed for children and adolescents to advance research in this area. The purpose of this investigation was to determine the comparative validity and test-retest reliability of the BEVQ-15 for assessing usual beverage intake in children and adolescents. Participants (n=326) completed four laboratory sessions, which included providing demographic information, assessment of height/weight, and four 24-hour dietary recalls (24HR). The BEVQ was completed at 2 sessions (BEVQ1, BEVQ2). Validity was assessed by comparing beverage intake from dietary recalls (24HR) to the BEVQ1; reliability was assessed by comparing BEVQ responses at two sessions (BEVQ1, BEVQ2). Data analysis included descriptive statistics, paired sample t-tests, independent sample t-tests, chi-squared tests and one-way ANOVA tests. Comparisons of validity and reliability were also made within two subsets; children (aged 6-11) and adolescents (aged 12-18). Self-reported water and total sugar-sweetened beverage intake (in fl oz) were not different between BEVQ1 and 24HR (mean difference  $0 \pm 1$  fl oz [ $P= 0.625$ ] and  $0 \pm 1$  fl oz [ $P= 0.723$ ], respectively). All beverage categories were significantly correlated for BEVQ1 and BEVQ2 ( $P < 0.001$ ) with the exception of energy (kcal) for diet soda. In children, milk and energy (kcal) for total beverages were not different between BEVQ1 and 24HR (mean difference whole milk =  $3 \pm 4$  kcal, reduced fat milk =  $9 \pm 5$  kcal, fat free milk =  $7 \pm 6$  kcal [ $P= 0.486, 0.101, 0.221$ ] and  $7 \pm 15$  kcal [ $P= 0.638$ ], respectively). All results were significantly correlated between BEVQ1 and BEVQ2 ( $P < 0.01$ ) in this age group. In adolescents, water and energy (kcal) for total-sugar sweetened beverages were not different between BEVQ1 and 24HR (mean difference  $-1 \pm 1$  fl oz [ $P= 0.414$ ], and  $12 \pm 9$  kcal [ $P= 0.196$ ], respectively). All responses were significantly correlated between BEVQ1 and BEVQ2 categories ( $P < 0.001$ ), with the exception of energy (kcal) for diet soda. Overall, these results demonstrate that the BEVQ-15 appears to be a valid and reliable tool to assess habitual water and total SSB intake in children and adolescents.

## 2.2 Introduction

The rate of obesity has grown drastically in both children and adolescents<sup>1,2</sup>. An estimated 34.2% of children ages 6-11 are considered overweight (body mass index percentile [BMI %] 85<sup>th</sup>-94<sup>th</sup> %) or obese (BMI %  $\geq$  95<sup>th</sup> %), and 34.5% of adolescents ages 12-19 are considered overweight or obese<sup>1-5</sup>. Childhood overweight and obesity is associated with serious long-term health consequences, including an increased risk for cardiovascular disease, type 2 diabetes, strokes, and different types of cancers<sup>6-10</sup>.

Added sugars (AS), defined as syrups and sugars that are added to foods during food processing, are a major source of excess energy in America's diet<sup>11</sup>. The primary source of AS in both children and adolescents is sugar-sweetened beverages (SSB), which are calorically sweetened drinks such as energy or sports drinks, fruit juice (excluding 100% fruit juice), sodas, and vitamin water drinks<sup>12,13</sup>. The 2015 Dietary Guidelines for Americans recommend that in all age groups, no more than 10% of total daily energy should come from AS<sup>14</sup>. However, children and adolescents are exceeding this recommendation by 5 to 7%, respectively<sup>14</sup>.

Consumption of AS in the form of SSB can lead to adverse health effects in children and adolescents, including increased risk for weight gain, obesity, type 2 diabetes, cardiovascular diseases, and dental problems<sup>15-19</sup>. SSB consumption is associated with an increase in weight gain and BMI in both children and adolescents<sup>15,20,21</sup> and water has been recommended as an alternative to consuming SSB in children and adolescents to decrease energy intake<sup>22-25</sup>.

Legislation has been put into place to help decrease the prevalence of child and adolescent obesity in the United States. In 2014, the Stop Subsidizing Childhood Obesity

Act was proposed to eliminate the tax deduction for the marketing of unhealthy food and beverages to children<sup>26</sup>. The money generated by the elimination of this tax subsidy would be used to fund the U.S Department of Agriculture's Fresh Fruit and Vegetable Program, providing fresh fruit or vegetable choices to students in low-income schools<sup>26</sup>. Currently, legislators are working to reintroduce this act, and promote it in the school systems<sup>27</sup>. However, there is substantial controversy over these and other similar types of policies, due in part to a limited evidence base.

A challenge to research in this area is the reliance on self-reported dietary intake assessment methods. Children under the age of 12 have a limited ability to estimate and indicate portion sizes, and parents may not be the most reliable source to help their children estimate dietary intake.<sup>28,29</sup> Discrepancies also occur between children and adolescents when reporting dietary intake. Adolescents eating habits are less likely to be supervised by their parents, and they are more likely to use food as a way of self-expression<sup>29</sup>. Parents generally monitor children's food consumption, and children tend to eat in response to hunger, rather than as a form of self-expression<sup>29</sup>.

Compared to food diaries, 24-hour dietary recalls (24HR) and food frequency questionnaires (FFQ) may be appealing to adolescents as they are less intrusive<sup>28,29</sup>. In adolescents, there is no method for dietary assessment that is considered superior<sup>30</sup>. Self-reporting is known to present over- and under- reporting issues in both children and adolescents<sup>31-33</sup>. 24HR in children and adolescents can provide more accurate measures of dietary intake, especially when conducted on non-consecutive days<sup>34-37</sup>. Additionally, four 24HR, paired with a FFQ and food-recording booklet, are shown to improve self-reporting in children and adolescents<sup>34-36</sup>.

Consumption patterns in the United States have shown a decrease in SSB intake among United States children and adolescents; however, children and adolescents are still exceeding the recommendation<sup>38,39</sup>. Due to the negative health effects of AS, mainly in the form of SSB, a valid and reliable brief beverage intake assessment tool is needed for children and adolescents to advance research investigating the health impacts of SSB consumption.<sup>15-19</sup>.

