Children's Water Intake Lower During In-Person School Compared To Virtual School During COVID-19 Pandemic

Adam Seal (adseal@calpoly.edu)
California Polytechnic State University

Todd Hagobian
California Polytechnic State University

Research Article

Keywords: Children's water intake, hydration, school policy, sugar sweetened beverages, family nutrition

Posted Date: December 6th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-1129315/v1

Abstract

Background: Children's hydration is often inadequate during school potentially causing detrimental effects on cognitive performance. Previous studies investigating water intake during school lack comparison to a control group. The rise of virtual school during the COVID-19 pandemic created a unique opportunity to assess water intake during school but in a setting outside of school.

Objective: Compare water intake of children attending in-person classrooms to water intake of children attending school virtually. We hypothesized water intake would be higher in children attending school virtually.

Methods: A validated water intake questionnaire was sent to parents and their children (aged 10-17 years) between September 2020 and March 2021. The questionnaire asked participants how often they consumed a standardized volume of beverage types over one week. Parents indicated if children were attending school in-person or virtually.

Results: 54 children indicated they were attending school in-person while 76 indicated attending school virtually (N = 130). Water intake of children attending in-person school (1688 ± 680 mL) was lower as compared to children attending school virtually (1998 ± 831 mL) ($F = 5.09$, $p < 0.05$, Figure 1). The multivariate regression examining demographics, parent water intake, and school setting as predictors of child water intake was significant ($R^2 = 0.33$, $p < 0.05$). Higher child water intake was associated with older age ($b = 0.29$, $p < 0.05$), lower family income ($b = -0.25$, $p < 0.05$), higher parent water intake ($b = 0.39$, $p < 0.05$), and virtual school setting ($b = 0.18$, $p < 0.05$).

Conclusion: Children's water intake was higher during virtual school as compared to in-person school. Hydration of parents may influence children, especially when the child is attending school virtually.

Introduction

Water plays vital roles in the human body including thermoregulation, waste elimination, metabolic reactions, and solute balance (1). Relative to adults, the importance of adequate hydration is amplified in children due to high body-surface-to-body mass ratio leading to increased water loss through the skin (2). Analysis of National Health and Nutrition Examination Survey (NHANES) data from 4,766 US children between the ages of 4-13 years indicate no groups (4-8 yr, 9-13 yr) satisfied the daily recommended intake of plain water established by the Institute of Medicine (3). Inadequate hydration (UOsm > 800 $mmol \cdot kg^{-1}$) in children has shown to effect cognitive measures such as mood, vigor, and short-term memory (4, 5). In school where cognitive function could be considered most critical, children only consume 14% of their total fluid intake despite spending ~ 8 hours per day in a classroom setting (6). This is supported by urinary concentration measures indicating children arrive to school underhydrated and remain so throughout the school day (7, 8).

Some studies suggest stringent rules regarding bathroom breaks, not allowing water bottles in class (9), and limited access to water in schools (10) limit opportunities for water intake and discourage students from drinking to avoid using the restroom including. Michels et al. showed that children's hydration status was favorable in schools with more access to water, dissemination of hydration related education, agreements in policies regarding drinking in class, and well-maintained restroom facilities (11).

While previous research suggests hydration is inadequate in schools, these studies lack comparison to a control group outside of school. The recent shift to virtual classrooms associated with COVID-19 provided a unique opportunity to evaluate water intake while some children attend in-person classes and others attend virtual classes during the same time span. Therefore, the purpose of this study was to compare water intake (from plain water and other beverages) of children attending in-person school to water intake of children attending school virtually. Secondarily, the study sought to identify potential predictors of children's hydration habits.

