Effects of Water and Soft Drink Consumption on Mental Health of Teenagers

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Abstract

This study investigated the effects of water and soft drink consumption on the mental health of teenagers. We hypothesized that people who drink a large number of soft drinks would have worse mental health, compared to people that don't consume many soft drinks. We also hypothesize that people who consumed large amounts of water would have lower mental health symptoms. Participants in our study were asked to take a modified DASS 21 test once for three weeks. In this study, we found that there wasn't a significant relationship between water consumption and mental health. We also found that there wasn't a significant relationship between SSB and mental health. However, the correlations were in the directions predicted by our hypotheses. Our data suggest that although there wasn't significant data to support both of our hypotheses, available evidence suggests people shouldn't consume a large amount of SSB.

Introduction

This study investigated the effect of water and soft drink consumption on the mental health of teenagers. Sugar-sweetened beverages (SSB) are the largest source of added sugar and calories in the United States (1). In the years 1999-2004, it was reported that 84% of adolescents, and 63% of adults consumed SSBs on any given day. Along with this data, in 2009, the average American consumed 45 gallons of SSBs, which averages to be around 15.8-oz per day, with nearly 7 teaspoons of sugar per serving (1).

Frequent consumption of large amounts of SSB leads to increases in blood sugar, which may cause insulin resistance; this may lead to type 2 diabetes. SSBs have also been found to increase hypertension, atherogenic dyslipidemia, which leads to heart disease, and visceral adiposity which leads to excessive fat around the stomach (1). In animal studies, sugar damages the brain by increasing inflammation in the brain, and decreasing serotonin (hormone that stabilizes mood and happiness) which might cause depression, or make it worse (2). In this study, we wanted to know if sugar can damage the mental health of humans, especially with teenagesr. Teenage years are when habits are being formed, and when people are at a high risk of going through problems, due to school stress and poor diet.

Water Consumption & Mental Health

Masento et al. looked at water consumption, brain performance, and mood by completing a meta analysis of other studies (3). For mood, people reported feeling calmer and more alert after drinking water, but very few studies have asked about mood or measured mental health, so little is known about water's effects. Other research has considered the effect of changes in water consumption on mood. In a 6-day study of 52 people, Pross et al. measured mood over many days and times. During this study, the amount of water given to two different groups was altered depending on the group (2.5L to 1L and vice versa). This study found that depression rates were higher when water was reduced, and people also felt sleepy. A decrease in water damaged mood and positive emotions. The results of the study give evidence that more water might improve mood and make people feel better.

Sugar Consumption Among Adults & Mental Health

In this study, the participants were asked about their drink habits and depression symptoms they may have experienced. In this study, Kashino et al. studied soft drinks and depressive symptoms in 935 non-depressed Japanese adults over three years (2). They found that after 3 years, 16.8% of the participants developed depression symptoms. The study also found that people who drank more soft drinks (> 4 cups/week) were more likely to be depressed (Odds Ratio = 1.91) than people that barely consumed soft drinks (< 1 cups/week). Other research has found a similar relationship with females (4). Depression in females was associated with the consumption of two or more soft drinks a day.

Shi et al. studied soft drink consumption and mental health problems among adults in Australia (5). In the study, 4,741 people that were 16 years old or older, were assessed with various assessments. The study found that high soft drink consumption was positively associated with symptoms of depression, and psychological distress, but not anxiety. The study also found that people that consumed ½ liters or more of soft drinks, had higher levels of psychological distress than people that did not.

Sugar Consumption Among Adolescents & Mental Health

In order to conduct this study, 8,085 newly enrolled college students in China were surveyed. Xiao et al. focused on if daily consumption of soft drinks are associated with depression and anxiety (6). This study found that there was a positive relationship between soft drink consumption, and symptoms of anxiety and depression. The authors identified a positive dose-response relationship between sugar and mental health. A positive slope means that there more drinks consumed, and more depression & anxiety occured as the consumption increases. An increase in sugar was related to an increase in depression, suggesting drinking less sugar might help with depression.