The Beverage Intake Questionnaire (BEVQ-15) is a validated 15-item tool used to estimate habitual beverage intake over 15-beverage categories in adults<sup>40-42</sup>. This tool provides an estimate of total beverage and SSB intake, along with milk, water, and other beverages (fl oz, kcal). The purpose of this investigation is to determine the comparative validity and test-retest reliability of the BEVQ-15 for assessing usual beverage intake in children and adolescents.

## **2.3 Methods**

### **Subjects and Design**

Children and adolescents (n=326) aged 6-18 years old were recruited for this cross-sectional investigation. Participants were recruited from the Blacksburg community and the surrounding New River Valley areas from January 2014 to September 2015. The Virginia Tech Institutional Review Board approved the study protocol.

### **Protocol**

To determine the validity and reliability of the BEVQ-15, participants completed four laboratory sessions within a two to three week period, in a randomly assigned visit sequence. Randomly assigned visit sequences were utilized to avoid changes in dietary consumption due to questions asked at each visit (**Figure 1**)<sup>43</sup>. Interested participants

signed a consent form at the first visit. Parental consent was also obtained if the participant was under 18 years old.

At the first visit, height and weight was measured for all participants. Height was measured in centimeters without shoes, using a mounted stadiometer (Seca version 216, Seca, United Kingdom). Weight (kg) was assessed without shoes, using a digital scale (Scale-Tronix version 5002, Scale-Tronix, Illinois). A demographic survey was completed, which included information about the participant's date of birth, health status, and medication use. A record-assisted 24HR was also administered to each participant at all four visits. Sequence 1 participants completed the BEVQ-15 at the first and third visit, whereas sequence 2 participants completed the BEVQ-15 at the second and fourth visit. Participants also received a food-recording booklet after the each visit that was used as a reference when administering the 24HR<sup>34</sup>. Four 24HR, paired with a FFQ and food-recording booklet, are shown to improve self-reporting in children and adolescents<sup>34-36</sup>. BMI, BMI-for-age percentile,<sup>44</sup> and estimated energy requirements (EER) were calculated for each participant<sup>45</sup>.

24HR dietary recalls were obtained on non-consecutive days, including 1 weekend day and 3 week days, as adolescents are more likely to consume SSB on the weekends compared to the weekdays<sup>36</sup>. Parents were allowed to assist their children with the 24HR if needed. 24HR were analyzed using nutritional analysis software (Nutrition Data System for Research software version 2013, Nutrition Coordinating Center [NCC] at the University of Minnesota, Minneapolis, MN). Trained research assistants administered 24HR to help prompt participants when recalling their food intake, and the automated multiple-pass method (AMPM) was utilized<sup>46</sup>. Food models and food

diagrams were used to help study participants estimate portion sizes. Participants were compensated \$50 for completing all sessions.

Results packets were sent to all participants, which included a complete dietary analysis, an analysis of the participants BMI, and a summary of MyPlate dietary recommendations for children<sup>47,48</sup>.

### **Data Analysis**

Statistical analyses were performed using SPSS statistical analysis software (SPSS version 22.0 for Windows, SPSS Inc., Chicago, IL). Descriptive statistics (mean  $\pm$  standard error and frequencies) are reported for demographic characteristics. Descriptive statistics (mean  $\pm$  standard error and frequencies) are reported for the full sample and children (aged 6-11) and adolescents (aged 12-18). Independent sample t-tests and chi-squared tests were used to assess potential age group differences. One-way ANOVA tests were used to indicate if there were differences in water (fl oz), total SSB (kcal), and total beverage intake (kcal) across BMI classifications.

Paired sample t-tests were used to assess validity, by comparing beverage intake from the dietary recalls (4 day average) to the BEVQ1, as in prior studies of adults<sup>41</sup>. Correlational analyses were used to evaluate associations between 24HR and BEVQ1 results. Paired sample t-tests were used to assess test-retest reliability by comparing BEVQ-15 responses at two sessions (BEVQ1, BEVQ2). Correlational analyses were used to evaluate associations between BEVQ1 and BEVQ2 results. Validity and reliability results were reported as mean  $\pm$  standard error. Beverage categories were reported in fl oz and energy (kcal). Comparisons of validity and reliability were also be made within two



age group subsets; children (aged 6-11) and adolescents (aged 12-18). The alpha level was set a priori at  $p \leq 0.05$ .

## 2.4 Results

333 children and adolescents enrolled in this investigation, and 326 children and adolescents (126 children, 200 adolescents) completed all four study visits (98% completion rate). No differences were reported between completers and non-completers for race, gender, BMI classification or age. Demographic characteristics are presented in **Table 1**. Participants were primarily white (93% of the sample), which was consistent between age subgroups. The mean age for the entire sample was  $12 \pm 0$  years. Most children were classified as normal weight (78%), but BMI ( $\text{kg}/\text{m}^2$ ) differences were seen across the subgroups. Differences were noted between the two age groups in the underweight and obese weight categories, with a higher prevalence of underweight in children and a higher prevalence of obesity in adolescents. No differences were noted for intake of water (fl oz), total SSB (kcal), and total beverage intake (kcal) across BMI classifications.

### Full Sample

Validity and test-retest reliability results for the full sample are reported in **Table 2**. Of the 15 beverage categories assessed plus total sugar-sweetened beverages and total beverages (fl oz, kcal), responses of the BEVQ1 and 24HR were all significantly correlated ( $P < 0.001$ ), indicating that responses using each tool were associated, with the exception of sweetened tea/coffee with milk and liquor. No correlations were reported with beer and wine, which is attributed to no intake of these beverages. Validity (i.e., no difference between BEVQ1 and 24HR responses) was demonstrated for water, sweetened

juice drink, sweet tea, and total sugar-sweetened beverages. All beverage categories were significantly correlated (i.e., test-retest reliability) for BEVQ1 and BEVQ2 ( $P < 0.001$ ) with the exception of energy (kcal) for diet soda. No correlation was reported for wine, due to no intake of this beverage. Reliability was acceptable with r-values in the moderate to strong range of 0.3-0.9<sup>49</sup>. Responses between BEVQ1 and BEVQ2 were not different in intake (fl oz) and energy (kcal) for all variables except sweetened juice drinks and total beverages (mean difference of 1 fl oz and 3 fl oz, respectively).