Methods

This study was approved by the Institutional Review Board at California Polytechnic State University (Cal Poly) and was performed in accordance with the Declaration of Helsinki. All participating parents gave online consent for their child and themselves and children gave online assent. Recruiting was completed through Research Match (researchmatch.org, Vanderbilt University Medical Center) and through Cal Poly's Center for Health Research online channels. Participants were recruited across the U.S. in all 50 states with a majority from California (12%), Ohio (12%), and Washington (9%). To be included participants must have lived in the United States, had internet access, and had a valid email address. Additional participant eligibility included parents aged ≥ 18 years with a child aged 10-17 years. Research Match uses a randomizer function to match individuals who have agreed to be added to databases with institutional research surveys. Once contacted a link to the consent/assent forms and a survey was sent using Qualtrics Survey Software (Qualtrics International Inc., Provo, UT).

In this cross-sectional study, the survey was sent to participants between September 2020 and March 2021. Parents were encouraged to complete the surveys with their child and assist only if needed. The survey was comprised of 3 sections including basic demographic questions (for parent and child), parent hydration habits across the past week, and child hydration habits across the past week (see below for details). After completing the survey, participants were entered into a raffle to win a $100 gift card. All participants were given the option to omit any questions they did not feel comfortable answering.

Demographics

Basic demographic information was collected including age, sex, ethnicity, race, family income, and state of residence. A question indicating school status of the child (in person or virtual) was included. For the purposes of analysis, "in-person" was defined as class held by a teacher in-person at a location different from home and "virtual" was defined as class conducted online from home. Body mass index (BMI;

kg/m^2) was calculated and used to categorize weight status (Underweight: < 18.5, Healthy Weight: 18.5-24.9, Overweight: 25-29.9, Obese: > 30).

Fluid Intake Questionnaire

A validated questionnaire was used to determine water intake for both parents and children (12). The questionnaire asked participants to indicate how often they consumed a standardized volume of various beverage types over the past week. Beverage types included plain water, tea, coffee, sport and energy drinks, juice, soft drinks, dairy, and alcohol (parents only). The nine frequency of consumption options ranged from “Never or less than 1 per week” to “7+ per day.” Water intake volume was extrapolated by using the percentage of each beverage composed of water. Sugar-sweetened beverage (SSB) intake volume for parents and children was calculated as the sum of fresh juice, packaged juice, regular soft drinks, diet soft drinks, sport drinks, and energy drinks.

Statistical Analysis

All data were analyzed using JMP Pro 16 (SAS Institute, Cary, NC). Summary statistics are reported as mean and standard deviation unless otherwise noted. To ensure data quality, preliminary exploratory analyses were performed for each study variable to identify outliers and/or values outside of logical ranges. Pearson chi-square analysis was used to examine differences in child sociodemographic variables between in-person and virtual school attendance. A one-way analysis of variance (ANOVA) was used to assess the difference in water intake between children in school and children attending school virtually. Homogeneity of variance between groups was assessed using the Brown & Forsythe test. Simple linear regression was used to evaluate the relationship between parent and child SSB intake. A multivariate regression was used to identify predictors of children’s water intake including demographics, parent water intake, and school setting. Statistical significance was set *a priori* at 0.05.

Results

Participant characteristics and demographics are presented in Table 1. In total, 506 potential participants were initially contacted and 163 participants responded. Of 163 total respondents, 33 were removed from analyses for incomplete or incorrectly completed questionnaires. The final sample size for all analyses was 130. Demographics of parents were mainly female (79.8%), non-Hispanic (93.1%), white (88.5%), and varied in family income and BMI status (Table 1). Fifty-four children were attending school in-person and 76 were attending school virtually. Demographics of children attending in-person school and those attending school virtually were mainly white (88.5% and 94.4%, respectively) non-Hispanic (93.1% and 98.1%, respectively) with no differences in demographic variables between children attending school in-person and those attending school virtually (Table 1, $p > 0.05$).