Xu et al. looked at association b/w screen time, fast food, SSB and depression in Chinese adolescents (7). Middle school students ranging from the ages of 10-20 years old were observed in order to obtain results. This study found that screen time and depression had an odds ratio of 1.075, fast food had an odds ratio of 1.062, and SSB had the largest odds ratio, 1.140, with depression. Overall, fast food and SSB could possibly magnify the effect of screen time on depression.

Lien et al. focused on soft drinks, hyperactivity, conduct and the mental health of teens in Norway (8). A total 7,343 10th graders ranging from the ages of 15 and 16 year of age in Norway were given a self-reported questionnaire. The study found a J shaped relationship between sugar and mental health, and also found that people that did not consume sugar had more problems than those who drank a little bit of sugar, but the difference was not very noticable. Something important to note is that a serving of SSB in this study is 7oz instead of the 8oz common in the United States. They found that boys who drink 4+ servings per day were 2.95 times as likely to suffer from mental health issues, and 5.11 times to have bad behavior compared to those who drink 1 or fewer. This study also found that girls that consumed 4 or more soft drinks per day were 2.62 times more likely to suffer from mental health issues, and 5.72 times more likely to exhibit bad behavior. Drinking more soft drinks seems to be linked to worse mental health, and behavior being worse.

Study Hypotheses

Overall, the research says that soft drink consumption has a negative effect on mental health, compared to water consumption despite the evidence for the benefits of water being limited. Unlike other studies, we will be conducting the study on teenagers during the COVID-19 pandemic. The entire student body learned virtually, experienced similar levels of activity, learned through a screen (laptop, tablet, phone etc.), and more than likely experienced the same amount of stress. Other studies tend to focus on self-reported data and will only ask questions one time. In this study, we will be keeping track of high schoolers for a few weeks, and we will be tracking what they are drinking (water and soda) as well as their mental health symptoms.

We hypothesize that people who drink a large number of soft drinks will have worse mental health, compared to people that drink very few soft drinks. Research suggests that sugar-sweetened beverages (SSB) are related to depression (2, 6, 7). We also hypothesize that people who drink large amounts of water will have lower mental health symptoms. Research suggests that water consumption is related to better mental health (3).

Methods

The people that participated in this survey were 11th and 12th high school students that attend the Neighborhood Academy. In total, 33 students were asked to participate, and 29 students participated. Eighteen percent of the students answered the survey three times, 39% of the students answered twice, 30% of the students only answered the survey once, and 12% of the asked students never participated. Twenty one percent of the students that participated in the study were males, and 79% of the students were females.

In this study, the DASS21, a common mental health survey was modified so that the questions that measured stress were taken out. We also modified the survey by adding a question that measured what beverages, and how much of those beverages the student consumed in a 24 hour time period. In this question, we asked the students to be very specific when answering. Anxiety was scored based upon the sum of the seven anxiety questions. Depression was scored by adding the scores of the seven depression questions. Questions were awarded a 0-4 for each, depending on how much it applied to them.

Beverages were scored in two ways. If the participant was specific enough for us to know exactly what they consumed, then they were scored accordingly. If the participants weren't very specific, we used various ways to measure their beverages. If a drink was mentioned once, we just assumed that they only consumed this beverage once. A "cup" was counted as one 12 oz serving, and a "tall glass" was counted as a 16 oz serving (we also consider this a 1.5 servings). If a specific product was mentioned, we used Google to determine the serving size. A bottle of water was counted as 16.9 oz serving. If someone mentioned "coffee," this was given a score of zero because sugar wasn't mentioned. However, if someone mentioned something along the lines of "vanilla coffee," this was considered a SSB because it contains sugar.