### Children

Validity and test-retest reliability of children aged 6-11 are reported in **Table 3**. In children, BEVQ1 and 24HR responses were significantly correlated across all beverage categories ( $P < 0.05$ ), with the exception of sweetened juice drinks. Validity was demonstrated in most beverage categories, with a few exceptions. No differences were noted between the BEVQ1 and 24HR intake in energy (kcal) for total beverages, all the milk categories, sweet tea, sweetened tea/coffee with milk, and energy drinks. All results were significantly correlated between BEVQ1 and BEVQ2 ( $P < 0.01$ ) in this age group. Acceptable reliability was demonstrated, with most r-values falling in the moderate range of 0.3-0.9<sup>49</sup>. No significant differences were seen between BEVQ1 and BEVQ2 across beverage categories.

### Adolescents

Validity and test-retest reliability of adolescents aged 12-18 are reported in **Table 4**. In adolescents, responses on the two assessment tools (BEVQ1, 24HR) were significantly correlated across all beverage categories ( $P < 0.001$ ), with the exception of sweetened tea/coffee with milk and liquor. No correlation was reported for wine, which is

likely attributed to no intake of this beverage. Validity was demonstrated for the following: water, sweetened juice, sweet tea, fl oz for energy drinks and kcal of total sugar-sweetened beverages. All responses were significantly correlated between BEVQ1 and BEVQ2 categories ( $P < 0.001$ ). No correlation was reported for wine, which is likely attributed to no intake of this beverage. Acceptable test-retest reliability was demonstrated, with  $r$ -values in the moderate to strong range of 0.3-0.9<sup>49</sup>. No significant differences were detected between BEVQ1 and BEVQ2 responses with the exception of total beverages.

## **2.5 Discussion**

In general, a small but systematic overestimation was evident for the BEVQ-15 compared to 24HR responses in both age subsets, in that mean 24HR responses were generally lower compared to mean BEVQ-15 results. Although differences were noted between the BEVQ-15 and the 24HR responses, the differences may not be clinically significant. For example, only a 10-20 calorie difference in the regular soft drink and milk categories across the two methods was detected. These results demonstrate that the BEVQ-15 appears to be a valid and reliable tool to assess habitual water and total SSB intake in children and adolescents. In children, this tool also provides valid estimates of milk and energy for total beverages. In adolescents, the BEVQ-15 can be used to provide valid estimates of water and energy for total SSB. Thus, this tool could be used in epidemiological and clinical research examining the impact of SSB intake, as well as intake of several other beverages, on health, although some additional refinements may be needed.

In both age groups, moderate to strong r-values were reported for reliability. This is consistent with other studies of FFQ, which typically report r-values between 0.5 and 0.7<sup>49</sup>. An overestimation of daily intake of beverages was seen from the BEVQ-15 compared to the 24HR in both age subsets. This could be due to the fact that the BEVQ-15 is an estimation of habitual beverage intake over 30 days,<sup>40</sup> whereas 24HR represent an average daily intake from 4 days. Therefore, differences could occur between BEVQ-15 responses and 24HR responses since they are estimations from a different number of days. However, 4 24HR were chosen as the method for comparison in this study because they require less subject burden, and have been demonstrated to accurately measure energy intake in children and adolescents<sup>36</sup>.

Our findings were consistent with beverage consumption trends in the United States<sup>39</sup>. SSB consumption is very prevalent among children and adolescents in the United States,<sup>39</sup> and the primary source among SSB consumers in children is fruit drinks<sup>39</sup>. This is consistent with our findings. In children, an average of 33 calories was seen from 24HR responses of sweetened juice drinks. In adolescents, the number one source of calories from SSB is in the form of regular sodas<sup>39</sup>. Our findings also demonstrated high regular soda consumption in adolescents, reporting an average of 54 calories in 24HR responses. Differences also exist among children and adolescents in consumption of energy drinks. Research shows that in general, adolescents consume more energy drinks compared to children<sup>39</sup>. This was reflected in our results with adolescents consuming approximately 4 more calories from energy drinks compared to children. Compared to the general population, our sample consumed less total SSB. Between 2009-2010, the average energy intake from SSB in children was 118 kcal/day<sup>38</sup>.