Table 1
Parent and child demographics

Demographic	Parents	Children (In-Person School)	Children (Virtual School)	Children (Total)
N	130	54	76	130
Sex, n (%)				
Male	26 (20.2)	30 (55.6)	37 (48.6)	67 (51.9)
Female	103 (79.8)	24 (44.4)	38 (50.0)	62 (48.1)
Prefer not to answer	1 (0.7)	0 (0.0)	1 (1.3)	1 (0.7)
Hispanic or Latino, n (%)				-
Yes	9 (6.9)	1 (1.9)	8 (10.5)	
No	121 (93.1)	53 (98.1)	68 (89.5)	
Not Reported	0 (0.0)	0 (0.0)	0 (0.0)	
Race (participants could select multiple), n (%)				-
White	115 (88.5)	51 (94.4)	64 (84.2)	
Asian	3 (2.3)	0 (0.0)	3 (3.9)	
Black or African American	7 (5.4)	0 (0.0)	7 (9.2)	
American Indian or Alaska Native	2 (1.5)	1 (1.9)	1 (1.3)	
Other	2 (1.5)	1 (1.9)	1 (1.3)	
Not Reported	1 (0.7)	1 (1.9)	0	
Annual Family Income, n (%)				-
$0 to $49,999	22 (17.2)	10 (18.9)	12 (16.0)	
$50,000 to $99,999	43 (33.6)	18 (34)	25 (33.3)	
$100,000 and above	63 (49.2)	25 (47.2)	38 (50.7)	
Not reported	2 (1.5)	1 (1.9)	1 (1.3)	
Age, yrs, mean ± SD	43.7 ± 7.3	12.8 ± 2.4	13.1 (2.4)	13.0 ± 2.4
BMI, (kg/m^2), mean ± SD	27.5 ± 6.6	21.4 ± 6.1	20.3 (5.5)	20.7 ± 5.8

Demographic	Parents	Children (In-Person School)	Children (Virtual School)	Children (Total)
BMI Category, n (%)				
Underweight	5 (3.8)	21 (38.9)	30 (39.5)	51 (39.2)
Normal Weight	45 (34.6)	21 (38.9)	29 (38.2)	50 (38.5)
Overweight	39 (30.0)	7 (13.0)	7 (9.2)	14 (10.8)
Obese	40 (30.8)	5 (9.3)	7 (9.2)	12 (9.2)
Not Reported	1 (0.7)	0 (0.0)	3 (3.9)	3 (2.3)

Water intake of children attending school in-person (1688 ± 680 mL) was lower as compared to water intake of children attending school virtually (1998 ± 831 mL) ($F = 5.09$, $p < 0.05$, Figure 1). The overall multivariate regression model examining demographics, parent water intake, and school setting as predictors of child water intake was significant ($R^2 = 0.33$, $p < 0.05$). Specifically, higher child water intake was associated with virtual school setting ($\beta = 0.18$, $p < 0.05$), higher parent water intake ($\beta = 0.39$, $p < 0.05$, Figure 2), older age ($\beta = 0.29$, $p < 0.05$), and lower family income ($\beta = -0.25$, $p < 0.05$). No other demographic factors including sex, BMI, race, or ethnicity were predictors of child water intake.

Discussion

The main finding of this study was children attending school virtually consumed more water than those attending school in-person. Furthermore, there were positive relationships between parent and child water and SSB intake. Previous studies have shown children may drink less water during school due to classroom policies, lack of hydration education, and poorly maintained restroom facilities (9–11). We took advantage of the pandemic where many children attended virtual school at home and found that these children consume more water compared to those attending school in-person.

Children may have consumed more water attending school virtually as compared to in-person due to perceptions of school water sources. In one study, 30% (n = 3211) of middle school children indicated they were unlikely to consume water at school, 59% indicated the fountains were unclean, 48% cited poor taste, and 24% that the fountains were contaminated (13). Since school water intake data in the current study was collected during the COVID-19 pandemic, perceptions of drinking fountain sanitation were likely worsened. Furthermore, early in the pandemic it was recommended by the Centers for Disease Control and Prevention (CDC) to restrict public water fountain access (14). This may have contributed to reduced water consumption at school in the current study.

