Improved Interpretive Accuracy of Sugar Content on Beverage Labels Following an Educational Intervention for Children

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Abstract: To address childhood obesity, it is important to help children make better choices with regards to intake of sugary drinks and snacks. The purpose of this study was to evaluate the validity of a novel educational intervention designed to convert grams of sugar into teaspoons on labeled beverages. A convenience sample of children (n = 21) at a charter elementary school in Washington, D. C was studied. A pre-test required an estimation of teaspoons of sugar on labels, followed by a practice demonstration and song. A post-test was given requiring estimation of teaspoons of sugar in on the same labels. Two weeks later, a retention test as well as qualitative questions assessed participant learning and information usage. Test scores revealed increased accuracy from pre-test (26.2%) to post-test (79.8%). Estimations were more accurate after the demonstration, as evidenced by the decreased range in average variation of responses (+25.6 tsp to +1.8 tsp). Two-week recall maintained accuracy (66.7%), with an average variance of +3.8 teaspoons. Qualitative responses revealed participants had learned and used the conversion concepts. These results suggest that the educational intervention was effective. Qualitative data suggest behavior change, increased awareness, and the potential for change extending to caregivers.

Key words: children, obesity, sugar-sweetened beverages, education.

1. Introduction

Recent NHANES (National Health and Nutrition Examination Survey) data show a slight decrease in childhood obesity rates (from 2003 through 2010, a decrease of 15.21% to 14.94%) [1]. However, more than one in three children in the United States are still overweight or obese [2]. SSBs (sugar-sweetened beverages), which include sodas, fruit drinks, sports drinks, and energy drinks, are some of the main caloric contributors in children’s diets [3]. An average of 8.0% of total calories per day is from added sugars in SSBs among children aged 6-11 years old [4]. These beverages may promote obesity [5, 6]. Besides adding 11.4 teaspoons of added sugar per day in children aged 2-19, SSBs are associated with poor dietary choices in general [4, 7]. Further, there appears to be a positive association between SSBs consumption in children 3-11 and CVD (cardiovascular disease) risk factors, where each additional serving was positively associated with increased CRP (C-Reactive protein) markers (an inflammatory response measure), increased waist circumference, and lowered HDL (high-density lipoprotein) cholesterol [8].

Attempts to reduce SSB consumption include initiatives by major beverage companies to reduce the caloric content, taxation policies, nutritional counseling, and substituting with water or non-caloric sweeteners instead [9-14]. Although several investigators have demonstrated the effectiveness of education, in a meta-analysis of recent studies aimed at reducing SSB consumption, none included an
 educational intervention aimed specifically at children and devoted to awareness of sugar content in beverages [15]. The investigators saw a need to address this gap by creating an educational intervention with the assumption that improving knowledge and awareness of the sugar content in SSBs may translate to behavior change regarding the consumption of added sugars in food, generally. The intervention was aimed at young children since lifestyle patterns are developed in childhood, making it crucial that interventions designed to change eating habits be aimed at children to prevent or reverse the effects of obesity or poor eating habits [16].

In the U.S., food labels use the metric system by expressing nutrients in grams. This math concept is unfamiliar to children and most adults; as such, little attention may be paid to the mix of household and metric measures on labels. Additionally, although beverage serving size is given as one cup (8 fl.oz), most drinks that are intended by the manufacturer to be consumed at one time contain from one to two servings per container. This makes it difficult to conceptualize the amount of added sugar in each container. Education on the conversion of grams of sugar to a more commonly understood household measurement (the teaspoon) may increase awareness of actual sugar intake.

This study aimed to test an educational intervention that would result in improved knowledge and awareness of school-aged children regarding the consumption of SSBs. The conceptual framework of the intervention was the construction of a learning module that incorporated six different styles of learning: visual (spatial), aural (auditory-musical), verbal (linguistic), physical (kinesthetic), logical (mathematical), and social (interpersonal) [17,18].

The objectives of the study were: (1) to test an intervention designed to teach school-age children the conversion of grams of sugar into teaspoons based on the nutrition fact labels of different common beverages, (2) to determine the effectiveness of the intervention, and (3) to determine whether the knowledge gained was retained after a period of two weeks. As such, three hypotheses were postulated: (1) children’s knowledge of sugar added to common beverages based on the nutrition fact labels will increase after the intervention, (2) the amount of error students make in estimating teaspoons will decrease after the intervention, and (3) children will be able to accurately convert grams of sugar into teaspoons two weeks after the initial intervention. In addition, student’s perceptions of what they had learned and if they had used these new skills since the intervention were examined.

2. Methods

The study design consisted of five parts: (1) a pre-test questionnaire, (2) a lab demonstration, (3) a post-test questionnaire, (4) group participation in singing an original song, and (5) a retention test two weeks following the intervention. Both qualitative and quantitative data were collected. The protocol was approved via expedited review by the Georgetown University Institutional Review Board (IRB#2013-1302). Written informed consent was obtained for participants younger than 18 years old, in addition to parent/guardian consent.

