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Sugar Shenanigans: Curbing the Added Sugar Epidemic in Children and Adolescents

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Abstract

Background: The consumption of added sugar is one of the most dangerous problems regarding the health of society's youngest generation. Children today consume added sugar at an alarming rate, on average surpassing the daily limit recommended by the American Heart Association. This study aims to educate and empower the child and adolescent population for the purpose of increasing knowledge and improving dietary practices. **Methods:** An educational program, entitled "Sugar Shenanigans" was delivered to groups of children between the ages of 8 and 13. Data was gathered from pre- and post-tests and "Impact Level Questionnaire" surveys for both participants and parents/guardians of the participants. Data was analyzed using one-way analysis of variance (ANOVA) statistics. **Results:** A total of 54 participants met the criteria to be surveyed. Scores displayed an overall mean improvement from 9.89 average correct pretest answers to 12.52 correct posttest answers. Based on a 36-hour dietary recall, participants consumed more fruit and vegetables one-month post-presentation compared to the numbers reported prior to the presentation. According to the "Impact Level Questionnaire" 61% of participants reported a positive or healthy change in their eating habits, and 48% reported being fed healthier foods following the program. **Conclusions:** An educational program to increase knowledge and promote reduction of the excessive consumption of sugar by participants and their parents/guardians resulted in improved understanding and a change in dietary habits.

Keywords

Sugar, Education, Children, Obesity

1. Introduction

Childhood consumption of added sugar is one of the most influential and troub-

ling realities concerning diet today. The average daily sugar intake of a child is more than triple the amount recommended by the American Heart Association [1]. Short- and long-term health problems related to excess sugar consumption, including obesity, cardiovascular disease, among many others, affect the functionality and success of both the current and future generations [2]. An educational program, entitled “Sugar Shenanigans” was delivered in effort to achieve the aim of this study: educate and empower the child and adolescent population to increase knowledge and improve dietary practices.

The American Heart Association (AHA) strongly recommends that children ages 2 to 18 consume less than six teaspoons (<25 grams) of added sugar per day [3]. Added sugar is defined as “all sugars used as ingredients in processed and prepared foods, and sugars eaten separately or added to foods at the table” [4]. The United States Department of Agriculture (USDA) 2020-2025 Dietary Guidelines state that “most Americans have less than eight percent of calories available for added sugars” [5]. In contrast, children are found to consume on average more than 81 grams of sugar per day [6], approximately 19 teaspoons per day. The most prominent sources of childhood sugar consumption include intake of drinks and desserts/snacks [4].

There is strong evidence that the effects of added sugar are overwhelmingly negative. Added sugar contributes zero nutrients to the body [7], and these “empty” calories do not simply disappear. The direct risk of obesity associated with increased sugar consumption is evident [2]. Increased insulin resistance, caused by a pattern of excessive sugar consumption, contributes to excessive weight gain and is found to contribute to diagnosis of diabetes [8]. Excess insulin may also lead to leptin resistance, which causes sluggishness and overeating due to decreased feelings of fullness [1]. Sugar-sweetened beverages (SSBs) specifically are on the radar of sugar researchers to be a significant root cause of obesity [9]. Data also shows that the excess of added sugar not only promotes low quality calorie intake and higher weight, it may put one at higher risk for other diseases such as cardiovascular disease, cognitive problems (*i.e.*, dementia, Alzheimer’s), various forms of cancers, and others [2]. Additional risks may include high blood pressure, cholesterol, high triglyceride levels, kidney disease, liver disease and sensory nerve, retina and muscle damage [2].

Due to an overwhelming large number of calories consumed by sugar, children are more at risk for nutritional deficits in other areas. Included in these insufficiencies are iron deficiency, decreased bone health [10], dental caries [10], thyroid and hormone imbalances [11]. In addition to other nutritional deficiencies, children are at risk for addiction to sugar, as it has been studied that “sugar causes changes in peoples’ brains similar to those in people addicted to drugs such as cocaine and alcohol” [1]. This is in stark contrast to the outcome of eating a balanced diet, where the brain releases a consistent amount of dopamine each time foods are eaten [12].

There are many strategies to curb the childhood sugar intake today. However, a radical this is not a simple fix. Studies show a significant knowledge deficit re-

garding the realistic level of sugar intake and the harmful effects of sugar. This deficiency manifests through inability to interpret ingredients labels [13], absence of viable replacements for sugary foods in the community, and decreased awareness of individual daily allowance recommendations. The key to overcoming this deficit is through education, whether it be individual, community, national or worldwide efforts. This study represents a school system-based attempt at implementing knowledge. It has been shown that school-based interventions can lead to better diets [14] [15]. The main way to target children is in school. For this reason, this study aimed to implement the tactic of sugar education through classroom teaching.