Two of my senior seminar classmates and the primary researcher picked from a pool of 36, 11th and 12th grade students to survey based upon the relationships we've built with them. At the end of picking students, we emailed surveys to the 12 students we each selected once every three weeks. We made sure that instead of just emailing the people we selected, the primary researcher also worded the initial email as if we wanted to start a conversation with them. We did this so that it felt like a more personalized experience, which would hopefully produce more accurate results. We made sure that we were very clear that this survey was going to be emailed to them 3 times.

Results

This study investigated how water and sugar-sweetened beverages (SSB) affect the mental health of teenagers. In order to carry out this study, the primary researcher and two collaborators emailed 12 students a survey once a week for three weeks to assess what drinks they have consumed, and to assess their anxiety and depression scores. We hypothesized that people that consume more soft drinks will have worse mental health than those that consume low amounts of soft drinks. We expected water to have a positive effect.

Throughout the surveys, we found that 27 of 29 people consumed water, and 24 out of the 29 people that completed the surveys consumed some type of SSB. According to the data collected, the average student that participated in our survey consumes around 27 ounces of water, and also consumed around 16 ounces of SSB. It can be said that the average student at the high school the survey took place at consumes more water than SSB. The average student typically has a depression score of around 5, and an anxiety score of 6. On average, the students taking our survey did not report symptoms of severe mental health problems.

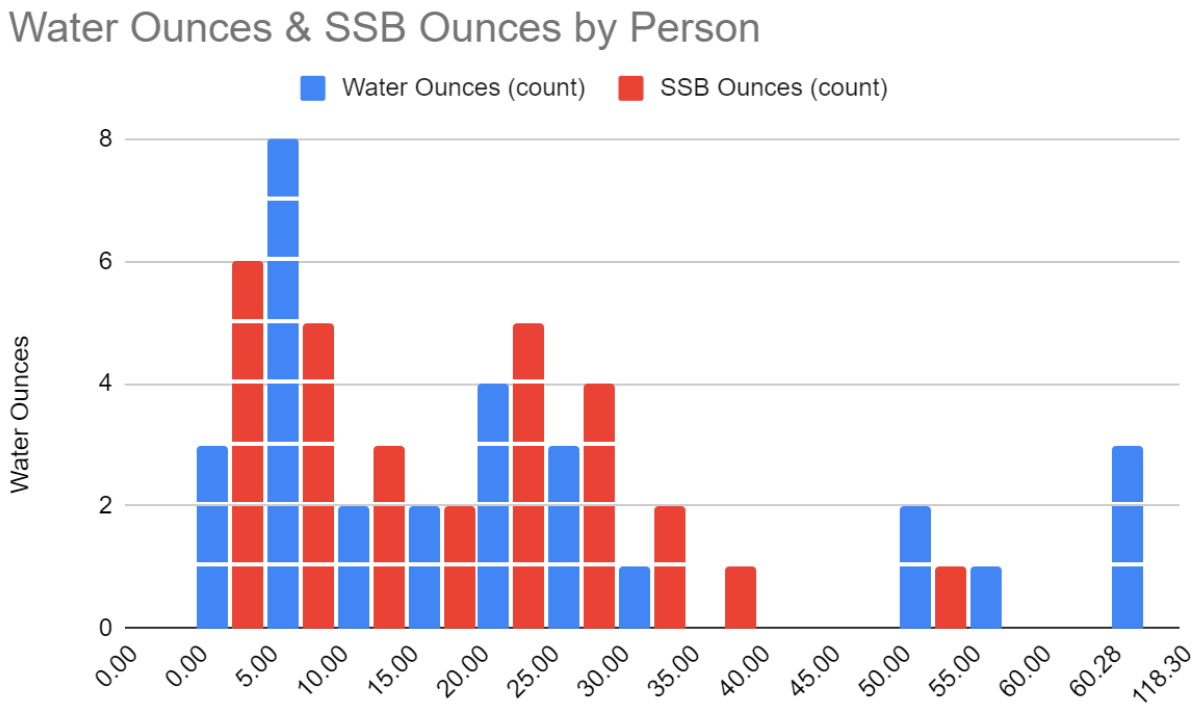

Figure 1. Water and Sugar Sweetened Beverages Consumption (in Ounces). *The above histogram displays the pattern in water (blue) and sugar sweetened beverages (red) per person per day. Twenty nine students responded to a survey about their drinking habits. The average consumption of water was 27 ounces and 16 ounces of sugar sweetened beverages.*