Parental influence may have also played a role in the discrepancy between water intake during virtual school as compared to in-person. Higher parental water and SSB intake was associated with higher child

water and SSB intake. These data suggest the hydration habits of parents influenced the habits of their children. It has been suggested dietary profiles of children are influenced by parents (15–17) and that children's dietary profiles away from home are unfavorable as compared to at home (18, 19). Although these associations have been shown particular to diet, data supporting parental and environmental influence on water intake are scarce (6). A report by the National Hydration Council compared hydration habits of 1,000 parents and their children indicated a 38% increase in frequency of water intake in households whose parents drank water often. Furthermore, cross-sectional data from 1187 children and their children indicate stricter parental attitudes towards SSB intake were associated with higher child water intake (20). In the current study, parental attitudes may have affected child water and SSB intake while attending school virtually. Since many schools shifted to virtual instruction, parental influence may be more relevant due to increased time around children.

Aside from family income, there were no differences in child water intake based on other demographic factors. Previous studies have shown water intake to be lower in non-Hispanic black males, which contradicts the current findings (21). This could reflect the limited diversity of people enrolled in the current study. Lower family income was associated with higher child water intake, which contrasts previous data indicating a positive association (3) or no association (22). This could reflect that only 17% of people enrolled were classified as low income.

This study has some strengths specifically the inclusion of a comparison group and congruent demographics between children attending school virtually and those attending school in-person. However, limitations include use of self-reported data from children and not recording water content of food. Parents were explicitly asked to assist their child when completing the questionnaire, but these data may be subject to reporting errors. Lastly, the questionnaire did not account for water content of food, which could affect the variability of total water intake. However, the main purpose of this study was to examine water intake from fluids specifically.

To conclude, drinking habits of children may be affected by in-person school setting. Specifically, the current study showed that water intake was higher in children attending virtual school compared to in-person school. These data support previous studies indicating school setting and policies may discourage children from drinking adequate water while attending school.

Declarations

Patient Consent and Ethics Approval

All participating parents gave online consent for their child and themselves and children gave online assent. This study was approved by the Institutional Review Board at California Polytechnic State University (Cal Poly) and was performed in accordance with the Declaration of Helsinki.

Consent for Publication

Not applicable.

Availability of Data

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author's Contributions

ADS developed the questionnaire and conducted data collection. ADS and TH analyzed the data and provided interpretations. ADS wrote the paper. TH was the principal investigator and had primary responsibility for the final content. All authors read, critically revised, and approved the final manuscript.

Acknowledgments

Not applicable.

References

1. EFSA Panel on Dietetic Products. Scientific Opinion on Dietary Reference Values for Water. EFSA Journal. 2010;8(3):1459.
2. Manz F. Hydration in children. J Am Coll Nutr. 2007;26(5 Suppl):562S-9S.
3. Drewnowski A, Rehm CD, Constant F. Water and beverage consumption among children age 4-13y in the United States: analyses of 2005-2010 NHANES data. Nutr J. 2013;12:85.
4. Bar-David Y, Urkin J, Kozminsky E. The effect of voluntary dehydration on cognitive functions of elementary school children. Acta Paediatr. 2005;94(11):1667–73.
5. Fadda R, Rapinett G, Grathwohl D, Parisi M, Fanari R, Calo CM, et al. Effects of drinking supplementary water at school on cognitive performance in children. Appetite. 2012;59(3):730–7.
6. Bottin JH, Morin C, Guelinckx I, Perrier ET. Hydration in Children: What Do We Know and Why Does it Matter? Ann Nutr Metab. 2019;74 Suppl 3:11–8.
7. Stookey JD, Brass B, Holliday A, Arieff A. What is the cell hydration status of healthy children in the USA? Preliminary data on urine osmolality and water intake. Public Health Nutr. 2012;15(11):2148–

56.