2.1 Participants

A convenience sample of 24 children was recruited from fourth and fifth grade classes at Elsie Whitlow Public Charter School in Washington, DC. Criteria for participation in the study included the ability to read and comprehend English, the availability of a parent/guardian to give informed consent, the ability of the child to give assent, the child’s ability to perform two-digit division, and completion of all three tests. Due to the small sample size, gender and age were not included as variables.

2.2 Instrument

To measure the effectiveness of the educational
intervention, an evaluation instrument (test) was developed with the goal of creating a standardized measure that can easily be implemented in schools nationwide to evaluate children’s ability to correctly convert grams of sugar into teaspoons based on nutrition fact labels of common beverages. The written test pictured four commonly consumed SSB labels and a picture of a teaspoon (see Appendix A). Participants were instructed to estimate the number of teaspoons of sugar in each drink. One beverage on each of the tests had a quantity that was not easily divisible, testing the student’s ability to perform two-digit division in determining sugar content on food labels to one decimal place. The pre- and post-test were identical, however the retention test showed four different beverages to eliminate memorization. The retention test also included two qualitative written questions: “What did you learn?” and “How have you used what you learned?”

2.3 Procedure

The pre-test was administered prior to the lab demonstration to determine the students’ ability to estimate the total number of teaspoons of sugar on each label. The educational intervention began with a visual demonstration by the investigator on how to convert the information about sugar content on beverage labels into teaspoons of sugar (e.g. 1 level teaspoon = 5 grams). Participants were then given the opportunity to measure the quantities of sugar listed on nutrition fact labels into their clear 8-ounce plastic container using the measuring teaspoons and leveling stick provided. Following the post-test, a critical component of the education instrument was the inclusion of an original rhythmic song emphasizing conversion concepts (see Appendix B). Research has shown that the rhythms in music enhance motivation for optimized learning [19, 20]. After a two-week period, the retention test was administered to determine recall of concepts presented in the lab.

2.4 Data Analysis

Data consisted of test scores (percent-accurate) and amount of error in estimations of teaspoon quantities. “Accuracy” was defined as an answer given within the range ± 1 whole teaspoon to the correct response. An answer of 3.5 teaspoons would be within the range of 2.5-4.5 and accepted as accurate. This was done to account for errors in division, resulting in incorrect decimals and rounding. Answers were also analyzed based on the average variance in teaspoons from the correct answer. For example, an answer of 25 teaspoons would have a variance of 22 teaspoons higher than the expected answer of 3. Variance is expected to decrease with increased understanding of conversion concepts.

Data were descriptively compared among the pre-test, post-test and 2-week follow-up tests to evaluate changes in score and accuracy over time. Due to the small sample, significance testing was not attempted. Content of participant responses to two written discussion questions on the retention test was inspected for common themes.

3. Results

Of the 24 children recruited, data were collected from 21 due to failure to complete all tests, and one outlier was excluded from average variance analysis for the retention test resulting in 20 responses. All participants provided open-ended responses, resulting in a total of 24 students analyzed for qualitative data. Addressing each study hypothesis, knowledge and amount of error in answers immediately following the intervention, as well as retention at two-week follow-up were examined.

3.1 Knowledge

As hypothesized, the children’s knowledge of sugar added to common beverages based on the nutrition fact labels increased following the intervention, such that accuracy rate increased from 26.2% pre-test to 79.8% post-test (Fig. 1).
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3.2 Amount of Error in Conversion

Similarly, the average amount by which answers varied from correct answer decreased from 25.6 teaspoons too high prior to the intervention to 1.8 teaspoons too high following the intervention (Fig. 1). Degree of accuracy was not lower for those questions requiring long division.

3.3 Retention of Learning

Between the post-test and the retention test, accuracy decreased from 79.8% to 66.7%. The average variance increased from 1.8 teaspoons on the post-test to 3.8 teaspoons on the retention test, as shown in Fig. 1, respectively. Again, degree of accuracy was not lower for those questions requiring long division.

3.4 Student's Perceptions

In addition to test performance, student perceptions of what they had learned and if they had used these new skills since the interventions were examined via content analysis of written response on the retention test to two open-ended questions (Table 1). In response to the question, “What did you learn?” there were four common themes observed with respect to participants’ learning: (1) that five grams is equal to one teaspoon, and how to divide grams of sugar on nutrition labels to find teaspoons of sugar; (2) how to physically measure teaspoons sugar found in SSBs; (3) how to interpret the sugar content in a beverage before drinking or purchasing it; and (4) there is a lot of sugar in foods or beverages that participants eat or drink daily.

Regarding the question, “How have you used what you learned?” one of the most commonly observed responses was that participants reported reducing their consumption of sugary drinks. Another pervasive theme was that participants now look at labels when grocery shopping with adult caregivers, and making decisions on what to eat or drink with respect to sugar contents (Table 1).

