ORIGINAL ARTICLE

Is beverage intake related to overweight and obesity in school children?

Papandreou D[1,2], Andreou E[2], Heraclides A[2], Rousso I[1]

[1]2nd Department of Pediatrics, School of Medicine, Aristotle University of Thessaloniki, Thessaloniki, Greece.
[2]Department of Life and Health Sciences, School of Sciences, University of Nicosia, Nicosia, Cyprus.

Abstract:
Background and Aim: Recently, considerable attention has been given to beverage intake as a source of calories which may be linked to pediatric obesity. The purpose of our study was to evaluate the beverage intake in school children and adolescents aged 7 to 15 years old.
Methods: Six hundred and seven (607) out of 655 children participated in the study. One hundred percent fruit juice were classified those beverages that contain 100% fruit juice, without sweetener. Sweetened sugar beverages (SSBs) were included (fruit drinks sweetened fruit juice, fruit-flavored drink or drink that contained fruit juice in part, sweeten soft drinks, coffee, and tea).
Results: Around 84% of subjects consumed water while 81% of children who were included in the analysis consumed milk, 49.5% consumed 100% fruit juice, and 79.4 % SSBs. Whole milk was consumed by 40.9% of school children. Skim milk and 1% milk were consumed by 3.6% and 4.7% of the children, respectively. Children and adolescents consuming SSBs were 2.57 (95% CI: 1.06, 3.38) times more likely to become obese compared to normal peers.
Conclusion: Sugar beverage drinks but not 100% fruit juices and milk are associated with obesity. Further studies investigating the relationship among beverage consumption, total energy intake, and development of overweight are needed.

Key words: Sugar beverage intake, obesity, children, Greece

Corresponding author: Dr Dimitrios Papandreou, Ass. Professor of Nutrition, University of Nicosia, 46 Makedonittisas Ave., 1700, Nicosia, Cyprus. Senior Researcher of Nutrition, 2nd Dep. of Pediatrics, Aristotle University of Thessaloniki, St.kiriakidi 1, TK 54636, Thessaloniki, Greece, tel.+302310232390, fax: +302310232390, e-mail: papandreoudimitrios@yahoo.gr

Introduction

Obesity prevalence is growing very fast and is associated with increased mortality and morbidity[1]. Around 30% of obese adults show such signs before adolescence[2]. According to the International Obesity Task Force (IOTF)[2], 25% of children between 6-14 years are overweight and 9% obese. The prevalence of pediatric obesity in Greece is very high[3]. Possible risk factors that have been found to associate with obesity were sedentary behavior, watching TV, parental obesity and high intake of sugar-beverages[4-6].

In addition to Greek studies, others have also researched the association of overweight, obesity and diabetes type 2 and the intake of sweetened beverages among children. In the study by Dennison et al[7], 100% of fruit juice and sweetened fruit drinks have been found to be positively correlated with obesity in children, who consumed ≥360 ml/d compared to those who consumed ≤360 ml/d (32% vs. 9%). More recently, in a meta-analysis review of 310,819 participants the authors concluded that in addition to weight gain, higher consumption of SSBs was associated with development of metabolic syndrome and type 2 diabetes[8]. On the other hand, Welsh et al[9] examined the association of sweetened drink consumption, defined as 100% fruit juice, fruit drinks and sodas and found no statistically significant association between development of overweight and sweet-drink consumption.

Studies have been also reported on milk intake and adiposity in children with conflicting results. Barba et al[10] found a statistically significant inverse relationship between milk consumption and Body Mass Index (BMI). On the other hand, more recently, Noel et al[11] found that milk intake is not associated with body fat prevention in children aged 10-13 years.

In 2001, the American Academy of Pediatrics (AAP)[12] published its recommendations for 100% fruit juice consumption in children and concluded that 100% fruit juice has no nutritional benefit over whole fruits and may contribute to the child's over- nutrition. More specifically, they recommended that 100% fruit juice intake should be limited to 8 to 12 ml/d or 220-345 ml/d for children aged 7 to 18 years.

The aim of this study is to evaluate the beverage intake among school children and investigate possible associations among types of beverages and weight status, to assess whether overweight/obese children consumed

more 100% fruit juice, fruit drink or soda compared to normal peers. Moreover, this study aims to evaluate whether school children who consumed larger quantities of 100% fruit juice, fruit drinks or soda have higher rates of being overweight/obese compared to those who consumed little to no 100% fruit juice, fruit drink or soda.