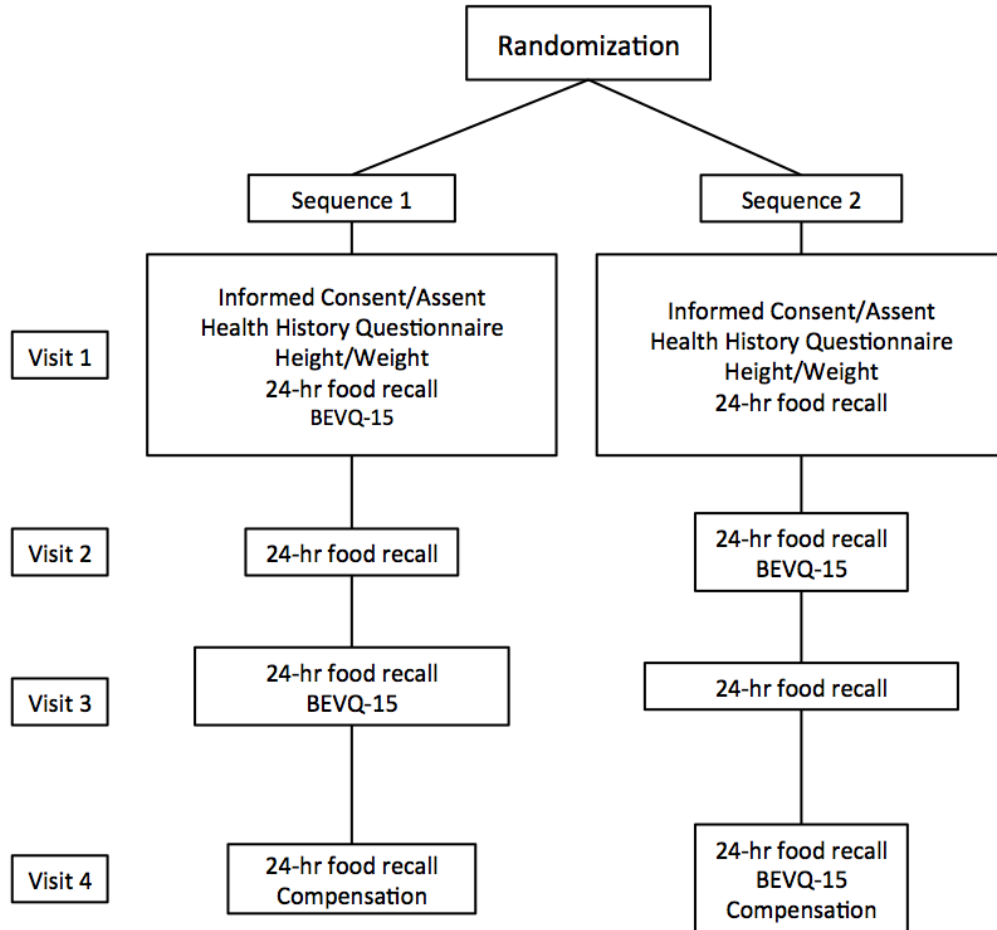
From the 24HR responses, our sample reported consuming 79 kcal of total SSB.

Similarly the average energy intake from SSB in adolescents was 225 kcal/d<sup>38</sup>. According to the 24HR responses, adolescents in our sample reported 110 kcal from total SSB.

Several limitations are acknowledged. Since the BEVQ-15 was originally validated in an adult population, some modifications could be made to the beverage categories when using this tool in children and adolescents<sup>40</sup>. For example, the wine, liquor, and beer categories could be removed for children aged 6-11 years old. Questions from study participants during sessions revealed that more current juice examples in the categories might help younger children determine how to categorize certain beverages, such as adding a popular juice drinks (e.g., Capri Sun). Another modification could be considered for the milk categories, which is to add the cap color for milk containers to more easily determine what type of milk they have at home (e.g. red cap for whole milk). Strengths of this investigation are also noted. Participants were given food-recording booklets to help assist with 24HR, as this approach along with parental help has been shown to reduce self-reporting errors in children<sup>34</sup>. Trained research assistants also administered 24HR to help prompt participants when recalling their food intake, and the automated multiple-pass method (AMPM) was utilized<sup>46</sup>. The large sample size of this study is also a strength<sup>43</sup>, and the large number of both children and adolescents allowed for age group comparisons to be made within the sample. It is noted that differences in dietary intake occur between children and adolescents<sup>29,38,39</sup>. Adolescents are more likely to use food as a way of self-expression, whereas children tend to eat when they are hungry<sup>29,38,39</sup>.

Future studies should explore whether a change in some of the BEVQ-15 categories and format could improve validity. Studies could utilize two different beverage questionnaires when working with both children and adolescents, since discrepancies do occur between these two age groups when reporting dietary intake<sup>29,38,39</sup>. The BEVQ-15 could also be used as an interviewer-administered tool in young children, versus self-administered. Overall, strong reliability was demonstrated in almost all of the beverage categories, across both age groups. However, validity was not demonstrated in several beverage categories. Since our sample size was primarily white, future studies should include more ethnic diversity to determine if the BEVQ-15 is valid and reliable across all ethnicities and racial groups.

**Figure 1.** Study Procedures: Validity and Reliability of a Beverage Intake Questionnaire in Children and Adolescents



Note: BEVQ-15 = Beverage Questionnaire-15

<b>Table 1.</b> Baseline participant characteristics in the full sample, and in the children and adolescent subgroups				
Mean ± Standard Error (SE)/N (%)				
Characteristic	Full Sample (n= 326)	Age 6-11 yrs. (n= 126)	Age 12-18 yrs. (n= 200)	p-value <sup>A</sup>
<b>Age (years)</b>	12+0	9+0	15+0	p< 0.001
<b>Highest grade of school completed</b>	6+0	3+0	9+0	p< 0.001
<b>Height (cm)</b>	155+1	137+1	166+1	p< 0.001
<b>Weight (kg)</b>	49+1	32+1	60+1	p< 0.001
<b>BMI (kg/m<sup>2</sup>)</b>	20+0	17+0	22+0	p< 0.001
<b>BMI-for-age percentile</b>	56+2	50+3	60+2	p= 0.001
<b>BMI Classification, n (%)</b>				
Underweight (<5 <sup>th</sup> percentile)	12 (4)	9 (7)	3 (2)*	p= 0.010
Normal weight (5 <sup>th</sup> -85 <sup>th</sup> percentile)	254 (78)	101 (80)	153 (77)	
Overweight (85 <sup>th</sup> -94 <sup>th</sup> percentile)	35 (11)	11 (9)	24 (12)	
Obese (>95 <sup>th</sup> percentile)	25 (8)	5 (4)	20 (10)*	
<b>Estimated Energy Requirements (kcal)</b>	1891+26	1736+37	1992+34	p< 0.001
<b>Gender, n (%)</b>				
Male	159 (49)	71 (56)	88 (44)	p= 0.030
Female	167 (51)	55 (44)	112 (56)	
<b>Hispanic or Latino, n (%)</b>				
Hispanic or Latino	6 (2)	4 (3)	2 (1)	p= 0.351
Not Hispanic or Latino	303 (93)	115 (91)	188 (94)	
Not Sure	17 (5)	7 (6)	10 (5)	
<b>Race, n (%)</b>				
White	304 (93)	116 (92)	188 (94)	p= 0.385
Black	3 (1)	1 (1)	2 (1)	
Asian	7 (2)	5 (4)	2 (1)	
Not sure	1 (0)		1 (1)	
Other	2 (1)		2 (1)	
More than 1 race	9 (3)	4 (3)	5 (3)	