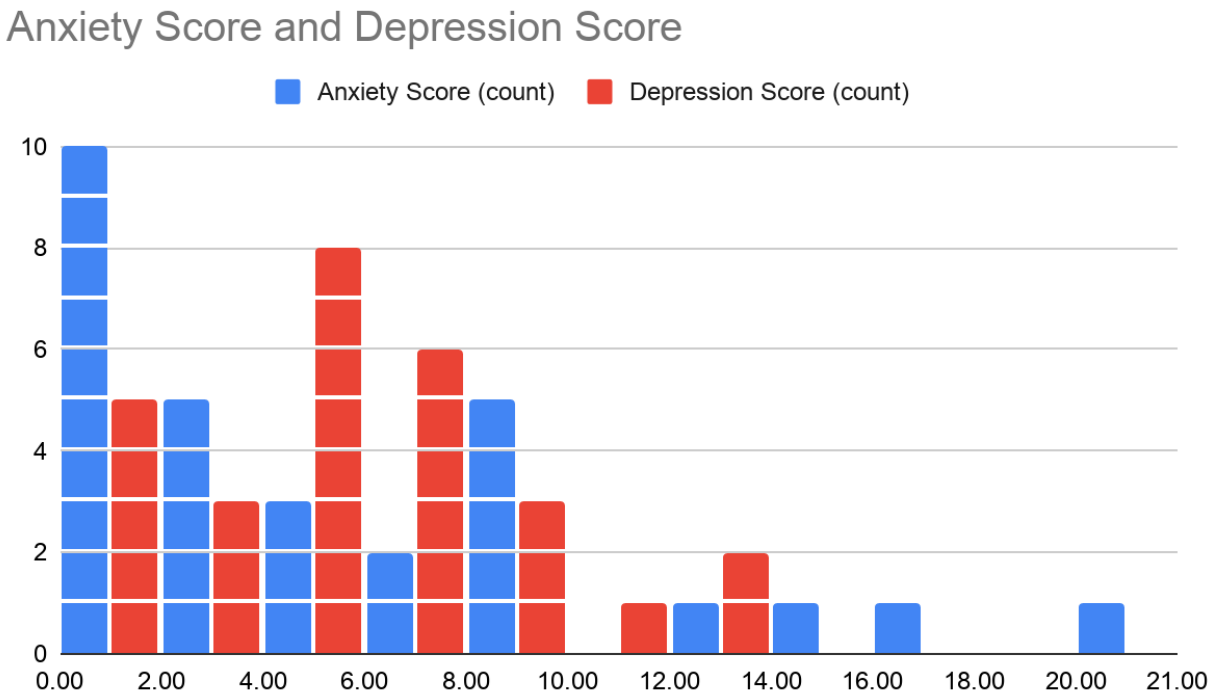

Figure 2. Anxiety and Depression Scores. *The above histogram displays the pattern in anxiety scores (blue) and in depression scores (red). The DASS 21 was used to score mental health in order to obtain these results*

	SSB Ounces	Water Ounces
Anxiety	r = 0.203, p = 0.14	r = -0.1468, p = 0.22
Depression	r = 0.237, p = 0.10	r = -0.1996, p = 0.14

Table 1. Averages and P-values Between Mental Health and Beverage Ounces. *The above table displays the averages and p-values between anxiety, depression, SSB ounces, and water ounces. After finding the values represented in the table, we found no significant relationships between SSB ounces consumed, and anxiety/depression. The same can be said for water and anxiety/depression.*

