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ORIGINAL ARTICLE

Beverage intake and obesity in early childhood: evidence form primary health care clients in Northwest Argentina

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Sugar sweetened beverages (SSB) are thought to play an important role in weight gain. We examined the relationship between the intake of caloric and noncaloric beverages (SSB and water) and the nutritional status of children. In 2014, we randomly selected 16 public health clinics in four cities of Northwest Argentina and conducted a survey among mothers of children 0–6 years of age. Children's beverage intake was ascertained by 24-h dietary recall provided by the mothers. Children's weight and height measures were obtained from clinic's registries. We calculated the body mass index using the International Obesity Task Force standards. The analysis included 562 children 25 months to 6 years of age with normal or above normal nutritional status. Children's beverage consumption was as follows, water 81.8%, carbonated soft drinks (CSD) 49.7%, coffee/tea/cocoa 44.0%, artificial fruit drinks 35.6%, flavored water 17.9%, natural fruit juice 14.5%. In multivariate logistic regression models the likelihood of being obese *v.* being overweight or having normal weight doubled with an intake of one to five glasses of CSD (OR = 2.2) and increased by more than three-fold with an intake of more than five glasses (OR = 3.5). Drinking more than five glasses of water decreased the likelihood of being obese by less than half (OR = 0.3). The percentage of children drinking more than five glasses of other beverages was low (3.3–0.9%) and regression models did not yield significant results. The study contributed evidence for reducing children's CSD intake and for promoting water consumption, together with the implementation of comprehensive regulatory public health policies.

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Key words: beverages, dietary sugar, latin America, pediatric obesity, water

Pediatric obesity has important consequences for health and wellbeing across the life span.[1] Excess weight increases a child's risk for adverse short- and long-term mental and physical health consequences, including depressive symptoms, anxiety, low self-esteem, low body image, mood and conduct disorders, high blood pressure, diabetes, elevated cholesterol, fatty liver disease, cancers, type 2 diabetes and obstructive sleep apnea.[2–4]

The prevalence of overweight and obesity in early childhood increased significantly in the last decades.[5–7] Globally, in 2012 the number of overweight children under the age of five was estimated to be 44 million with the majority living in low and middle income countries.[8] A review of published data from 2008 to 2013 showed that among children <5 years of age in Latin America, the estimated prevalence of overweight was 7.1%, and that the South American sub-region had the highest increase.[9]

Human and animal studies have shown that the environment in early life can increase the risk of later metabolic disease.[10] Hales and Barker[11] proposed that pre- and peri-natal nutritional status, developmentally programs the organism's adult metabolism and energy balance.[12] Other studies indicate that the window for the developmental effects of diet may extend into childhood.[13] Postweaning exposure to a high fat-sugar diet was associated with the amplification of effects in animal models, and may have a profound effect on offspring weight gain and glucose tolerance.[14,15] These findings highlight the relevance of conducting studies assessing the role of human nutrition in early childhood.

Sugar sweetened beverages (SSB) and obesity trends

Among the diverse factors contributing to the rising epidemic of obesity, the intake of SSB is thought to play an important role.[16,17] A wide variety of drinks can contribute the dietary sugar load, including natural fruit juice, and sweetened caffeinated beverages like tea or coffee. However, because of current changes in consumption patterns related to promotion and commercialization schemes by large-scale international companies, carbonated soft drinks (CSD), artificial juices and energy drinks that contain high levels of sugar constitute a salient focus of attention. The sale of CSD has increased rapidly in low and middle income countries, and may constitute the largest source of added sugar in the diet of many consumers.[18,19] In a cross-national study of 79 countries Basu *et al.*[20] showed that the average soft drink intake increased from

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9.5 gallons/person/year in 1997 to 11.4 gallons/person/year in 2010. Argentina ranked third with 30.6 gallons, after Mexico (31.5 gallons) and the United States (31.2 gallons). The intake of crystal or powder drinks which are similarly sweetened and are often consumed in large amounts by toddlers and young children, reportedly parallels the patterns of CSD consumption.[17]