2. Methods

A project was created targeting groups of children and adolescents between the ages of eight and thirteen years old. The presentation was approved by the Murray State University Institutional Review Board. It was determined that all research would be conducted in compliance with Murray State University guidelines for the protection of human participants and no ethical approval was needed. No funding was elicited for this project and there were no conflicts of interest. To address these specific groups, schoolteachers from a private grade school were contacted. Permission was requested to present a project to the teachers' individual classes. Each schoolteacher was given a summary sheet about the project, entitled "Sugar Shenanigans". Prior to the presentation, each child's guardian signed a consent form. In addition, each child signed an assent form. The consent and assent forms indicated allowance of participation by the child's legal guardian and expressed willingness of the child to participate.

In order to prepare, an initial practice presentation was conducted for two individual children and for a group of 8-year-old females. The data collected was not recorded due to inconsistencies with the finalized presentation. The finalized version of "Sugar Shenanigans" was conducted independently to 5 groups of students, namely the 3rd, 4th, 5th, 6th, and 7th grades. There was a total of 54 children/adolescents that received the presentation. This project took place over a span of one week and was spread out over various days of that week. Because this project was conducted during the COVID-19 pandemic, social distancing guidelines were enforced. To maintain a 6-foot distance from researcher to child and between the children, the school gymnasium was utilized for the presentation space. The presenter's table was centered around clusters of tables that faced toward the presenter, allowing each child a complete view of the presentation. Each identical presentation lasted one hour.

The presentation began with a pre-test that was distributed to test the initial knowledge of each child. The pre-test consisted of 25 questions: six demographic questions and 19 additional project-portion questions. The project questions determined knowledge of the nature of added sugar, the levels consumed by children/adolescents today, and effects of added sugar such as childhood obesity.

Some questions also surveyed the specific child's dietary intake over the past 72 hours.

A poster pad was created to guide the flow of the presentation. This strategy was done in support of certain teaching methods, particularly mentioned in a study done by Dung & McDaniel. It was found that learning aids and illustrative diagrams were helpful in the improvement of knowledge [16]. Therefore, each poster sheet included a colorful, aesthetically memorable topic regarding added sugar. During the presentation, there was also a demonstration displaying various amounts of sugar present in certain foods and drinks. Objects used for the demonstration included unopened food and drink packages, a piece of animal fat, measuring bowls/spoons, and granulated white sugar. Each item was presented in an appropriate and understandable manner for the age group of participants.

The main focuses throughout the lecture and demonstration were consistency, accuracy and awareness. The information presented was based on extensive research and conducted as similarly as possible throughout each presentation. Attention to each child's feelings was maintained throughout the entirety of the presentation, ensuring that they would experience no ill psychological effects from exposure to the information presented. Children participated throughout the presentation by answering and asking questions. Ample time remained at the conclusion of the hour for children to ask questions. A post-test survey was given to the participants immediately following the presentation and any discussion. These survey questions were identical to the pre-test, excluding the initial demographical information. A final source of information was provided to children and their parents through a "Take Home Brochure". This originally created pamphlet outlined ten nutrition-based ways to foster a healthier environment at home.

In addition to immediate feedback from the pre- and post-tests, information was collected on two specified dates. Exactly one week after the presentation to an individual grade, the parents/guardians of that age group received a "Parent Impact Level Questionnaire". This evaluated the child's response to the presentation through parental perspective. Additionally, a "Student Impact Level Questionnaire" was given to children one month following their presentation date. This evaluated the impact of the presentation, but from the child's perspective.