In this study, we hypothesized that there is a positive relationship between SSB and poor mental health symptoms. We asked the participants to list all of the beverages they recalled consuming over the last 24 hours. Then we took the average servings and ounces of the SSB for every individual person. The DASS 21 was also used to score mental health. A Pearson correlation r-test found no significant relationship between SSB ounces consumed, and anxiety ($r(27) = 0.203$, $p = 0.14$) or depression ($r(27) = 0.237$, $p = 0.10$). Overall, the results of the study

suggest that the relationship SSB and mental health is very miniscule. The points on Figure 3 were scattered. Despite this, there were a few outliers on the graph, but removing these outliers didn't significantly change the patterns represented in the correlation.

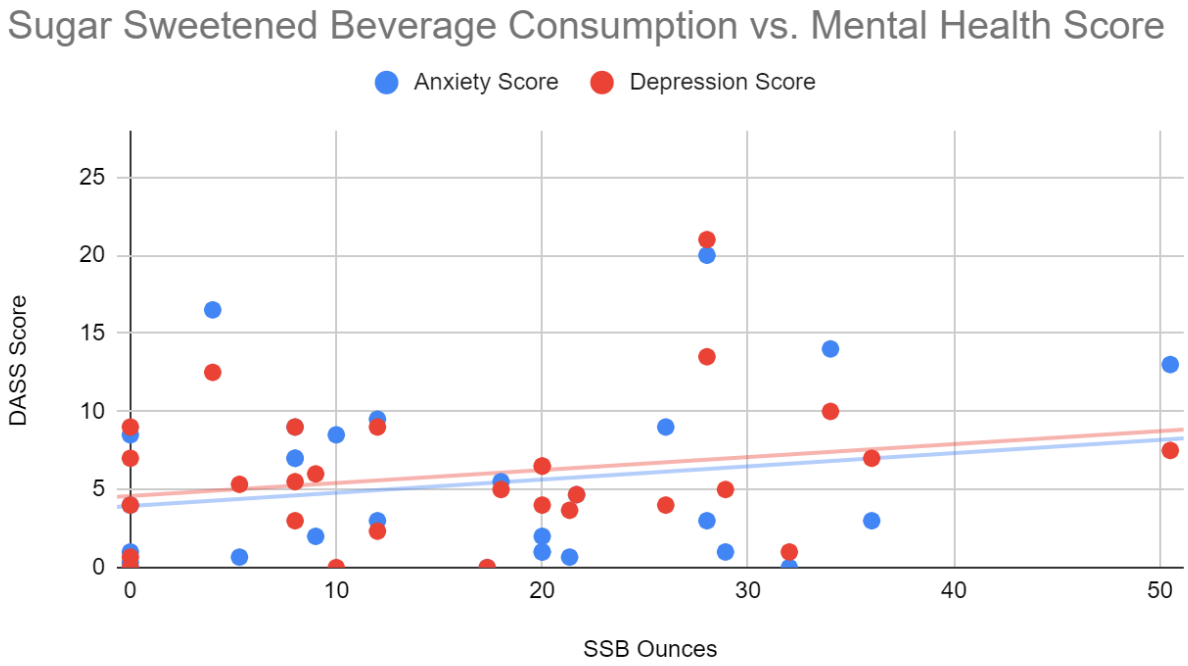

Figure 3. SSB Consumption vs. Mental Health Score. *The above scatterplot displays the pattern in DASS scores and SSB ounces. A Pearson correlation r-test found no significant relationship between SSB ounces consumed, and anxiety or depression*