The relationship of beverage intake with childhood obesity

Fewer studies have examined the relationship between the intake of SSB and obesity among small children, compared with studies among older age groups.[17,19] In a cross-sectional study, Jiménez-Cruz *et al.*[21] conducted a survey among low income mothers attending primary health care clinics in three Mexican cities. The intake of carbonated and noncarbonated sweetened drinks among children 6 to 24 months of age, was associated with overweight and obesity after adjusting for family income and migration status. Another cross-sectional study[22] using data from the National Health and Nutrition Examination Survey (NHANES) 1999–2002, showed no statistically significant increase in body mass index (BMI) among children 2 to 5 years of age on the basis of milk, 100% fruit juice, fruit drink or soda consumed. Fruit juices have been associated with increased energy intake and weight status among preschool children in some studies[23,24] but not in others.[25,26]

Among longitudinal studies in the United States, one showed that SSB intake at age 5, but not milk or 100% fruit juice, was positively associated with weight status assessed biannually from 5 to 15 years of age.[27] Another prospective cohort study[26] showed no significant results. It was conducted among children between 2 and 5 years of age participating in the North Dakota Special Supplemental Nutrition Program for Women, Infants and Children. On two visits, 6 to 12 months apart, weight change was unrelated to intake of fruit juice, fruit drinks or soda. A systematic review of prospective studies examined the association between SSB intake before age 6 and nutritional status among older children.[28] Three studies in this review showed a consistent association between SSB and increased weight, BMI or waist circumference.[29–31] One study among African-American preschool children showed a positive association trend between consumption of SSB and obesity, but did not reach statistical significance.[32] The review also included the studies of Skinner and Carruth[25] and Newby *et al.*[26] that showed no association between SSB and BMI status.

Although hydration needs are a primary public health concern, few studies have evaluated water intake among children. In Mexico, Piernas *et al.*[33] analyzed 24-h dietary recall from the 2012 Mexican National Health and Nutrition Survey. About 73% of respondents aged 1 to18 years reported drinking plain water. Other beverages and plain water represented 65.5 and 26.5% of total daily water intake, respectively. Another study of respondents 4 to 13 years of age, used two nonconsecutive 24-h dietary recall from three cycles (2005–2010) of the US NHANES. Water and other beverages contributed 70–75% of dietary water, and water contributed only 25–30% of the total intake.[34] Total daily water intake was below the Dietary Reference Intake[35] levels in both studies.

In a systematic review of 10 cross-sectional and four longitudinal studies including children and youth aged 2 to19 years, Muckelbauer *et al.*[36] assessed the association between water consumption and body weight-related outcomes. Six cross-sectional studies found a direct association between water consumption and at least one body weight outcome. Four cross-sectional studies did not show any association. One nonrandomized controlled study and two observational longitudinal studies showed that increased water consumption reduced the risk of overweight or increased BMI. Another observational longitudinal study showed no association. Among randomized intervention studies, a cluster trial conducted in 32 elementary schools in Germany found that provision of drinking water significantly reduced the risk of overweight in children.[37] In a double blind intervention study involving masked replacement of sugar-containing beverages with noncaloric beverages, Dutch children were followed from 4 to 11 years of age. Noncaloric beverage intake reduced weight gain and fat accumulation in normal-weight children.[38]

The levels of consumption of SSB in Latin American countries like Argentina are among the highest in the world. There is currently no sign of tempering of this trend. There is a need to increase the regional evidence base in support of public health policies and social denormalization of high-energy beverage consumption. The purpose of this study was to examine the relationship between the intake of caloric and noncaloric beverages (SSB and water) and the nutritional status of children in the 1st years of the life span.

Methods

Study site

The study was conducted in Northwest Argentina, a socioeconomically disadvantaged region of the country, with human development indicators significantly lower than national averages. Argentina faired 49th in the 2013 ranking of the human development index with a value of 0.808 and an inequality-adjusted index of 0.680.[39] The nutritional profile of children in the Northwest region has been historically characterized by high prevalence of low weight and stunting.[40–43] However, following a persistently increasing trend, childhood overweight and obesity currently prevails, with published rates ranging from 5 to 12%.[43–45]