8. Bar-David Y, Urkin J, Landau D, Bar-David Z, Pilpel D. Voluntary dehydration among elementary school children residing in a hot arid environment. J Hum Nutr Diet. 2009;22(5):455–60.
9. Kaushik A, Mullee MA, Bryant TN, Hill CM. A study of the association between children's access to drinking water in primary schools and their fluid intake: can water be 'cool' in school? Child Care Health Dev. 2007;33(4):409–15.
10. Kenney EL, Gortmaker SL, Cohen JF, Rimm EB, Cradock AL. Limited School Drinking Water Access for Youth. J Adolesc Health. 2016;59(1):24–9.
11. Michels N, Van den Bussche K, Vande Walle J, De Henauw S. School Policy on Drinking and Toilets: Weaknesses and Relation With Children's Hydration Status. J Nutr Educ Behav. 2019;51(1):32–40.
12. Johnson EC, Peronnet F, Jansen LT, Capitan-Jimenez C, Adams JD, Guelinckx I, et al. Validation Testing Demonstrates Efficacy of a 7-Day Fluid Record to Estimate Daily Water Intake in Adult Men and Women When Compared with Total Body Water Turnover Measurement. J Nutr. 2017;147(10):2001–7.
13. Patel AI, Bogart LM, Klein DJ, Burt C, Uyeda KE, Hawes-Dawson J, et al. Middle school student attitudes about school drinking fountains and water intake. Acad Pediatr. 2014;14(5):471–7.
14. Centers for Disease Control and Prevention. COVID-19 Employer Information for Office Buildings 2021 [Available from: https://www.cdc.gov/coronavirus/2019-ncov/community/office-buildings.html.
15. Robinson LN, Rollo ME, Watson J, Burrows TL, Collins CE. Relationships between dietary intakes of children and their parents: a cross-sectional, secondary analysis of families participating in the Family Diet Quality Study. J Hum Nutr Diet. 2015;28(5):443–51.
16. Scaglioni S, Salvioni M, Galimberti C. Influence of parental attitudes in the development of children eating behaviour. Br J Nutr. 2008;99 Suppl 1:S22-5.
17. Verjans-Janssen S, Van Kann D, Kremers S, Vos S, Jansen M, Gerards S. A Cross-Sectional Study on the Relationship between the Family Nutrition Climate and Children's Nutrition Behavior. Nutrients. 2019;11(10).
18. Poti JM, Slining MM, Popkin BM. Where are kids getting their empty calories? Stores, schools, and fast-food restaurants each played an important role in empty calorie intake among US children during 2009-2010. J Acad Nutr Diet. 2014;114(6):908–17.
19. Tyrrell RL, Townshend TG, Adamson AJ, Lake AA. 'I'm not trusted in the kitchen': food environments and food behaviours of young people attending school and college. J Public Health (Oxf). 2016;38(2):289–99.
20. Mantziki K, Renders CM, Seidell JC. Water Consumption in European Children: Associations with Intake of Fruit Juices, Soft Drinks and Related Parenting Practices. Int J Env Res Pub He. 2017;14(6).
21. Kenney EL, Long MW, Cradock AL, Gortmaker SL. Prevalence of Inadequate Hydration Among US Children and Disparities by Gender and Race/Ethnicity: National Health and Nutrition Examination Survey, 2009-2012. Am J Public Health. 2015;105(8):e113-8.

22. Rosinger AY, Bethancourt H, Francis LA. Association of Caloric Intake From Sugar-Sweetened Beverages With Water Intake Among US Children and Young Adults in the 2011-2016 National Health and Nutrition Examination Survey. JAMA Pediatr. 2019;173(6):602–4.