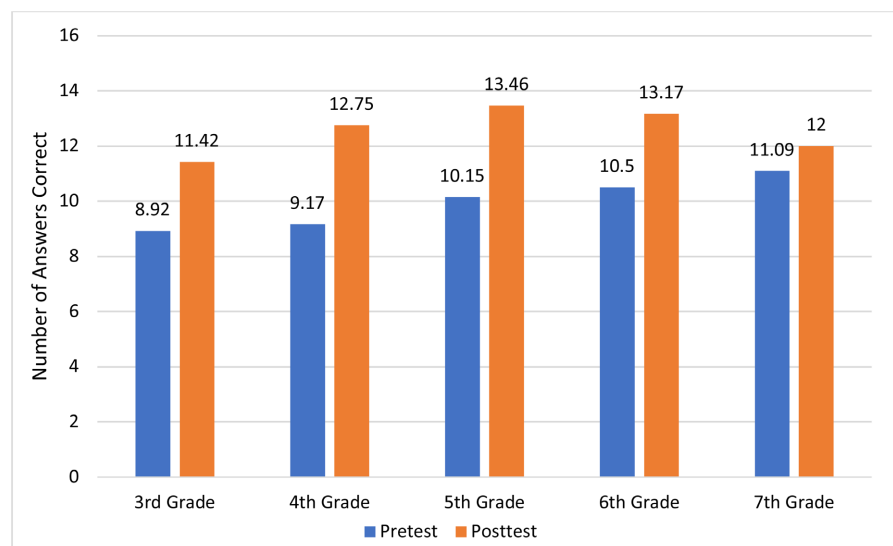
A separate quantitative data analysis was performed for the portion of the survey questions regarding dietary habits. The data was collected using a 36-hour dietary recall, performed once on the day of the initial presentation and once after four weeks post-presentation date. These questions specifically targeted the intake of SSBs, fruits, and vegetables. A definition of *fruit* was provided and examples of foods such as apple, blueberries or a peach were written for further clarification. Fruit roll-ups, fruit bars and fruit juices were explicitly directed to be excluded. Vegetables were defined with examples such as cucumber slices, celery stalks, broccoli and green beans.

Quantitative data analysis was performed using a one-way analysis of variance (ANOVA) to determine if the pretest and posttest results of the educational presentation were statistically significant. Using ANOVA, the researcher was able to determine the difference in questions answered correctly on the pretest and the posttest. ANOVA determines whether or not the differences in a test are a result of chance by comparing the means of the variables. This analysis was performed twice: once with the total number of participants and once for each individual grade.

3. Results

3.1. Demographics

Multiple data sets were employed to generate conclusions for this study. Participants' ages were between 8 and 13, distributed across the third through seventh grades. **Graph 1** displays the variety of children's ethnicities that participated, with 70.3% (n = 38) White, 18.52% (n = 10) African American, 7.4% (n = 4) Asian, 1.8% (n = 1) Latino, and 1.8% (n = 1) identifying as "Other". 56% (n = 30) of participants were Male and 44% (n = 24) were Female. The baseline demographic characteristics of child/adolescent participants can be found in **Table 1**.



Graph 1. Mean pretest and posttest comparison scores by grade.

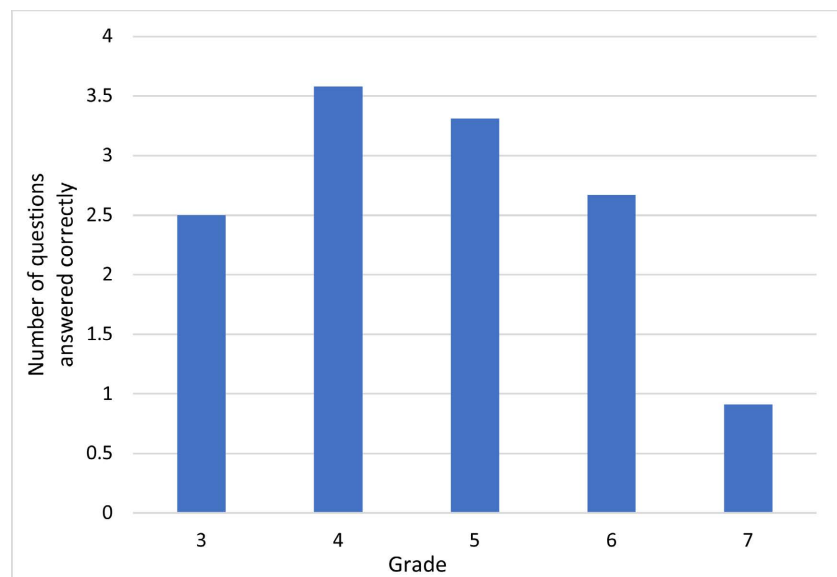
Table 1. Baseline demographics of participants.

Age	N	Grade	N	Race/Ethnicity	N	Sex	N
8	4	3	12	White	38	M	30
9	16	4	12	African American	10	F	24
10	13	5	13	Latino	1		
11	6	6	6	Asian	4		
12	9	7	11	Other	1		
13	6						

3.2. Education Program Outcomes

Upon consideration of the total number of participants, there was an overall mean improvement from pretest to posttest scores. Scores increased from an average of 9.89 correct answers on the pretest to 12.52 correct answers on the posttest.

