

Original

Is soft drink consumption associated with body composition? A cross-sectional study in Spanish adolescents

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Abstract

Objectives: Published data about the association between the consumption of sweetened soft-drinks (SSD) and obesity in childhood are controversial and still inconsistent. In addition, data are lacking in the Spanish population. The purpose of this study was therefore, to explore the cross-sectional association between body composition-related parameters and SSD consumption in Spanish adolescents.

Subjects and methods: A representative sample of 1,523 adolescents (768 boys and 755 girls), with complete dietary data as well as anthropometric measurements, were included in this study. Weight, height, waist circumferences, and 6 skinfolds were measured, and BMI and percentage body fat were calculated. From a 24h dietary recall the subjects were grouped in 3 groups according to their SSD consumption: 1) Non-consumers (0 g of SSD consumption); 2) Moderate consumption (< 336 g/day of SSD, equivalent to the average SSD portion size); and 3) High consumption (> 336 g/day of SSD).

Results: 67% males and 75% females did not consume any SSD the day before the dietary recall interview. Males consumed more SSD than females. Regarding the association between SSD consumption and measures of obesity, no difference was observed between the three groups of SSD consumption in any of the anthropometric measurement, BMI or body fat.

Conclusion: As no association was present between SSD consumption and obesity in our cross-sectional study we suggest that dietary patterns and habits as well as lifestyle factors such as physical activity should be pre-

¿SE ASOCIA EL CONSUMO DE REFRESCOS AZUCARADOS CON LA COMPOSICIÓN CORPORAL? ESTUDIO TRANSVERSAL EN ADOLESCENTES ESPAÑOLES?

Resumen

Objetivos: Los datos publicados sobre la asociación entre el consumo de refrescos azucarados (SSD) y la obesidad en la infancia son controvertidos y todavía inconsistentes. Además, estos datos son muy escasos en la población española. Por ello, el propósito de este estudio ha sido estudiar la asociación entre los parámetros relacionados con la composición corporal y el consumo de SSD en adolescentes españoles.

Sujetos y métodos: Se ha realizado el estudio en una muestra de 1.523 adolescentes (768 chicos y 755 chicas) que tenían cumplimentados los datos dietéticos y los parámetros antropométricos (peso, altura, circunferencias de cintura, y 6 pliegues). Se calculó el IMC y el porcentaje de grasa corporal. La dieta ha sido calculada a partir de un recordatorio de 24h. Los sujetos fueron divididos en grupos dependiendo de la cantidad de SSD que consumían: 1) No consumidores (0 g de consumo SSD); 2) Consumo moderado (< 336 g/día de SSD, equivalente a una bebida al día de SSD); y 3) Consumo alto (> 336 g/día de SSD).

Resultados: El 67% de los varones y el 75% de las mujeres indican no consumir este tipo de bebidas el día anterior a la encuesta. Los varones en general consumieron más SSD que las mujeres. En cuanto a la asociación entre consumo SSD y medidas antropométricas y de composición corporal, no se encontraron diferencias significativas entre los tres grupos de estudio en los parámetros antropométricos, IMC o grasa corporal.

Conclusión: Dado que no se ha encontrado en este estudio ninguna asociación entre el consumo de SSD y la obesidad, sugerimos que los patrones y hábitos dietarios así como los factores del estilo de vida, y la actividad física, deberían tenerse en cuenta al examinar las relaciones transversales o longitudinales con la obesidad, y que los

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sent when examining cross-sectional or longitudinal relationships with obesity. Multidisciplinary intervention studies are crucial when trying to develop solutions against the increasing obesity epidemic.

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Key words: *Soft-drink intake. Obesity. Adolescents.*

Introduction

The prevalence of obesity is increasingly recognized as a global health problem in developed countries.^{1,2} Obesity in childhood and adolescents, in particular, is a major concern due to the fact that physical and psychosocial problems are among the short-term adverse effects and associated risks from obesity in the early stages of life³ and because obesity tends to track over time.^{4,5} Certain lifestyle habits, such as unhealthy dietary habits and physical inactivity are obesity risk factors and may also be established during childhood and adolescence.⁶

The current high intake of sugar-sweetened beverages such as calorie-sweetened soft drinks (SSD) has been proposed to contribute importantly to the calorie intake excess which is the most important factor underlying the development of obesity. The evidence from nationally representative surveys in USA shows that both portion sizes and the number of servings of these beverages have increased. Therefore, according to some authors⁷ in the reduction of the calorie intake, the decrease in the consumption of calorically sweetened soft drinks should be part of the solution.