<sup>A</sup>p-value tests were used to compare group means;  $\chi^2$  tests were used to compare proportions across groups.  
\* Differences in BMI Classifications between children and adolescents



**Table 2.** Validity and test-retest reliability of a beverage intake questionnaire (BEVQ) in children and adolescents

Validity <sup>a</sup>				Reliability <sup>b</sup>			
Mean + Standard Error of the Mean				Mean + Standard Error of the Mean			
Beverage category	BEVQ1	24HR	Difference with BEVQ1 <sup>c</sup>	Correlation (r)	BEVQ2	Difference with BEVQ2 <sup>c</sup>	Correlation (r)
Water (fl oz)	23+1	23+1	0+1	0.601***	23+1	0+1	0.657***
100% Fruit juice							
fl oz	3+0	2+0	1+0***	0.372***	3+0	0+0	0.715***
kcal	48+5	31+3	17+5***	0.372***	44+5	4+4	0.715***
Sweetened juice drink							
fl oz	2+0	2+0	0+0	0.258***	1+0	1+0*	0.436***
kcal	25+3	28+2	-4+4	0.259***	18+2	7+3*	0.441***
Whole Milk							
fl oz	1+0	0+0	1+0**	0.309***	1+0	0+0	0.515***
kcal	22+6	8+2	15+5**	0.309***	14+3	8+5	0.515***
Reduced fat milk							
fl oz	3+0	2+0	1+0***	0.681***	4+0	0+0	0.671***
kcal	60+8	39+4	21+6***	0.681***	64+8	-4+6	0.674***
Fat free milk							
fl oz	5+1	4+0	1+0*	0.719***	5+1	0+0	0.781***
kcal	62+6	49+4	13+5*	0.718***	57+6	5+4	0.780***
Regular soft drink							
fl oz	2+0	3+0	-1+0***	0.495***	2+0	0+0	0.613***
kcal	30+3	44+4	-14+4***	0.498***	26+3	3+3	0.617***
Diet soft drink							
fl oz	1+0	0+0	0+0***	0.386***	1+0	0+0	0.717***
Sweet Tea							
fl oz	2+0	1+0	0+0	0.487***	2+0	0+0	0.570***
kcal	16+3	14+2	2+2	0.487***	17+2	-1+2	0.570***
Sweetened tea/coffee with milk							
fl oz	1+0	0+0	1+0***	-0.006	1+0	0+0	0.532***
kcal	8+1	1+0	7+1***	-0.006	6+1	2+1	0.532***
Unsweetened tea/coffee							
fl oz	0+0	1+0	-1+0***	0.414***	0+0	0+0	0.821***
Beer							
fl oz	0+0	0+0	0+0	-	0+0	0+0	0.945***
kcal	0+0	0+0	0+0	-	0+0	0+0	0.945***
Liquor							
fl oz	0+0	0+0	0+0	-0.004	0+0	0+0	0.358***
kcal	3+2	0+0	3+2	-0.004	1+1	2+2	0.353***
Wine							
fl oz	0+0	0+0	-	-	0+0	-	-
kcal	0+0	0+0	-	-	0+0	-	-
Energy drinks							
fl oz	1+0	1+0	0+0	0.310***	1+0	0+0	0.313***
kcal	18+3	12+2	7+3*	0.320***	15+2	3+3	0.343***
Total sugar-sweetened beverages							
fl oz	8+1	8+1	0+1	0.560***	7+1	1+1	0.612***
kcal	94+8	98+6	-3+7	0.550***	83+7	12+6	0.594***
Total beverages							
fl oz	45+1	40+1	4+1***	0.526***	42+1	2+1*	0.737***
kcal	292+17	226+9	66+13***	0.684***	263+15	28+11*	0.774***

<sup>a</sup>Validity was assessed comparing BEVQ1 with 24-hour recall responses (24HR)

<sup>b</sup>Reliability was assessed by comparing BEVQ1 and BEVQ2

<sup>c</sup>Mean differences according to a paired sample *t* test\**P*<0.05; slight differences may be noted from proceeding columns due to rounding, as whole numbers are presented in the Table.

\**P*<0.05

\*\**P*<0.01

\*\*\**P*<0.001

**Table 3.** Validity and test-retest reliability of a beverage intake questionnaire (BEVQ) in children (aged 6-11 yrs.) (n= 126)