Sample selection and procedures

Our study was conducted in 2014, in public health clinics providing free maternal-child health services in four cities of Northwest Argentina. Our catchment area included the four capital cities of the provinces of Tucuman, Jujuy, Santiago del Estero and Catamarca. We randomly selected a total of 16 clinics proportionally to the existing number in each of the four

cities 75, 51, 35 and 24, respectively. Participants were recruited from a designated starting date and during the consecutive days until completion of the quota of 300 for each province. We registered the name and address of mothers who attended the clinics seeking services for their children. Interviewers explained the content of the informed consent form and requested mother's consent. Structured interviews lasting ~30 min, and measurement of mother's waist circumference were conducted in the clinic or in the mother's home. Interviewers obtained children's height and weight measurements from the clinic's registries.[46] Mothers of children 0 to 6 years of age who attended the clinic for healthy-child control services and provided consent, were included in the study. This research was approved by the Ethics Committee of the Ministry of Health of the Province of Jujuy, in compliance with human subjects requirements.

Questionnaire development

The questionnaire was based on existing instruments[47–49] and on items developed by our research team. The questionnaire included sociodemographic and behavioral information, and anthropometric data of mothers and children. Children's food and beverage intake was ascertained by a 24-h recall provided by the mothers.

Exposure variables

The exposure variables were water, a noncaloric beverage and beverages that contribute to children's caloric intake (SSB). Among SSB we listed CSD, noncarbonated flavored water, artificial fruit drinks, natural fruit juice and tea, coffee or cocoa. We asked if children had consumed each kind of beverage and whether their intake was of one to five, or more than five glasses or cups.

Outcome variables

Our outcome variable was the nutritional status of children measured as the BMI and using the International Obesity Task Force (IOTF) cut-off points. The BMI has been extensively used to determine the nutritional status in adults[50–51] and the evidence to use this indicator to assess the nutritional status in children is increasing.[52–53] In children and adolescents the BMI changes substantially with age, therefore sex and age curves should be used.[54] The Centers for Disease Control and Prevention (CDC) has produced curves for the United States but these may not be applicable to all countries.[55] The IOTF produced curves based on BMI data from children of six countries.[52] More recently World Health Organization (WHO) produced curves that are descriptive of how children should grow.[56] The prevalence of normal weight, overweight and obesity differ somewhat according to the reference values and cut-off points used, and each measure should be used with caution.[57] In Argentina Padula *et al.*[57] reported that among children 2 to 5 years of age, the prevalence of overweight and obesity calculated with the IOTF cut-off points provide intermediate values, in relation to the rates obtained using the CDC and the WHO references. In our study the anthropometric data of children was obtained from clinic's registries where measurements were collected by trained personnel following the Ministry of Health standardized protocol.[46] To determine children's nutritional status we calculated the BMI (kg/m^2) by sex and age, and used the IOTF cut-off points. These cut-off points for different sex and age groups between 2 and 18 years of age, relate to the adult categories for low weight (BMI < 19), normal weight ($\geqslant 19$ to < 25), overweight (BMI $\geqslant 25$) and obesity (BMI $\geqslant 30$).[58] For the analysis we constructed two binary outcomes, obese or overweight *v.* normal weight, and obese *v.* overweight or normal weight.

Covariates

Covariates included mother's age, marital status, education level and their waist circumference. Waist circumference is a good indicator of whole body fat and it is simple to perform in respondent's homes.[59] A value of >80 cm is indicative of health risk. The WC measurement was made at minimal inspiration to the nearest 0.1 cm, midway between the last rib and the iliac crest.[60] Children's characteristics included sex, age and a physical activity indicator, daily hours of TV viewing, categorized as less than three or more than three. The intake of milk and the intake of high salt and fat (HSF) snacks (potato chips and/or salty sticks) were categorized as yes or no.

Data analysis

We used STATA 14.0 to conduct the analysis. We cross tabulated the sociodemographic characteristics of mothers and their waist circumference, children's sex, age, nutritional status (normal, overweight or obese), hours of TV viewing, intake of milk and of HSF snacks, by the sex of children. We also cross tabulated the variables by children's nutritional status and calculated Fisher's exact tests. We constructed separate multivariate logistic regression models using each beverage type as exposure variable. The mother–child characteristics were included as covariates. One set of models used obesity or overweight *v.* normal weight as the outcome variable. Another set used obesity *v.* overweight or normal weight as the outcome variable.