Published data about the association between the consumption of SSD and obesity is still controversial and inconsistent. Although soft drinks had long been suspected to contribute at least partially to the obesity epidemic, only very recently epidemiological studies have begun to investigate the direct relationship between soft drink consumption and long-term weight gain. Some studies have reported positive relations between sugar-sweetened beverage consumption and obesity in Spanish adults and adolescents.^{8,9} However, other studies have established a weak or no relationship between obesity and sugar-sweetened beverage consumption in children and adolescents,^{10,11} including a study evaluating sucrose intake from sugary beverages where sugar and sucrose consumption were not related to BMI.¹² Controversial results may arise from differences in the design of the studies (characteristics of participants, sample size, statistical power, etc.), methodology bias in self-reported data, lack of attention to confusion variables, among other factors.

Therefore, further research is needed to elucidate if SSD consumption is related to or cause obesity. The purpose of this study was to explore the cross-sectional association between body composition-related para-

estudios de intervención multidisciplinar son cruciales cuando se trata de desarrollar soluciones contra el incremento de una epidemia como la obesidad.

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Palabras clave: *Consumo de refrescos azucarados. Obesidad. Adolescentes.*

meters and SSD consumption in a representative sample of Spanish adolescents.

Subjects and study design

The final number of subjects included in the AVENA Study was 2,859 from which 1,523 adolescents (768 boys and 755 girls) were included in this study (table I), who completed dietary data as well as anthropometric measurements. The methodology of the AVENA study has been described elsewhere¹³⁻¹⁵. Briefly, a multicenter study was performed involving a representative sample of urban Spanish adolescents aged 13 to 18.5 years. The population was selected by multiple-step, simple random sampling —first taking into account location (Madrid, Murcia, Granada, Santander and Zaragoza) and then by random assignment of the school within each city. The cities were chosen according to the population rate (> 100,000 inhabitants), geographical location in the country (north-south gradient, in order to be representative) and taking into account the main technical question, that is, the necessity of having a research group in the city. Sample size was stratified by age and gender. The socio-economic variable was considered to be associated to location within the city and type of school. As the selection of schools was done by random selection proportionally to the number of schools in each city district, the socio-economic variable was also considered to be randomly assigned. After analysis of the data, this method has proven to be adequate, since the socio-economic status of our sample has a normal distribution according to the distribution in the Spanish society (data not shown).

The study was conducted in accordance with the ethical rules of the Helsinki Declaration (Hong Kong revision, September 1989), following the EEC Good

Table I
Descriptive characteristics of the study sample

	Boys (n = 768)	Girls (n = 755)
Age (y)	15.4	15.4 ± 1.5
Weight (kg)	64.1	56.5 ± 9.8
Height (m)	171.2	161.8 ± 6.0

Figures are means ± standard deviation.

Clinical Practice guidelines (document 111/3976/88 of July 1990) and current Spanish law which regulates clinical research in humans (Royal Decree 561/1993 regarding clinical trials). The protocol for the complete multicenter study was approved by the Review Committee for Research Involving Human Subjects from the Marqués de Valdecilla University Hospital (Santander, Spain).

Dietary assessment

One 24-h diet recall by subject was used for the dietary assessment. The 24-h recalls were administered throughout the year in order to avoid the influence of seasonal variations and to avoid bias brought on by day-to-day intake variability; the questionnaires were administered homogeneously from Monday to Friday. We used a nutrient database software.¹⁶ The subjects were asked to recall what they had eaten and drunk, from breakfast to bedtime the previous day. The whole class was asked for hints such as “did you use spread on the bread”, “don’t forget what you drank”, “remember to write if you added sugar”, “did you have any snack/drink when you returned home from school/while watching TV?” etc., and any doubt was solved between the student and the interviewer. All interviewers were trained according to a standardised protocol to assist with portion size estimations and followed the same procedure. When the data from the recalls were entered into the computer amounts of each food were pre-determined for all possible serving sizes, so the risk of different interpretations of food portion quantities by different interviewers was eliminated. SSD were defined as caloric soft drinks, colas, and isotonic drinks. Diet soft drinks (without sugar) were not included in the analysis.

The subjects were grouped according to their SSD consumption: 1) Non-consumer group was defined as that who did not consume any type of SSD (0 g); 2) Moderate consumer group was defined as that who consumed < 336 g/day of SSD (equivalent to the average SSD portion size); and 3) High consumer group was defined as that who consumed > 336 g/day of SSD.