Methods and subjects

The study was conducted from 2009 to 2011 in the city of Thessaloniki, Greece (population ~ 800,000). Thessaloniki is divided into four sections (northern, eastern, western and southern). Two or three schools from each section were randomly selected for each area. A total of ten schools participated in the study. Out of 36,530 students, a total of 655 subjects volunteered to participate in the study, however only 607 subjects (324 males, 283 females), aged 7-15 years old, completed the study. We categorized the entire subject data into three age groups. The study was approved by the ethical committee of Aristotle University of Thessaloniki and the Greek Ministry of National Education and Religious Affairs. In addition, written informed consent was also obtained from each child's parents who participated in the study.

Body weight was measured using a digital scale (SECA 700) with an accuracy of ±100 gr. All children were weighted without shoes and with light clothes. Height was measured to the nearest 0.1cm using a stadiometer (SECA 101). BMI was calculated and participants were defined as overweight or obese according to the International Obesity Task Force (IOTF) criteria[13].

Dietary information was collected by a registered dietitian using a 24-h recall technique for a total of 3 days, 2 weekdays and 1 weekend. Standard household measures (cups, tablespoons etc) were used to define the amounts of food. Food intake data was analyzed using a special software (Diet 200A, Science technologies, Athens) which consists all Greek food items and recipes, as described in Greek food composition tables[14].

One hundred percent fruit juice was classified as only those beverages that contain 100% fruit juice, without sweetener. Sweetened sugar beverages (SSBs) included fruit drinks sweetened fruit juice, fruit-flavored drink or drink that contained fruit juice in part, sweeten soft drinks, coffee, and tea. Milk included any type of cow milk and was subcategorized by the percentage of milk fat (skim, 1%, 2%, and whole milk), including chocolate and flavored milk as separate categories. Milk quantity was subcategorized as none, >0 to 240 ml, >240 to 480 ml, >480 to 600 ml, and >600 ml on the basis of current recommended servings of milk[15]. One hundred percent fruit juice and SSBs were reported as none, >0 to 180 ml, >180 to 360 ml, and >360 ml on the basis of the current American Academy of Pediatrics (AAP) recommendations[12].

Statistical Analysis:

Analysis of Variance (ANOVA) was used to assess descriptive characteristics of participants by body weight status, as well as beverage intake by body weight status and gender. Beverage consumption was presented as mean ± standard error, among BMI categories. The SSB variable (the only one which showed a significant association with body weigh status) was dichotomized (above and below the median intake) and logistic regression analysis was used to further assess the association between sugar beverages (independent variable) and prevalence of overweight/obesity (dependent variable), using 3 different models adjusted for potential confounders. A p-value less than 0.05 was considered statistically significant. Statistical analysis was performed by SPSS 17 (SPSS Inc. Chicago, USA).

Results

Table 1 describes the demographic characteristics. Of the total 607 children, 53.4% were boys and 46.6% were girls.

Table 2 provides the demographic characteristics based on the weight status using BMI in all 607 school children. Sixty six (66%) percent were considered normal, 25% were overweight and 9% were obese. There was no statistically significant difference in the BMI between boys and girls. However, a statistically significant difference in the age of the various weight categories was found (Table 2), with the overweight and obese children being older compared with the normal ones.

Water consumption was about 84% in all subjects per day. About 81% of children who were included in the analysis consumed milk and 79.4 % SSBs. Whole milk was consumed by 40.9% of school children. Skim milk and 1% milk were consumed by 3.6% and 4.7% of the children, respectively (Table 3).

Table 4 shows the beverage consumption based on gender and weight status. Overweight and obese children significantly consumed more SSBs as well more energy

Table 1: Demographic characteristics of 607 subjects.

Gender	n (%)
Male	324 (53.4)
Female	283 (46.6)
BMI (Kg/m^2)	
Normal	402 (66.0)
OW	152 (25.0)
OB	53 (9.0)
Age (y)	
7-9	146 (24.0)
10-12	188 (31.0)
13-15	273 (45.0)
Household Income	
€ 10,000 or less	195 (32.1)
€ 10,000 to 15.000	128 (21.1)
€ 15,000 to 20.000	105 (17.2)
€ 20,000 to 25.000	100 (16.5)
€ 25,000 or more	79 (13.1)

BMI: Body Mass Index.

Table 2: Descriptive characteristics of school children according to weight status.