Results

Our response rate was 93%. We collected data from a total of 1107 children 0 to 6 years of age. For the analysis we excluded children who had not reached the recommended weaning age of 2 years. Therefore, 488 children younger than 25 months of age were excluded. An additional 57 children with low weight were excluded to yield a final sample of 562. The majority of mothers (92.1%) reported having difficulties in making ends meet with their family income (data not shown). Table 1 shows the characteristics of the sample by sex. Among mothers,

Table 1. *Characteristics of the sample by sex*

	Boys (n = 298) (53.0%)	Girls (n = 264) (47.0%)	Total (n = 562)	P value
Mother's characteristics				
Age in years				0.429
≤30	189 (64.1)	165 (63.0)	354 (63.6)	
>30	106 (35.9)	97 (37.0)	203 (36.4)	
Marital status				0.016*
Single/divorced/widowed	92 (31.2)	59 (22.7)	151 (27.2)	
Married/living with partner	203 (68.8)	201 (77.3)	404 (72.8)	
Employment status				0.583
Employed	53 (18.0)	46 (17.6)	99 (17.8)	
Not employed/student	177 (60.0)	167 (63.7)	344 (61.8)	
Informal work/unemployed	65 (22.0)	49 (18.7)	114 (20.5)	
Education				0.775
Elementary or less	45 (15.6)	44 (17.4)	89 (16.4)	
Any high school	209 (72.3)	176 (69.6)	385 (71.0)	
Any technical/university	35 (12.1)	33 (13.0)	68 (12.6)	
Waist circumference				0.151
≤80 cm	115 (40.1)	91 (35.4)	206 (37.9)	
>80 cm	172 (59.9)	166 (64.6)	338 (62.1)	
Children's characteristics				
Age in years				0.439
2.1–3	152 (51.0)	132 (50.0)	284 (50.5)	
4–6	146 (49.0)	132 (50.0)	278 (49.5)	
Nutritional status				0.069
Normal	186 (62.4)	184 (69.7)	370 (65.8)	
Overweight	69 (23.2)	41 (15.5)	110 (19.6)	
Obese	43 (14.4)	39 (14.8)	82 (14.6)	
Hours of TV viewing per day				0.156
≤3	254 (85.8)	214 (82.3)	468 (84.2)	
>3	42 (14.2)	46 (17.7)	88 (15.8)	
Milk intake				0.230
No	50 (17.1)	37 (14.4)	87 (15.8)	
Yes	243 (82.9)	220 (85.6)	463 (84.2)	
HSF snacks				0.540
No	221 (76.5)	195 (76.5)	416 (76.5)	
Yes	68 (23.5)	60 (23.5)	128 (23.5)	
Caloric beverage intake				
CSD				0.322
None	141 (48.8)	133 (52.0)	274 (50.3)	
1–5 glasses	132 (45.7)	103 (40.2)	235 (43.1)	
>5 glasses	16 (5.5)	20 (7.8)	36 (6.6)	
Coffee/tea/cocoa				0.327
No	166 (57.0)	138 (54.8)	304 (56.0)	
Yes	125 (43.0)	114 (45.2)	239 (44.0)	
Fruit drink				0.241
No	190 (66.0)	158 (62.7)	348 (64.4)	
Yes	98 (34.0)	94 (37.3)	192 (35.6)	
Flavored water				0.396
No	238 (81.5)	211 (82.8)	449 (82.1)	
Yes	54 (18.5)	44 (17.3)	98 (17.9)	
Fruit juice				0.353
No	250 (86.2)	216 (84.7)	466 (85.5)	
Yes	40 (13.8)	39 (15.3)	79 (14.5)	
Noncaloric beverage intake				
Water				0.628
None	56 (19.3)	43 (16.9)	99 (18.2)	
1–5 glasses	139 (47.9)	132 (51.8)	271 (49.7)	
>5 glasses	95 (32.8)	80 (31.4)	175 (32.1)	

HSF, high salt and fat; CSD, carbonated soft drink.

A total of 562 children 2.1 to 6 years of age participating in Maternal Child Health Programs in Northwest Argentina, 2014.

P values refer to Fisher's exact test of variables by sex ($P < 0.05$).