Grade 4 demonstrated the largest increase in knowledge with 9.17 correct answers on the pretest and 12.75 correct posttest answers. The 5th grade classroom followed closely behind with an improvement of 3.31 more questions correct on the post test. Comparison scores and means improvement can be found in **Graph 1** and **Graph 2**. The overall P-value is <0.05 at $2.10E-12$. The significant level was set at 0.05. Therefore, the null hypothesis is rejected that all groups are equal, so the alternative hypothesis of the presence of acute differences is accepted. The P-values for each individual grade (3, 4, 5, and 6) were 0.0014, $2.97E-06$, $1.25E-05$, and 0.03, respectively. The class of 7th graders showed a slightly lesser degree of improvement, yielding the only insignificant group ANOVA measure. ANOVA results for all 54 participants can be seen in **Table 2**.



Graph 2. Mean improvement separated by grade.

Table 2. ANOVA results based on total number of participants.

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
Pre-survey	54	534	9.88888889	3.27044025		
Post-survey	54	676	12.5185185	2.63172607		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	186.703704	1	186.703704	63.2661615	2.10E-12	3.9306919
Within Groups	312.814815	106	2.95108316			
Total	499.518519	107				

3.3. Dietary Recall

Based on the dietary recall, participants reported a total of 96 fruits eaten in the past three days on the initial presentation date. After one month, participants reported a total of 103 fruits consumed in the past three days, divided among the 54 participants. Participants also ate a total of 84 servings of vegetables over the course of 3 days prior to the presentation. This number increased to 90 vegetables over the previous three days one month after the program. Of the subjects, there were two less sodas consumed in three days after one month of the program compared to before the program. For further information regarding these three categories, see **Table 3** below.

The participants also completed an “Impact Level Questionnaire” four weeks following the program, which relayed retention of knowledge and any changes in general diet made by the participants. Sixty-one percent reported making a positive or healthy change in their eating habits, and 26 out of 54 children reported that their parents fed them healthier foods following the program. 50 children (93%) remembered the acceptable amount of sugar to consume per day in grams on the questionnaire. This is a significant increase from the initial pretest score of 47% on this particular question and only slightly below the immediate posttest score of 95%.

3.4. Impact Level

A total of 34 responses to the “Parent Impact Level Questionnaire” were acquired. 94.1% of parents reported that their child mentioned “Sugar Shenanigans” at least once. 67.6% of children were said to have brought up the program more than one time. 28 of the 34 stated their children had a fairly positive or extremely positive reaction to the presentation, and there were 0 negative reactions reported. Over half of the children expressed interest in changing their unhealthy eating habits to their parents. 50% of the parents reported that their child voluntarily ate less added sugar, ate less “junk foods” or requested more fruits and/or vegetables. Most parents also encouraged these diet changes, documented by 70.6%. One third of parents/guardians stated to have improved their own diet

Table 3. 36-Hour dietary recall by participants.

Number of times food/ drink was consumed	Pretest			Posttest		
	Soda	Fruit	Vegetables	Soda	Fruit	Vegetables
None	40	7	7	39	6	8
One time	8	13	23	10	10	17
Two times	4	19	11	4	21	14
Three times	1	15	13	1	17	15
Four+	1	0	0	0	0	0
Total	23	96	84	21	103	90

as well (consumed less added sugars, less “junk food” or more fruits and/or vegetables). 94.11% reported no development of excessive concern about weight or diet due to the program. 100% of respondents agreed that children should be educated about the benefits of healthy eating and the dangers of added sugar consumption.

4. Discussion

In the investigative portion of this study, it was found that excess sugar consumption is both a current problem and a dangerous reality. There are far too many in the U.S. population unaware of the high levels of sugar they ingest and the subsequent health effects. The goal of this study was to not only assess the baseline knowledge regarding sugar consumption and health effects in children and to educate in an interactive way in order to bring about health changes. It was determined with evidence-based research that an educational program in schools would provide an appropriate avenue for information to be delivered. Participants in this study were able to tangibly view the facts through the presentation portion, an activity involving a fictional child’s dietary intake, and in the demonstration of food/drink sugar content. The demonstration revealed how beverages and desserts are indeed the largest contributing factors to added sugar in the diet [4].

Following the “Sugar Shenanigans” presentation, results support the use of verbal and visual education in schools in order to increase awareness and improve diet surrounding the topics of sugar and nutrition. There was a marked increase from pretest to posttest scores, and ANOVA results displayed a statistically significant outcome. Children were made more aware of their need for diet intervention when eating too much sugar, and they were empowered with the knowledge to facilitate change. These results were determined by both quantitative analysis and subjective qualitative responses. In addition to positive quantitative responses, the Student Impact Level Questionnaire subjectively showed that children had an overall positive and impactful experience.