	All	Normal	OW	OB
Age (y)*	11.2 ± 1.1	11 ± 1.2	11.7 ± 1.1	12.4 ± 1.3
Annual Income	€ 21,000±13,000	€ 10,000±7,500	€ 11,000±6,500	€ 19,000±14,000
Physical Activity (times/week)	6.5 ± 0.4	5.8 ± 0.1	6.6 ± 0.2	6.7 ± 0.2
Energy Consumed (kcal)	2,512±88	2,223±105	2,790±144	2,845±166
Total Beverages (ml/d)	778 ±31	677 ± 38	712 ± 44	821 ± 49

Data presented as mean± standard error. Statistical significant difference ($p<0.05$).
*Statistically significant differences between normal and overweight, normal and obese and overweight and obese group.
OW: overweight, OB: obese, BMI: body mass index. One-way ANOVA was used for assessing statistically significant differences in participant characteristics between the different categories.

Table 3: Prevalence of types of beverages consumed per day by 607 children.

Type of Beverage	Prevalence among Children (%)
Water	83.9
100% fruit juice	49.4
SSBs	79.4
Total milk	80.9
Whole milk	40.9
2% milk	20.8
1% milk	4.7
Skim milk	3.6
Chocolate milk	12.7

from sugar beverages compared to normal peers.

A total of 205 children were considered overweight and obese. Table 4 shows that the unadjusted odds ratio (95% CI) comparing high to low consumers of SSBs was 3.18 (1.51, 4.19). Adjusted odds ratio (model 2) was 2.95 (1.23, 3.60). Model 3 showed that, after addition of energy intake and physical activity, the ORs for sugar beverage intake were still significantly associated with overweight and obesity, [2.57 (1.06, 3.38)].

Discussion

Our results revealed that about 80% of children consumed some kind of milk. Wang et al[16] reported a 74% milk consumption in children aged 2-19 years old. The Dietary Guidelines for Americans[15] recommends 2-3 servings of milk per day. In our study, children consumed 2.1 servings per day. In addition, all children older than 2 years old should consume low or non-fat milk[12]. Our

Table 4: Beverage consumption by gender and weight status (n=607).

	Gender		Weight status		
Fluid (ml/d)	Boys n=324	Girls n=283	N n=402	OW n=152	OB n=53
Water	885.2±13	798±11	891±5	853±9	801±12
100% fruit juice	152 ± 25	148 ± 22	139 ± 10	148 ± 11	156 ± 16
SSBs	440 ± 37	410 ± 31	380 ± 10	420 ± 13	**435 ± 12***
Whole milk	207 ± 16	221 ± 18	200 ± 7	208 ± 8	212 ± 16
2% milk	199 ± 12	201 ± 24	201 ± 8	199 ± 5	201 ± 11
1% milk	122 ± 21	144 ± 15	128 ± 11	133 ± 7	139 ± 12
Skim milk	178 ± 20	176 ± 12	175 ± 3	180 ± 2	182 ± 4
Chocolate milk	238 ± 14	206 ± 12	208 ± 9	212 ± 11	221 ± 12
Energy (kcal)					
Water	0	0	0	0	0
100% fruit juice	295 ± 26	279 ± 21	270 ± 10	277 ± 11	298 ± 13
SSBs	859 ± 41	862 ± 49	920 ± 21	967 ± 20	**1,060 ± 18***
Whole milk	170 ± 17	179 ± 15	172 ± 9	174 ± 12	177 ± 11
2% milk	152 ± 14	144 ± 17	144 ± 3	148 ± 6	153 ± 3
1% milk	120 ± 12	122 ± 11	111 ± 9	117 ± 8	121 ± 6
Skim milk	192 ± 18	190 ± 18	89 ± 4	91 ± 6	92 ± 4
Chocolate milk	212 ± 18	221 ± 16	209 ± 13	214 ± 12	220 ± 11

Data presented as mean ± standard error. Statistically significant difference ($p<0.05$).
*Statistically significant differences between normal and overweight and normal and obese group after.
N: normal, OW: overweight, OB: obese, SSBs: sugar sweetened beverages. One-way ANOVA was used for assessing statistically significant differences in beverage intake between the different categories.

Table 5: Odd ratios for effect of SSBs intake on overweight and obesity.