Validity <sup>a</sup>				Reliability <sup>b</sup>			
Mean + Standard Error of the Mean				Mean + Standard Error of the Mean			
Beverage category	BEVQ1	24HR	Difference with BEVQ1 <sup>c</sup>	Correlation (r)	BEVQ2	Difference with BEVQ2 <sup>c</sup>	Correlation (r)
<b>Water (fl oz)</b>	18+1	16+1	3+1**	0.505***	19+1	0+1	0.399***
<b>100% Fruit juice</b>							
fl oz	3+0	2+0	1+0*	0.422***	3+1	0+0	0.597***
kcal	49+8	33+4	15+7*	0.422***	44+8	4+7	0.597***
<b>Sweetened juice drink</b>							
fl oz	1+0	2+0	-1+0*	0.053	1+0	0+0	0.189***
kcal	15+4	33+4	-18+6*	0.053	14+3	1+4	0.189***
<b>Whole Milk</b>							
fl oz	0+0	0+0	0+0	0.461***	0+0	0+0	0.449***
kcal	9+4	7+2	3+4	0.461***	7+3	3+4	0.449***
<b>Reduced fat milk</b>							
fl oz	2+0	2+0	1+0	0.710***	3+1	0+0	0.503***
kcal	41+7	33+5	9+5	0.715***	47+8	-5+8	0.498***
<b>Fat free milk</b>							
fl oz	5+1	4+1	1+1	0.716***	4+1	0+1	0.605***
kcal	55+8	48+6	7+6	0.712***	50+7	5+7	0.603***
<b>Regular soft drink</b>							
fl oz	1+0	2+0	-1+0*	0.330***	1+0	0+0	0.533***
kcal	16+3	26+4	-11+4**	0.348***	13+2	3+3	0.564***
<b>Diet soft drink</b>							
fl oz	1+0	0+0	0+0*	0.485***	1+0	0+0	0.496***
<b>Sweet Tea</b>							
fl oz	1+0	1+0	0+0	0.461***	1+0	0+0	0.761***
kcal	11+3	10+4	1+4	0.461***	14+4	-3+3	0.761***
<b>Sweetened tea/coffee with milk</b>							
fl oz	0+0	0+0	0+0	0.175*	0+0	0+0	0.252**
kcal	1+1	0+0	1+1	0.175*	1+1	0+1	0.252**
<b>Unsweetened tea/coffee</b>							
fl oz	0+0	0+0	0+0*	0.651***	0+0	0+0	0.880***
<b>Beer</b>							
fl oz	0+0	0+0	-	-	0+0	-	-
kcal	0+0	0+0	-	-	0+0	-	-
<b>Liquor</b>							
fl oz	0+0	0+0	-	-	0+0	-	-
kcal	0+0	0+0	-	-	0+0	-	-
<b>Wine</b>							
fl oz	0+0	0+0	0+0*	-	0+0	-	-
kcal	0+0	0+0	0+0*	-	0+0	-	-
<b>Energy drinks</b>							
fl oz	1+0	1+0	0+0	0.460***	1+0	0+0	0.504***
kcal	10+2	9+2	1+3	0.460***	7+2	3+2	0.524***
<b>Total sugar-sweetened beverages</b>							
fl oz	4+1	6+1	-2+1**	0.553***	4+1	0+1	0.692***
kcal	52+8	79+8	-28+8***	0.508***	50+7	1+6	0.649***
<b>Total beverages</b>							
fl oz	33+2	30+1	3+2*	0.468***	32+2	1+2	0.501***
kcal	207+17	200+10	7+15	0.545***	199+15	8+16	0.539***

<sup>a</sup>Validity was assessed comparing BEVQ1 with 24-hour recall responses (24HR)  
<sup>b</sup>Reliability was assessed by comparing BEVQ1 and BEVQ2  
<sup>c</sup>Mean differences according to a paired sample *t* test\**P*<0.05; slight differences may be noted from proceeding columns due to rounding, as whole numbers are presented in the Table.  
\**P*<0.05  
\*\**P*<0.01  
\*\*\**P*<0.001

**Table 4.** Validity and test-retest reliability of a beverage intake questionnaire (BEVQ) in adolescents (aged 12-18 yrs.) (n= 200)

Validity <sup>a</sup>				Reliability <sup>b</sup>			
Mean + Standard Error of the Mean				Mean + Standard Error of the Mean			
Beverage category	BEVQ1	24HR	Difference with BEVQ1 <sup>c</sup>	Correlation (r)	BEVQ2	Difference with BEVQ2 <sup>c</sup>	Correlation (r)
<b>Water (fl oz)</b>	27+1	28+1	-1+1	0.586***	26+1	1+1	0.746***
<b>100% Fruit juice</b>							
fl oz	3+0	2+0	1+0*	0.344***	3+0	0+0	0.797***
kcal	48+7	30+4	18+6*	0.344***	44+6	4+4	0.798***
<b>Sweetened juice drink</b>							
fl oz	2+0	2+0	0+0	0.400***	1+0	1+0**	0.514***
kcal	30+5	25+3	5+4	0.401***	20+3	11+4**	0.522***
<b>Whole Milk</b>							
fl oz	1+0	0+0	1+0**	0.288***	1+0	1+0	0.517***
kcal	31+ 8	9+ 3	22+8**	0.288***	19+5	12+7	0.517***
<b>Reduced fat milk</b>							
fl oz	4+1	2+0	2+1**	0.674***	4+1	0+1	0.698***
kcal	72+ 12	44+6	28+9**	0.674***	75+12	-4+9	0.702***
<b>Fat free milk</b>							
fl oz	6+1	4+1	1+1**	0.721***	5+1	0+0	0.835***
kcal	67+9	50+6	17+6**	0.721***	62+9	5+5	0.834***
<b>Regular soft drink</b>							
fl oz	3+0	4+0	-1+0**	0.503***	3+0	0+0	0.608***
kcal	38+ 5	54+5	-16+5**	0.503***	35+5	4+4	0.608***
<b>Diet soft drink</b>							
fl oz	1+0	0+0	1+0*	0.374***	1+0	0+0	0.774***
<b>Sweet Tea</b>							
fl oz	2+0	2+0	0+0	0.504***	2+0	0+0	0.471***
kcal	19+3	17+3	3+3	0.504***	18+3	1+3	0.470***
<b>Sweetened tea/coffee with milk</b>							
fl oz	2+0	0+0	1+0***	-0.040	1+0	0+0	0.525***
kcal	12+2	1+0	11+2***	-0.040	9+2	3+2	0.525***
<b>Unsweetened tea/coffee</b>							
fl oz	1+0	1+0	-1+0***	0.375***	1+0	0+0	0.818***
<b>Beer</b>							
fl oz	0+0	0+0	0+0	-	0+0	0+0	0.944***
kcal	1+0	0+0	1+0	-	1+0	0+0	0.944***
<b>Liquor</b>							
fl oz	0+0	0+0	0+0	-0.007	0+0	0+0	0.356***
kcal	5+3	0+0	4+3	-0.007	2+1	3+3	0.350***
<b>Wine</b>							
fl oz	0+0	0+0	0+0***	-	0+0	-	-
kcal	0+0	0+0	0+0***	-	0+0	-	-
<b>Energy drinks</b>							
fl oz	2+0	1+0	1+0	0.286***	1+0	0+0	0.282***
kcal	23+5	13+3	10+5*	0.299***	20+4	3+5	0.314***
<b>Total sugar-sweetened beverages</b>							
fl oz	10+1	9+1	2+1*	0.551***	9+1	2+1	0.566***
kcal	122+11	110+8	12+9	0.551***	104+10	18+10	0.554***
<b>Total beverages</b>							
fl oz	52+2	46+2	5+2**	0.454***	48+2	3+1*	0.761***
kcal	345+26	242+13	103+19***	0.708***	304+22	41+15**	0.806***

<sup>a</sup>Validity was assessed comparing BEVQ1 with 24-hour recall responses (24HR)

<sup>b</sup>Reliability was assessed by comparing BEVQ1 and BEVQ2

<sup>c</sup>Mean differences according to a paired sample *t* test\*P<0.05; slight differences may be noted from proceeding columns due to rounding, as whole numbers are presented in the Table.