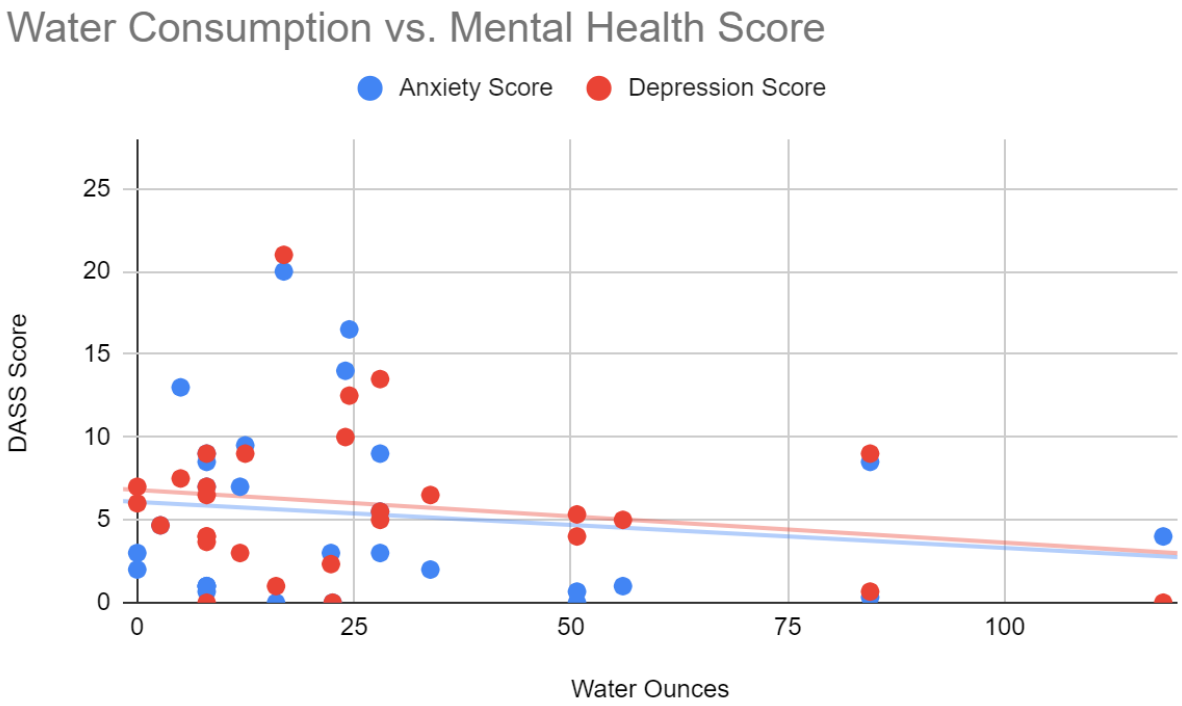

Figure 4. Water Consumption vs. Mental Health Score. *The above scatterplot displays the pattern in DASS scores and water ounces. A Pearson correlation r-test found no significant relationship between ounces of water consumed, and anxiety or depression.*

We hypothesized that there is a strong negative relationship between water consumption and mental health. A Pearson correlation r-test found no significant relationship between ounces of water consumed, and anxiety ($r(27) = -0.1468$, $p = 0.22$) or depression ($r(27) = -0.1996$, $p = 0.14$). The results of the study found a slight negative correlation between water consumption and mental health, but students were already very healthy. Removing extreme outliers from the data didn't make a significant difference in the pattern displayed on Figure 4.

Discussion

In our study, we found that a large majority of the students that participated were very healthy when it comes to mental health. To support this, most of the DASS21 scores were below 10, a common cut-off for the DASS21 (10). Overall, there was a non-significant relationship between SSB and mental health, and water and mental health (Table 1). Despite this, these relationships were trending in the directions that we expected. There was a slight positive correlation between SSB and mental health (Figure 3), and a slight negative correlation between

water and negative mental health (Figure 4). In conclusion, both of the hypotheses are partially supported.