Overweight and obesity (n=205)		
	OR (95% CI)	**p**
Model 1	3.18 (1.51, 4.19)	0.001
Model 2	2.95 (1.23, 3.60)	0.008
Model 3	2.57 (1.06, 3.38)	0.029

Statistical significant difference ($p<0.05$).
Model 1: unadjusted effects,
Model 2: adjusted for age, gender and income
Model 3: adjusted for age, gender, income, energy intake and physical activity,
OR=odds ratio, CI=confidence interval,
Multivariate logistic regression analysis was used for estimating the above Odds Ratios.

results apparently indicated that only 4.7% and 3.7% of children consumed 1% or skimmed milk, respectively.

Our data also reported that children consumed a mean amount of about 150 of 100% fruit juice per day, which is within the AAP recommendations of 100-180ml/day[12]. The amount of SSBs consumed by children in our study was higher compared to 100% fruit juices. In addition, obese children were found to consume significantly more SSBs compared to normal pears. This is a concern because these drinks have extra empty calories, and have no nutritional benefit compared with 100% fruit juices[17].

In our study, SSBs were the second most commonly consumed beverages. Recent data from European countries[18] showed that SSB intake were the largest contributors of total beverage energy intake. This data is also supported by Wang et al[16] who reported increased caloric contribution to weight in children who consumed sugar beverages and sodas. In addition, recently published reviews have linked the intake of sugar beverages with the intake to excess weight gain[8,19,20], although inconclusive evidence[21] also exists. In our study the increased energy intake was found to be associated with the quantity of fruit drinks and soda consumed by children. Moreover, this increased energy intake was also related with an elevated BMI.

High intake of SSB would also influence the association between the genetic predisposition and adiposity. In a very recent study by Qi et al[22], the authors analyzed the interaction between genetic predisposition and the intake of SSB in relation to body-mass index in three prospective cohorts of American men and women. It was found that the combined genetic effects on BMI and obesity risk among persons consuming one or more servings of SSB per day were approximately twice as large as those among persons consuming less than one serving per month. These data suggest that persons with greater consumption of sugar-sweetened beverages may be more susceptible to genetic effects on adiposity.

The prevalence of overweight and obesity in our study was 25% and 9%, respectively. The results are comparable with a recent Greek study by Antonogeorgos et al[23] where OW and OB levels of 27.6% and 9% were found, respectively. Similarly, in another nationwide study by Farajian et al[24] the authors examined 2,315 primary school children and found overweight rates of 29.5% for boys and girls and obesity rates of 13.1% and 9%, respectively.

In addition, a study by Manios et al[25] in 2,374 children found OW rates of 16.2% and OB rates of 17.5%. This difference compared to the present results is possibly due to the larger number of participants (2,374 vs. 607) and/or different method used to assess overweight and obesity values.

Limitations of our study include the 24-hour dietary recall used to assess the dietary patterns, as well as that this analysis was performed in a small sample of Thessaloniki. Thus, it was not a national representative sample. Moreover, we did not take into account factors such as breastfeeding and hours of watching TV or working on the computer. Finally, we did not include the genetic predisposition that could provide us with important information for the needs of our study.

Conclusions:

Children consuming sugar beverage drinks were 2.57 times more likely to become obese compared to normal peers. SSBs but not 100% fruit juices and milk are associated with obesity. Awareness of these trends among pediatricians will be critical in assisting children and parents to identify concrete targets of suboptimal dietary patterns that may contribute to excess caloric intake and obesity. Further studies investigating the relationship among beverage consumption, total energy intake, and development of overweight are needed.

Conflicts of interest

None declared.

References

1) Olshansky SJ, Passaro DJ, Hershow RC, Layden J, Carnes BA, Brody J, et al. A potential decline in life expectancy in the United States in the 21st century. N Eng J Med. 2005; 352: 1138-1145.
2) Lobstein T, Baur L, Uauy R ; IASO International Obesity TaskForce. Obesity in children and young people: A crisis in Public Health. Obes Rev. 2004; 5: 4-104.
3) Manios Y, Kourlaba G, Kondaki K, Grammatikaki E, Anastasiadou A, Roma- Giannikou E. Obesity and Television Watching in Preschoolers in Greece: The GENESIS Study. Obesity (Silver Spring). 2009; 17: 2047-2053.
4) Manios Y, Yannakouris N, Papoutsakis C, Moshonis G, Magkos F, Skenderi K, et al. Behavioral and physiological indices related to BMI in a cohort of primary schoolchildren in Greece. Am J Hum Biol. 2004; 16: 639-647.
5) Malindretos P, Doumpali E, Mouselimi M, Papamichail N, Doumpali Ch, Sianaba O, et al. Childhood and parental obesity in the poorest district of Greece. Hippokratia. 2009; 13: 46-49.
6) Linardakis M, Sarri K, Pateraki MS, Sbokos M, Kafatos A. Sugar-added beverages consumption among kindergarten children