4. Discussion

Although the sample size is small, the results from both test performance and qualitative questions suggest that this educational intervention can be a valuable tool.
in helping children understand and interpret the sugar content on nutrition labels. Our pre-test results illustrate that school-age children in the US are unable to interpret mathematical concepts on food labels, likely due to unfamiliarity with the metric system. Pre-test answers showed an average variance of 25.6 teaspoons above the correct value, indicating that participants had very little understanding of how to calculate teaspoons of sugar from information on beverage labels prior to the learning experience.

Upon completion of the educational intervention, these children were able to accurately convert metric measurements on a product label into household measures, evidenced by improved accuracy of estimation from the pre-test to the retention test. A comparison of variance before and after the demonstration suggests that knowledge required to calculate teaspoons of added sugar was acquired as a result of the intervention. The scores achieved on the retention tests indicate that participants retained the information and maintained improved accuracy from the pre-test, suggesting the intervention was effective in engaging participants with concepts ensuring retention.

Based on the results of the discussion questions, it appears that the educational intervention achieved its intended goal of testing an effective learning module that encourages self-awareness with respect to consumption of SSBs. The common themes observed from the answers demonstrated that after the intervention, the participants knew the number of grams in one teaspoon, and could then use that conversion to accurately interpret sugar content on beverage labels. Further, responses suggested behavioral change, in that the intervention led them to use nutrition labels to inform decisions regarding SSBs consumption, as well as that of other foods with added sugar.

It is hypothesized that contributing to the success of the intervention was the use of multi-modal teaching strategies, including the song. In that children are increasingly less involved in food preparation, making the abstract amounts (grams, teaspoons) concrete was likely an active component as well. Future work on larger samples should explore potential moderating factors on knowledge and retention including student characteristics such as age, gender, ethnicity, neighborhood and socioeconomic status. Many of these have independently been associated with childhood obesity [1], suggesting interactions with intervention effectiveness. Especially important is to determine effectiveness in sub-populations of students at high risk for developing obesity, diabetes, and metabolic syndrome. Testing to see how well the skills gained generalize to conversion accuracy in foods other than SSBs will expand the implications of the study. Most important will be further evaluation to determine the degree to which the intervention actually influences food choices.

4.1 Limitations

Both the small sample size and relatively short
follow-up time point limit estimates of effectiveness of the intervention. Further, the subject pool was restricted to one school limiting the generalizability of its results to children of the same age nationwide. As noted above, replicating the study in a larger and more diverse sample will allow for examination of potential student characteristics covariates (age, gender, ethnicity). To have an effect on obesity outcomes, it is important that students remain thoughtful consumers of sugar over the course of their lives, thus evaluations of use of conversion strategy at time-points beyond two weeks are necessary.

4.2 Conclusions

This study suggests that an educational intervention designed to teach children to read and interpret nutrition labels found on SSBs was successful, both in concept retention and utilization in other contexts. Qualitative results suggest that this information could be translated into behavioral change. Additionally as children share what they have learned and make dietary changes, they may influence those around them. The concepts in the educational intervention could potentially be applied to other foods with added sugar, as well. Although brief and simple, by providing the students a memorable method to calculate sugar content, the intervention has the potential to influence life-long food and beverage choices of students, and their care providers as well.

5. Implications for School Health

Obesity is a significant issue in school age children and puts them at risk for poor health and educational outcomes. Sugar intake is an important predictor of children being overweight or obese, so to the degree that they can moderate their own sugar consumption, these outcomes are minimized. Tested was a creative and novel multimodal educational intervention (including a measuring activity and a song) to teach children to convert sugar on a product label from grams to teaspoons, and evidence for good efficacy was provided.

Efficacy without feasibility is of no use to educators, thus the educational intervention was designed with pragmatic adequacy in mind. It can be easily delivered in a classroom or laboratory setting where students have the ability to observe an instructor demonstration and then work singly or in pairs to engage in sugar measuring activity. The intervention itself is of relatively short duration and instrument to test learning is brief. Little instructor training is required and the cost of supplies (sugar, spoons) is minimal. The nature of the content lends itself to different competency domains, including math, health or science classes. Further, the skills are those the students could be asked to practice on a food shopping trip or over lunch.

6. Human Subjects Approval Statement

The protocol was approved with expedited review by the Georgetown University Institutional Review Board, and assigned the study IRB#2013-1302. Written informed consent was obtained for participants younger than 18 years old, in addition to parent/guardian consent.

References


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1084-102.


Appendix A

Based on the amount of sugar shown on the label, write how many teaspoons of sugar are in each drink.

Name______________________

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<th>Calories</th>
<th>Total Fat</th>
<th>Saturated</th>
<th>Cholesterol</th>
<th>Total Carbs</th>
<th>Dietary Fiber</th>
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Appendix B

Sugar Rhythm Rap

- Ask students to remember the number “5” (1 tsp = 5 grams).
- All students repeat after instructor, with clapping rhythm, *I got it, you got it, the number 5 we got it!*
- All students point to other students repeating the mantra above.
- Continue while students rap to the mantra a few times.