\*P<0.05

\*\*P<0.01

\*\*\*P<0.001

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## Chapter 3

### 3.1 Future Directions

Establishing the BEVQ-15 FFQ as valid, reliable, and sensitive means for assessing habitual beverage intake in youth could further epidemiological and clinical research examining the impact of SSB intake, as well as intake of other beverages, on health. This tool could provide clinicians with a noninvasive and rapid means to assess dietary intake in children and adolescents; which could help clinicians create individualized plans to establish healthy behaviors in their clients. The beverage questionnaire (BEVQ-15) used in this study was previously validated in an adult population<sup>1-3</sup>. In order to make this tool more suitable to use in a younger population, some refining may be needed. The beverage categories for beer, liquor, and wine are not necessary when administering this questionnaire to children (aged 6-11). However, it is appropriate to keep these categories for an adolescent (aged 12-18) population. Future studies could utilize two different beverage questionnaires when working with both children and adolescents, since discrepancies do occur between these two age groups when reporting dietary intake<sup>4</sup>. Changes in the milk categories could also provide more accurate responses from participants. For example, including the color of the milk label next to each category could prompt participants to accurately choose what type they drink at home. Questions from study participants revealed that children might need additional help while filling out the BEVQ-15. To address this issue, future versions should include additional instruction for the researchers, in order to make sure younger children understand how to correctly fill out the questionnaire. The BEVQ-15 could also be used as an interviewer-administered tool in young children, versus self-administered. Future



work will need to determine whether incorporating these changes could result in more accurate responses.

Due to the primarily white composition of this sample, future studies that include larger numbers of minorities are suggested. Additionally, this sample consumed less sugar-sweetened beverages (SSB) compared to the general US population for children and adolescents. As reported in the average 4-day 24HR children reported consuming 79 kcal from total SSB. The average energy intake from SSB in the US children population is 118 kcal/d. Similarly adolescents reported consuming 110 kcal from total SSB in their 24HR, whereas the general US adolescent population reports consuming 225 kcal/day from SSB. Future studies that include larger numbers of minorities and a more generalizable population for SSB intake are warranted to determine whether the BEVQ-15 is a valid tool across the entire US population. Studies show that children and adolescents from low-income, low-education families are more likely to consume SSB<sup>5</sup>. Additionally, Hispanic and Black children and adolescents are more likely to consume SSB compared to White children and adolescents<sup>5</sup>.

It is also suggested that future work in this area include a physical activity questionnaire (PAQ) for both children and adolescents along with the BEVQ-15. The PAQ has been validated as a tool to assess physical activity in older children and adolescents<sup>6</sup>. Studies have shown that adolescents who consume SSB are more likely to exhibit sedentary lifestyles, compared to those who are involved in physical activity<sup>7</sup>. Similar findings have also been found in children<sup>7</sup>. By administering a PAQ, along with the BEVQ-15, future work could determine if SSB intake is associated with an increased or decreased amount of physical activity in participants.

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# Appendix A

## Beverage Questionnaire

**Instructions:**

In the past month, please indicate your response for each beverage type by marking an "X" in the bubble for "how often" and "how much each time"

1. Indicate how often you drank the following beverages, for example, you drank 5 glasses of water per week, therefore mark 4-6 times per week
2. Indicate the approximate amount of beverage you drank each time, for example, you drank 1 cup of water each time, therefore mark 1 cup under "how much each time"
3. Do not count beverages used in cooking or other preparations, such as milk in cereal
4. Count milk added to tea and coffee in the *tea/coffee with cream beverage category* **NOT** in the milk categories

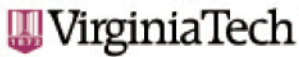
Subject ID \_\_\_\_\_

Date \_\_\_\_\_

Type of Beverage	HOW OFTEN (MARK ONE)							HOW MUCH EACH TIME (MARK ONE)				
	Never or less than 1 time per week (go to next beverage)	1 time per week	2-3 times per week	4-6 times per week	1 time per day	2+ times per day	3+ times per day	Less than 6 fl oz (3/4 cup)	8 fl oz (1 cup)	12 fl oz (1 1/2 cups)	16 fl oz (2 cups)	More than 20 fl oz (2 1/2 cups)
Water	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
100% Fruit Juice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sweetened Juice Beverage/ Drink (fruit ades, lemonade, punch, Sunny Delight)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Whole Milk	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reduced Fat Milk (2%)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Low Fat/Fat Free Milk (Skim, 1%, Buttermilk,	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Soft Drinks, Regular	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Diet Soft Drinks/Artificially Sweetened Drinks (Crystal Light)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sweetened Tea	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tea or Coffee, with cream and/or sugar (includes non-dairy creamer)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tea or Coffee, black, with/ without artificial sweetener (no cream or sugar)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Beer, Ales, Wine Coolers, Non-alcoholic or Light Beer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hard Liquor (shots, rum, tequila, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wine (red or white)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Energy & Sports Drinks (Red Bull, Rockstar, Gatorade, Powerade, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (list):	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Virginia Polytechnic Institute and State University, 2010

## Appendix B



Office of Research Compliance  
Institutional Review Board  
North End Center, Suite 4120, Virginia Tech  
300 Turner Street NW  
Blacksburg, Virginia 24061  
540/231-4606 Fax 540/231-0959  
email [irb@vt.edu](mailto:irb@vt.edu)  
website <http://www.irb.vt.edu>

### MEMORANDUM

**DATE:** September 17, 2013  
**TO:** Brenda Davy, Shaun Karl Riebl  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)  
**PROTOCOL TITLE:** Determining the Validity, Reliability, and Sensitivity of the d13C Added Sugar Biomarker and BEVQ-15 in Adolescents and a Qualitative Analysis of Beverage Choices in Adolescents and Their Parents using the Theory of Planned Behavior.  
**IRB NUMBER:** 13-810

Effective September 17, 2013, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

<http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

### PROTOCOL INFORMATION:

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 7**  
Protocol Approval Date: **September 17, 2013**  
Protocol Expiration Date: **September 16, 2014**  
Continuing Review Due Date\*: **September 2, 2014**

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

### FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY  
*An equal opportunity, affirmative action institution*

Date*	OSP Number	Sponsor	Grant Comparison Conducted?

\* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

**MEMORANDUM**

**DATE:** August 19, 2014  
**TO:** Brenda Davy, Shaun Karl Riebl  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)  
**PROTOCOL TITLE:** Determining the Validity, Reliability, and Sensitivity of the d13C Added Sugar Biomarker and BEVQ-15 in Adolescents and a Qualitative Analysis of Beverage Choices in Adolescents and Their Parents using the Theory of Planned Behavior.  
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(Please review responsibilities before the commencement of your research.)

**PROTOCOL INFORMATION:**

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 7**  
Protocol Approval Date: **September 17, 2014**  
Protocol Expiration Date: **September 16, 2015**  
Continuing Review Due Date\*: **September 2, 2015**

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

**FEDERALLY FUNDED RESEARCH REQUIREMENTS:**

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*Invent the Future*

Date*	OSP Number	Sponsor	Grant Comparison Conducted?
07/16/2014	13173902	NIH, Center for Scientific Review	Compared on 07/17/2014

\* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

**MEMORANDUM**

**DATE:** February 13, 2015  
**TO:** Brenda Davy, Madlyn Irene Frisard, Valisa Ellen Hedrick, Tina Savla, Elaina Lynn Marinik  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)  
**PROTOCOL TITLE:** d13C Added Sugar Intake Biomarker: Determining Validity in Children  
**IRB NUMBER:** 15-067

Effective February 11, 2015, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

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(Please review responsibilities before the commencement of your research.)

**PROTOCOL INFORMATION:**

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 3,4,6,7**  
Protocol Approval Date: **February 11, 2015**  
Protocol Expiration Date: **February 10, 2016**  
Continuing Review Due Date\*: **January 27, 2016**

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

**FEDERALLY FUNDED RESEARCH REQUIREMENTS:**

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

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Date*	OSP Number	Sponsor	Grant Comparison Conducted?
01/28/2015	13173902	National Institute of Child Health & Human Development	Compared on 02/02/2015

\* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

**MEMORANDUM**

**DATE:** August 19, 2015  
**TO:** Brenda Davy, Shaun Karl Riebl  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires July 29, 2020)  
**PROTOCOL TITLE:** Determining the Validity, Reliability, and Sensitivity of the d13C Added Sugar Biomarker and BEVQ-15 in Adolescents and a Qualitative Analysis of Beverage Choices in Adolescents and Their Parents using the Theory of Planned Behavior.  
**IRB NUMBER:** 13-810

Effective August 18, 2015, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Continuing Review request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

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**PROTOCOL INFORMATION:**

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 7**  
Protocol Approval Date: **September 17, 2015**  
Protocol Expiration Date: **September 16, 2016**  
Continuing Review Due Date\*: **September 2, 2016**

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

**FEDERALLY FUNDED RESEARCH REQUIREMENTS:**

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

*Invent the Future*

Date*	OSP Number	Sponsor	Grant Comparison Conducted?
07/16/2014	13173902	NIH, Center for Scientific Review	Compared on 07/17/2014

\* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

**MEMORANDUM**

**DATE:** January 13, 2016  
**TO:** Brenda Davy, Madlyn Irene Frisard, Valisa Ellen Hedrick, Tina Savla, Elaina Lynn Marinik  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires July 29, 2020)  
**PROTOCOL TITLE:** d13C Added Sugar Intake Biomarker: Determining Validity in Children  
**IRB NUMBER:** 15-067

Effective January 13, 2016, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Continuing Review request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

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(Please review responsibilities before the commencement of your research.)

**PROTOCOL INFORMATION:**

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 3,4,6,7**  
Protocol Approval Date: **February 11, 2016**  
Protocol Expiration Date: **February 10, 2017**  
Continuing Review Due Date\*: **January 27, 2017**

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

**FEDERALLY FUNDED RESEARCH REQUIREMENTS:**

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

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*Invent the Future*

Date*	OSP Number	Sponsor	Grant Comparison Conducted?
01/28/2015	13173902	National Institute of Child Health & Human Development	Compared on 02/02/2015

\* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

**MEMORANDUM**

**DATE:** June 15, 2016  
**TO:** Brenda Davy, Madlyn Irene Frisard, Valisa Ellen Hedrick, Tina Savla, Elaina Lynn Marinik, Carly Rimmer Macdougall, Catelyn Hill  
**FROM:** Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)  
**PROTOCOL TITLE:** d13C Added Sugar Intake Biomarker: Determining Validity in Children  
**IRB NUMBER:** 15-067

Effective June 14, 2016, the Virginia Tech Institutional Review Board (IRB) Chair, David M Moore, approved the Amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

<http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

**PROTOCOL INFORMATION:**

Approved As: **Expedited, under 45 CFR 46.110 category(ies) 3,4,6,7**  
Protocol Approval Date: **February 11, 2016**  
Protocol Expiration Date: **February 10, 2017**  
Continuing Review Due Date\*: **January 27, 2017**

\*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

**FEDERALLY FUNDED RESEARCH REQUIREMENTS:**

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

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Date*	OSP Number	Sponsor	Grant Comparison Conducted?
01/28/2015	13173902	National Institute of Child Health & Human Development	Compared on 02/02/2015

\* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.