16.4% had only up to elementary instruction and 62.1% had a waist circumference of >80 cm. The nutritional status of children was as follows, 65.8% with normal weight, 19.6% with overweight and 14.6% with obesity. A 15.8% of children watched TV for >3 h/day and 23.5% consumed HSF snacks. The percentage of children drinking the different types of beverages were as follows: water 81.8%, CSD 49.7%, coffee/tea/cocoa 44.0%, fruit drinks 35.6%, flavored water 17.9% and fruit juice 14.5%. The percentage of children drinking more than five glasses of fruit drinks (3.3%), flavored water

Table 2. *Characteristics of the sample by nutritional status*

	Normal weight (n = 370) (65.8%)	Overweight (n = 110) (19.6%)	Obesity (n = 82) (14.6%)	P value
Mother's characteristics				
Age in years				0.948
≤30	232 (65.5)	69 (19.5)	53 (15.0)	
>30	135 (66.5)	40 (19.7)	28 (13.8)	
Marital status				0.055
Single/divorced/widowed	88 (58.3)	35 (23.2)	28 (18.5)	
Married/living with partner	279 (69.1)	72 (17.8)	53 (13.1)	
Education				0.161
Elementary or less	54 (60.7)	16 (18.0)	19 (21.3)	
Any high school	264 (68.6)	73 (19.0)	48 (12.5)	
Any technical/university	40 (58.8)	16 (23.5)	12 (17.7)	
Employment status				0.144
Employed	58 (58.6)	25 (25.3)	16 (16.2)	
Not employed/student	232 (67.4)	58 (16.9)	54 (15.7)	
Informal work/unemployed	78 (68.4)	25 (21.9)	11 (9.6)	
Waist circumference				0.563
≤80 cm	141 (68.5)	36 (17.5)	29 (14.1)	
>80 cm	216 (63.9)	70 (20.7)	52 (15.4)	
Children's characteristics				
Sex				0.069
Boys	186 (62.4)	69 (23.2)	43 (14.4)	
Girls	184 (69.7)	41 (15.5)	39 (14.8)	
Age in years				0.117
2.1–4	179 (63.0)	55 (19.4)	50 (17.6)	
5–6	191 (68.7)	55 (19.8)	32 (11.5)	
Hours of TV viewing per day				0.008*
≤3	320 (68.4)	88 (18.8)	60 (12.8)	
>3	46 (52.3)	21 (23.9)	21 (23.9)	
Milk intake				0.653
No	54 (62.1)	19 (21.8)	14 (16.1)	
Yes	309 (66.7)	87 (18.8)	67 (14.5)	
HSF snacks				0.654
No	277 (66.6)	81 (19.5)	58 (13.9)	
Yes	82 (64.1)	24 (18.8)	22 (17.2)	
Caloric beverage intake				
CSD				0.044*
None	190 (69.3)	56 (20.4)	28 (10.2)	
1–5 glasses	150 (63.8)	43 (18.3)	42 (17.9)	
>5 glasses	20 (55.6)	7 (19.4)	9 (25.0)	
Coffee/tea/cocoa				0.248
No	207 (68.1)	59 (19.4)	38 (12.5)	
Yes	151 (63.2)	46 (19.2)	42 (17.6)	
Fruit drinks				0.348
No	238 (68.4)	64 (18.4)	46 (13.2)	
Yes	120 (62.5)	40 (20.8)	32 (16.7)	
Flavored water				0.507
No	320 (66.8)	82 (18.3)	67 (14.9)	
Yes	62 (63.3)	23 (23.5)	13 (13.3)	
Fruit juice				0.918
No	310 (66.5)	89 (19.1)	67 (14.4)	
Yes	51 (64.6)	16 (20.3)	12 (15.2)	
Noncaloric beverage intake				
Water				0.000*
None	53 (53.5)	23 (23.2)	23 (23.2)	
1–5 glasses	176 (64.9)	50 (18.5)	45 (16.6)	
>5 glasses	131 (74.9)	33 (18.9)	11 (6.3)	

HSF, high salt and fat; CSD, carbonated soft drink.

A total of 562 children 2.1 to 6 years of age participating in Maternal Child Health Programs in Northwest Argentina, 2014.