Figures

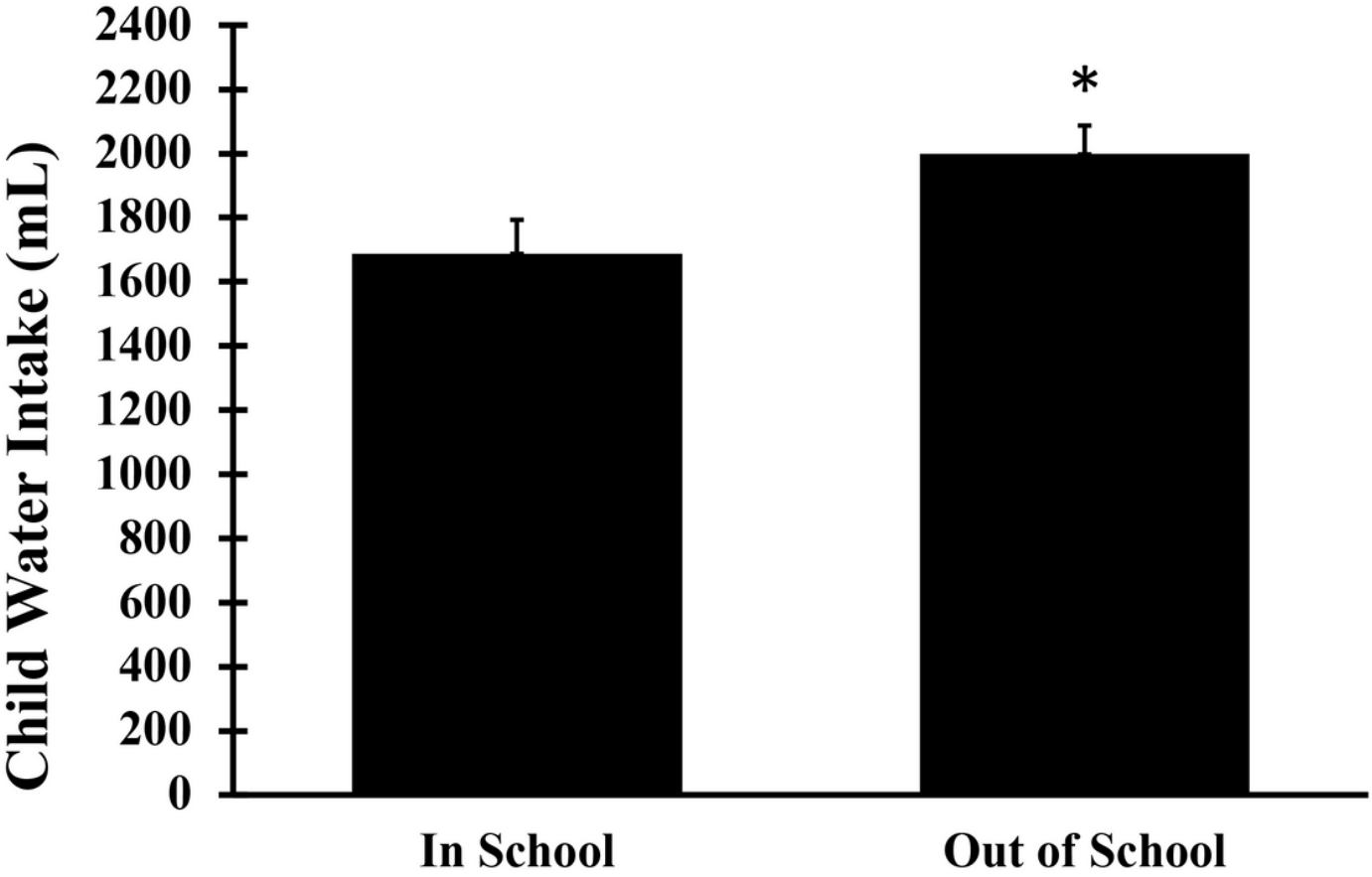

Figure 1

Child plain water intake in school and out of school * Indicates significantly different from in school water intake, $p < 0.05$ Error bars represent SE