Using all parts of data collected, the majority of children indicated some degree of diet improvement and sugar reduction. Not only did their knowledge improve directly following the presentation, but they retained and implemented what was learned in their daily lives. One seventh grader wrote, “[After the presentation,] I ate more fruits/veggies. I ate better snacks and less candy.” Multiple children stated they ate fewer sweets. “I don’t eat Ho-Hos anymore” said a third grader. One child wrote, “I check the nutrition facts label before eating something”. Some responses stated that the child stopped drinking soda or generally consumed fewer SSBs.

Almost all children reported that they talked with their families about “Sugar Shenanigans”. One stated that she and her family talked about, “How we would do it”. By this, the child meant that they discussed the strategy to be used as a family to implement a better lifestyle. Children reported to have communicated

about the correct level of sugar and how the excessive level consumed often goes unnoticed. A child from fourth grade wrote that her family said, “We need to have at least 1 fruit or vegetable in our lunches”. The children also talked about this program with their friends. One fourth grader recorded that he talked with his friends about not drinking apple juice anymore (due to its sugary and refined nature). See supplementary material for additional participant data.

Many recounted that, after the presentation, their parents cooked healthier meals and provided more vegetables in meals. A fifth-grade girl reported, “My mom gives me more smoothies with vegetables”. Another direct quotation read, “My parents gave me more fruits and veggies”. There were many quotes similar to this response. One question asked whether or not there were any new types of foods that were eaten or tried in the past month. Many confirmed a positive response. One child said, “Instead of chips, we now eat dried fruits”. The individual responses to this question included foods such as apples, oranges, kiwi, and chicken with veggies, vegetable soup, veggie straws, cauliflower, tomato, lettuce, cucumber, avocado, grapes, and strawberries.

Children also expressed genuine enjoyment in the project. One 6th grade boy reported that he discussed “Sugar Shenanigans” with his family in a positive way. He said they talked about “how it was fun to learn about”. The majority of children marked that they “Really liked” or “Liked” the Sugar Shenanigans program.

In addition to children’s written responses, the Parent/Guardian Impact Level Questionnaire, given one week after their child’s presentation date, showed that children were excited about their newfound knowledge and were working to implement change in their everyday diets. Parents themselves were empowered with knowledge relayed by their own children and the Take Home brochure provided by the researcher.

Subjective comments by the parents were voluntarily communicated without prompting from the researcher. Names are abbreviated using single letters to maintain anonymity. A comment from one parent said, “Dinner conversation at the house tonight: Sugar Shenanigans! Wow...did you cover lots of great stuff with the kids! S was a wealth of knowledge and was looking up the nutrition facts on everything he eats. Thanks for doing this!” It was reported to the researcher that one family now has a fruit bowl because of the presentation. Another parent stated, “You made quite an impression on R. She has really changed how she is eating and says things like, ‘Can you believe I used to eat this stuff?!’ Way to go!”s These messages display the true impact of “Sugar Shenanigans” on children and their families.

Suggestions for Further Research or Project Improvement

There are several areas of improvement that could be implemented in further research. Presentation formatting and the methods used to collect survey scores are two areas that likely could have been improved. Performing this experiment in the midst of the COVID-19 pandemic limited the accessibility to all partici-

pants in an in-person format. The survey questions regarding dietary habits or changes have the potential to hold inaccurate information as well. This could be due to untruthful responses from children and parents. Data would also be inaccurate if children were already eating/drinking in a way recommended by this project.

Further research should include more resources on how to tangibly correct unhealthy habits and implement healthy eating. Children, especially those that are young, are not able to make many dietary changes without the help of their parents. The researcher should consider ways to better enact this change in the future. An overall increase in research must be done regarding the harmful and negative effects on sugar. Although there is a solid base of knowledge in the present day, more should be done on the impending side effects of overconsumption of sugar.

5. Conclusion

Sugar has been found to be an empty source of nutrition that threatens the health of children. It was evident from this study that an educational program was effective in increasing the knowledge of children about the danger and consumption of sugar. The posttest results, along with the child and parental impact level questionnaires, show evidence of increased knowledge and a sustained, improved diet. Because overall data was proven to be effective and statistically significant, this educational program can be used in future educational programs. Similar studies should be performed in order to educate a broader population. This will allow more children to be instructed regarding this topic, leading to betterment of general health, increased longevity and improved quality of life.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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