Previous research found that an increase in SSB consumption leads to more mental distress in males and females (8). Our study found that an increase in SSB consumption leads to more depression and anxiety, although results weren't significant. When compared to each other, the participants in both studies were different. In the prior research, 58.6% of females never consumed soda (8), but only 17% of females haven't consumed soda in our study. In prior research, 25.8% of females had mental distress, but only 5 people (17%) in our study scored highly when we asked for questions relating to mental health. The results of both studies are consistent with each other in the direction of the relationship. Both found a positive relationship between SSB consumption and depression. Even though our results weren't significant, we can argue there is evidence that SSB consumption may be related to depression.

Prior research found that a decrease in water consumption leads to a worsening mood, and a negative impact on positive emotions (9). We found that there was a slight negative correlation between water consumption, and negative mental health. Compared to our study, prior research is very similar in gender (9). Both studies have the exact same percentages of male participants (21%), and female participants (79%). Overall, the results of both studies are consistent with each other. Both studies found a deterioration in mental health when water consumption is lower. The only difference is that our study didn't find a strong relationship between water consumption and mental health; our study found a non-significant negative relationship. Therefore, we argue that water may still have benefits for one's mental health, due to our findings alignment with other research.

Previous research found that people that consumed more than four cups of SSB a week were more likely to be depressed, compared to those who consumed less than one cup of SSB a week (2). We found that the four people in our study who had a depression and/or an anxiety score of over 10 consumed 21.25 oz of SSB a day, or about 2.6 cups of SSB a day. These results suggest these four people were likely consuming over 4 cups of SSB a week. Our results may be weak due to the fact that there are only 4 people that had concerning mental health issues, but our evidence can still solidify that SSB should not frequently be consumed.

One factor that might have affected my study is the COVID-19 pandemic. Due to the pandemic, we could only record data by giving out surveys online. The pandemic has also

limited the way people behave, specifically, the way that SSB are obtained. At the school the survey took place in, a few students were actively selling SSB prior to the pandemic as a fundraiser. Due to COVID-19, the students may not have been able to easily access sugary drinks. We also expected that students would have more mental health issues due to them not having the ability to change locations, and because of the stress we thought a pandemic should cause. However, few students in our study reported mental health problems.

Our study found that the students participating didn't have problematic mental health scores. These results made us question two things: are the students downplaying their mental health issues, or did we misunderstand the pandemic? We also were not completely sure if the students were being honest about their true drinking habits. In pop culture, SSB have a negative stigma surrounding them, and water has a positive stigma. The students may have downplayed their drinking habits so that they seem healthier than they actually are. The answer to these questions could simply be the fact that people struggled with following all the directions given. Many of the students in the survey weren't very clear when it came to telling us about the quantity of the beverages they consumed.

Another factor that may have affected our study is the paradox of cause versus effect. In general, correlation students don't typically explain if A causes B, or if B causes A. For example, our study can't necessarily explain if drinking soda causes mental health issues, or if drinking water decreases symptoms of poor mental health. An prior animal study found that sugary drinks increased inflammation, and decreased serotonin in rats (2). Despite this, these results are from rats, and not actual humans. Depressed people might crave sweet things because they make one feel better. Research says humans have trained themselves to crave sweet things due to the challenges our ancestors went through in order to obtain calories to survive (11).

Future studies should strive to improve the quality of the data collected. This can be done by having engaging conversations with the people that agree to be in the study, and by asking questions in an one-on-one environment. Accuracy of the questions answered can be improved by being more specific when it comes to describing the serving sizes to the participants. Furthermore, future researchers could incorporate social media into their studies and/or offer an award for participants. Another way to improve the quality of future studies is to consider doing an actual experiment rather than just doing surveys. Directing people to consume different drinks

while also studying their mood may be a great way to investigate the causes and effects of water, SSB, and mental health.

We argue schools should consider making changes so that drinking water is encouraged. For example, adding water machines may be a good way to promote water consumption, as the only source of drinkable water at many schools is undesirable water fountains. Despite our weak correlations, all of the available evidence suggests that we should consume more water, and consume less SSB. Doing this may lower symptoms of negative mental health.

Acknowledgements

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