P values refer to Fisher's exact test of variables by nutritional status ($P < 0.05$).

(3.1%), fruit juice (1.3%) and coffee/tea/cocoa (0.9%) (data not shown) was half or less than the percentage drinking more than five glasses of CSD (6.6%). About a third of the children (32.1%) were drinking more than five glasses of water. Hours of TV viewing ($P = 0.008$), drinking CSD ($P = 0.044$) and water intake ($P = 0.000$) were significantly associated with nutritional status (Table 2). Figure 1 shows obesity rates by CSD intake and by water intake. Obesity rates increased significantly with increased CSD intake (10.2, 17.9, 25.0%), and decreased with water consumption (23.2, 16.6, 6.3%).

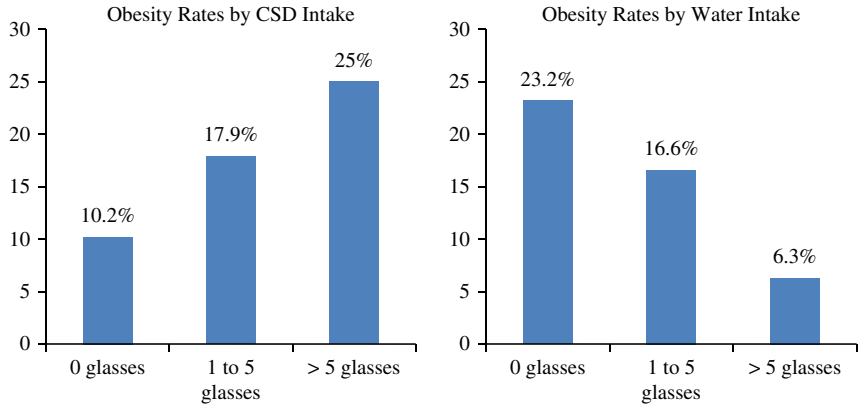

Fig. 1. Obesity rates by CSD and by water intake. A total of 562 children 2.1 to 6 years of age participating in Maternal Child Health Programs in Northwest Argentina, 2014. The *P* value of the Fisher's exact test was 0.048 for obesity by CSD intake and 0.001 for obesity by water intake. CSD, carbonated soft drink.

Table 3. *Multivariate logistic regression of nutritional status by beverage intake, sociodemographic and behavioral factors*

CSD	Obesity/overweight *v.* normal weight [OR (95% CI)]	Water	Obesity/overweight *v.* normal weight [OR (95% CI)]
None *v.* 1–5 glasses	1.3 (0.9–2.0)	None *v.* 1–5 glasses	0.7 (0.4–1.1)
None *v.* >5 glasses	1.8 (0.8–4.1)	None *v.* >5 glasses	0.4 (0.2–0.8)*
CSD	Obesity *v.* overweight/normal weight [OR (95% CI)]	Water	Obesity *v.* overweight/normal weight [OR (95% CI)]
None *v.* 1–5 glasses	2.2 (1.2–4.0)*	None *v.* 1–5 glasses	0.7 (0.4–1.2)
None *v.* >5 glasses	3.5 (1.3–9.6)*	None *v.* >5 glasses	0.3 (0.1–0.6)*

HSF, high salt and fat; CSD, carbonated soft drink.

A total of 562 children 2.1 to 6 years of age participating in Maternal Child Health Programs in Northwest Argentina, 2014.

The models controlled for mother's age, marital status, education level, employment status, waist circumference and for child's sex, age, TV viewing, HSF snacks and milk intake. *$P < 0.05$.

In multivariate logistic regression models with overweight and obesity *v.* normal weight as the outcome variable, drinking CSD was not a significant risk factor, but drinking more than five glasses of water was protective (OR 0.4; 95% CI 0.2–0.8) (Table 3). When using obesity *v.* overweight or normal weight as the outcome, the likelihood of being obese doubled among children who consumed one to five glasses of CSD (OR = 2.2; 95% CI 1.2–4.0) and increased by more than three-fold among those who consumed more than five glasses (OR = 3.5; 95% CI 1.3–9.6), showing a dose–response relationship. On the other hand, drinking more than five glasses of water decreased the likelihood of being obese by less than half (OR = 0.3; 95% CI 0.1–0.6). When assessing obesity and overweight *v.* normal weight, TV viewing was a significant risk factor in models with the CSD exposure variable (OR = 2.0; 95% CI 1.2–3.3) and in models using water as the exposure variable (OR = 1.8; 95% CI 1.1–3.0) (data not shown). Multivariate logistic regression models using fruit drinks, fruit juice, flavored water or coffee/tea/cocoa as separate, binary (yes/no) exposure variables did not yield significant results.