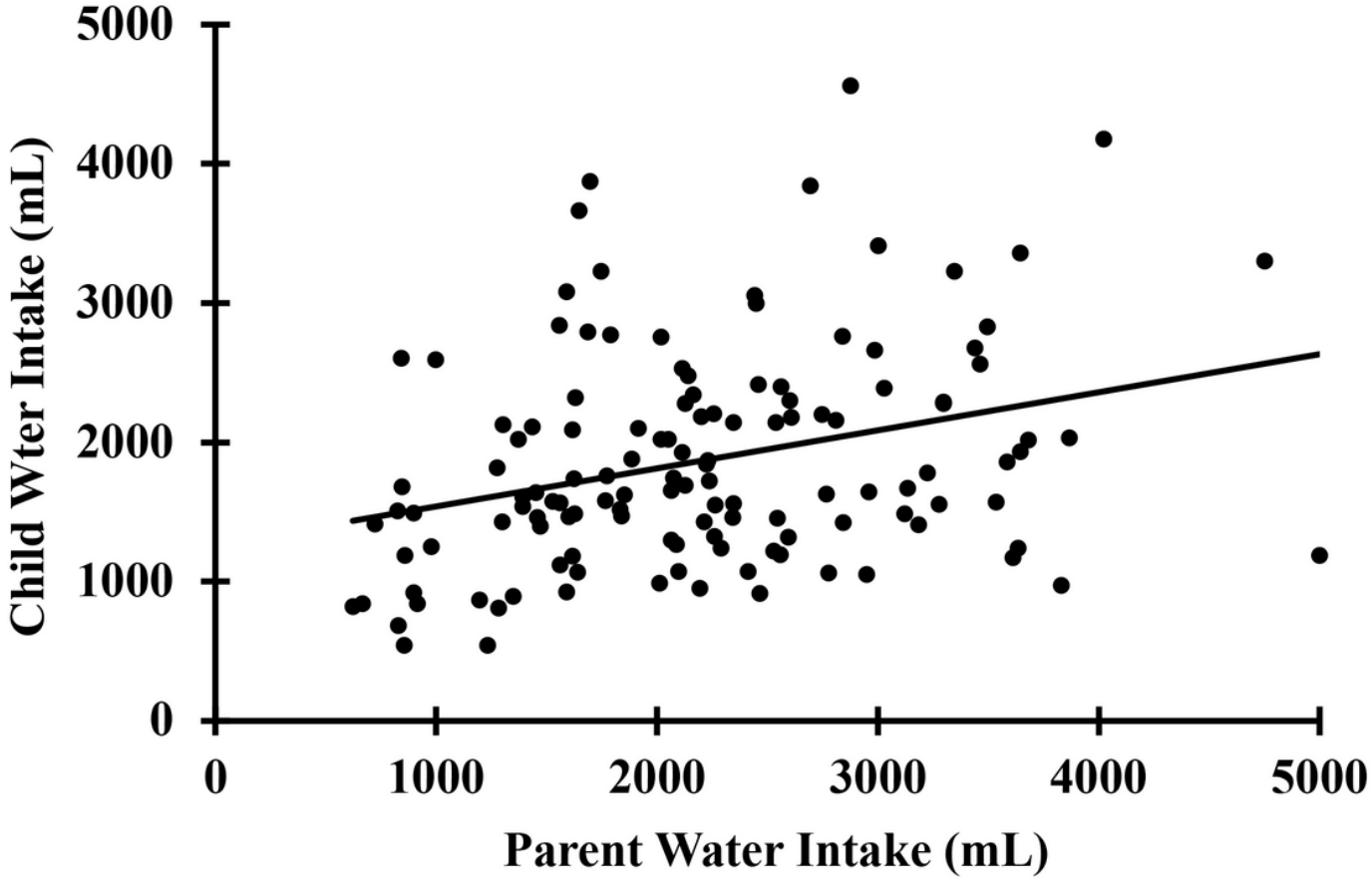

Figure 2

Relationship between parent and child plain water intake