of Crete: effects on nutritional status and risk of obesity. BMC Public Health. 2008; 8: 279.
7) Dennison BA, Rockwell HL, Baker SL. Excess fruit juice consumption by preschool-aged children is associated with short stature and obesity. Pediatrics. 1997; 99: 15-22.
8) Malik VS, Popkin BM, Bray GA, Després JP, Willet WC, Hu FB. Sugar-Sweetened Beverages and Risk of Metabolic Syndrome and Type 2 Diabetes: a meta-analysis. Diabetes Care. 2010; 33: 2477-2483.
9) Welsh JA, Cogswell ME, Rogers S, Rockett H, Mei Z. Grummer-Strawn LM. Overweight among low-income preschool children associated with the consumption of sweet drinks: Missouri, 1999-2002. Pediatrics. 2005; 115: e223- e229.
10) Barba G, Troiano E, Russo P, Venezia A, Siani A. Inverse association between body mass and frequency of milk consumption in children. Br J Nutr. 2005; 93: 15-19.
11) Noel SE, Ness AR, Northstone K, Emmett P, Newby PK. Milk Intakes Are Not Associated with Percent Body Fat in Children from Ages 10 to 13 Years. J Nutr. 2011; 141: 2035-2041.
12) Committee on Nutrition. American Academy of Pediatrics: The use and misuse of fruit juice in pediatrics. Pediatrics. 2001; 107: 1210-1213.
13) Cole JT, Bellizzi CM, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ. 2000; 320: 1240-1247.
14) Trichopoulou A Georga K. Composition tables of foods and Greek dishes, 3rd edition, Parisianou Publications, Athens, Greece, 2004.
15) Nicklas T, Johnson R; American Dietetic Association. Position of the American Dietetic Association: Dietary guidance for healthy children ages 2 to 11 years. J Am Diet Assoc. 2004; 104: 660-677.
16) Wang YC, Bleich SN, Gortmaker SL. Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among US children and adolescents, 1988-2004. Pediatrics. 2008; 121: e1604- e1614.
17) Briefel RR, Wilson A, Gleason PM. Consumption of low-nutrient, energy-dense foods and beverages at school, home, and other locations among school lunch participants and nonparticipants. J Am Diet Assoc. 2009; 109: S79-S90.
18) Duffey KJ, Huybrechts I, Mouratidou T, Libuda L, Kersting M, De Vriendt T; HELENA Study group. Beverage consumption among European adolescents in the HELENA study. Eur J Clin Nutr. 2012; 66: 244-252.
19) Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. Am J Clin Nutr. 2006; 84: 274– 288.
20) Pereira MA. The possible role of sugar-sweetened beverages in obesity etiology: a review of the evidence. Int J Obes (Lond). 2006; 30: S28– S36.
21) Bachman CM, Baranowski T, Nicklas TA. Is there an association between sweetened beverages and adiposity? Nutr Rev. 2006; 64:153– 174.
22) Qi Q, Chu AY, Kang JH, Jensen MK, Curhan GC, Pasquale LR, et al. Sugar-sweetened beverages and genetic risk of obesity. N Engl J Med. 2012; 367:1387-1396.
23) Antonogeorgos G, Panagiotakos DB, Papadimitriou A, Priftis KN, Anthracopoulos M, Nicolaidou P. Breakfast consumption and meal frequency interaction with childhood obesity. Pediatr Obes. 2012; 7: 65-72.
24) Farajian P, Panagiotakos DB, Risvas G, Karasouli K, Bountziouka V, Voutzourakis N, et al. Socio-economic and demographic determinants of childhood obesity prevalence in Greece: the GRECO (Greek Childhood Obesity) study. Public Health Nutr. 2013; 16: 240-247.
25) Manios Y, Moschonis G, Grammatikaki E, Anastasiadou A, Liarigkovinos T. Determinants of childhood obesity and association with maternal perceptions of their children's weight status: the "GENESIS" study. J Am Diet Assoc. 2010; 110: 1527-1531.