Discussion

This study is the first to analyze the relationship of caloric and noncaloric beverage intake, and childhood obesity in Latin America. About half the children in our sample consumed CSD and almost 20% did not drink water. In multivariate models we found a dose–response relationship between CSD consumption and obesity, while consumption of more than five glasses of water was protective, even after accounting for sociodemographic and behavioral factors. The lack of a significant association of other SSB with nutritional status may be due to the lower intake volume of these beverages, compared with CSD or water.

Our results showing an association between CSD intake and obesity are in agreement with published cross-sectional[21] and longitudinal studies[27] and with a randomized intervention trial.[38] The results differ, however, from the cross-sectional study of O'Connor Young and Nicklas[22] and from the prospective study of Newby *et al.*[26] An inverse association of water intake with obesity was ascertained in the randomized trial

conducted in Germany among elementary school children, by Muckelbauer *et al.*[37] Drinking water as a protective factor for obesity in children has not been reported previously in Latin America. This finding provides support for recommendations encouraging the replacement of CSD with noncaloric beverages.[19,61,62]

CSD intake is thought to lead to weight gain because of the high added sugar content and low satiety of these beverages.[63–65] The rapidly absorbable carbohydrates may also increase risk of type 2 diabetes mellitus, as a potential contributor to a high dietary glycemic load leading to insulin resistance and impaired β-cell function.[17,63,66–68] Furthermore, analysis of gene–SSB interactions suggest that regular consumption of CSD exacerbates the genetic risk of obesity, and that persons with a greater genetic predisposition to obesity may be more susceptible to the deleterious effects of SSB on BMI.[18,69] Thus, genetic predisposition to obesity could be partly offset by healthier beverage choices.

Our study has several limitations. One refers to the cross-sectional design that precludes assessment of causal effects. Another is that the data collected on beverage intake and other behavioral factors was reported by the mothers and the accuracy of the information may not be optimal. Although we were able to ascertain significant associations between beverage consumption and nutritional status, we conducted only one 24-h dietary recall and the data may not represent habitual consumption. Future studies should aim to confirm these results using more than one nonconsecutive 24-h recall. There is an ongoing discussion referring to the choice of reference values to determine children's nutritional status. Our choice was guided by results of comparative studies conducted in Argentina.[57,70] In our sample, we found no significant differences between the prevalence of overweight and obesity using the IOTF and the WHO standards. The anthropometric data of children was obtained from clinic registries rather than measured by our interviewers on the basis that the quality of this data is systematically ascertained by internal and external auditors. Children in our sample did not drink large amounts of beverages other than CSD or water. Therefore, we could not evaluate the relationship between obesity and high intake of other SSB. Changes in the intake patterns of these other types of beverages should be monitored across time to address potentially detrimental health effects.

Conclusion

In conjunction with results from more robust longitudinal studies and intervention trials conducted in other world regions, our study contributes with evidence for reducing children's CSD intake and for promoting water consumption. In concordance with the life-course approach, interventions within maternal-child health programs of the Primary Health Care System, can play an important role in the prevention of childhood obesity.[19] The life-course approach postulates that interventions in early life, when biology is most amenable to change, are likely to have sustained effects on health because they can influence responses to later challenges such as living in an obesogenic environment.[71] In addition to focalized interventions, WHO proposes the implementation of population-wide strategies to reduce SSB intake, including improved labeling, regulating sugar content, banning advertising and marketing to children, and bringing preschool food and nutritional supplement programs up to recommended standards.

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Conflicts of Interest

None.

Ethical Standards

This research complied with the ethical principles for research with human subject of the World Medical Association Declaration of Helsinki, Finland, June 1964 and the 1975, 1983 and 1898 amendments.

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