Anthropometric assessment

Two anthropometry experts performed all the measurements in each city; one of them measured weight, height and circumferences, and the other one was in charge of measuring skinfolds.¹⁷ Body mass index (BMI) was calculated as body weight (kg) without shoes and with light clothing, divided by height (m) squared. Body weight was measured to the nearest 0.05 kg using a standard beam balance. Skinfold thicknesses were measured at the left side of the body¹⁸ to the nearest 0.1 mm using a Holtain skinfold caliper, at the following sites: 1) triceps, halfway between the acromion process and the olecranon process; 2) biceps, at the same level as the tri-

ceps skinfold, directly above the centre of the cubital fossa; 3) subscapular, about 20 mm below the tip of the scapula, at an angle of 45 degrees to the lateral side of the body; 4) suprailiac, about 20 mm above the iliac crest and 20 mm towards the medial line; 5) thigh, in the midline of the anterior aspect of the thigh, midway between the inguinal crease and the proximal border of the patella; 6) calf, at the level of maximum calf circumference, on the medial aspect of the calf.¹⁸ Intraobserver reliability for skinfold thickness was higher than 95% for almost all the cases; interobserver reliability for skinfold thickness ranged from 83.05 for biceps skinfold to 96.38 for calf skinfold.¹⁸ The complete set of anthropometric measurements was performed three times, but not consecutively; we measured all the anthropometric variables in order, and then we repeated the same measurements two more times. Mean values were obtained from the three measurements. As an index of total adiposity, we calculated the sum of the six measured skinfold thicknesses (sum of 6 skinfolds) and circumference waist. Body fat percentage (BF%) was also calculated by the formulas previously described.¹⁹

Statistics

The sampling was determined for the distribution of BMI; the confidence intervals were established at 95% with an error ± 0.25 . After data collection was completed, the sample was adjusted by a weight factor in order to equilibrate the sample in accordance to the distribution of the Spanish population (source: The Spanish National Institute for Statistics) and to guarantee the real representativeness of age and gender. Statistical analyses were performed using the SPSS statistical software release 14 for windows XP. The differences in groups were compared by ANOVA and post hoc multiple test (Bonferroni) was used to test differences between pairs of groups. Statistical significance was set a $P < 0.05$.

Results

A total of 1,523 adolescents (768 boys and 755 girls) from the AVENA study (table I), with valid and complete dietary data as well as anthropometric measurements, were included in this study and had a mean age (SD) of 15.4 (1.4) and 15.4 (1.5) years, respectively. Mean SSD consumption in the studied population, according to gender and age groups are presented in table II. Males consumed more SSD than females in all age groups. While there were no significant differences in SSD consumption between age groups in male adolescents, in females, however, the age group of 15 years showed lower values compared to the age group of 16 years that consumed the highest amounts of SSD (table II). As shown in table III, 67% males and 75% females did not consume any SSD the day before the dietary recall interview.

Table II
SSD consumption (g/day) according to gender and age groups

	Boys (n = 768)	Girls (n = 755)
13 years	164.5 ± 274.2 (n = 145)	113.5 ± 213.7 ^{ab} (n = 145)
14 years	157.8 ± 283.5* (n = 132)	81.1 ± 179.5 ^{ab} (n = 130)
15 years	160.5 ± 257.3* (n = 179)	71.6 ± 150.8 ^a (n = 155)
16 years	179.5 ± 297.3 (n = 148)	145.0 ± 314.7 ^b (n = 155)
17-18.5 years	110.2 ± 217.3 (n = 164)	89.0 ± 175.1 ^{ab} (n = 170)

Figures are means ± standard deviation. SSD means sweetened soft drinks.

P > 0.05 between year groups within each gender.

P > 0.05 between genders within each age.

Regarding the association between SSD consumption and measures of obesity, no difference was observed between the three groups of SSD consumption in any of the anthropometric measurement, BMI or calculated body fat (table IV). To examine the potential that we made a type II error, we performed a posthoc power calculation using the data from the final sample size and determined that we had 80% power to detect differences in BMI.

Discussion

Indeed childhood and adolescent obesity is a major public health concern. Spain has one of Europe's highest prevalence of overweight and obese children and

Table III
SSD consumption (g/day) in each of the studied groups

	Non-consumer	Moderate consumer	High consumer
Boys (n = 768)	0 (n = 511)	228.3 ± 78.5 (n = 65)	535.1 ± 265.4 (n = 192)
Girls (n = 755)	0 (n = 568)	206.3 ± 83.7 (n = 74)	512.6 ± 261.5 (n = 113)

Figures are means ± standard deviation. SSD means sweetened soft drinks.

adolescents. The AVENA study, which the subjects of this report belongs to, reveals alarmingly high overweight + obesity prevalence of 25.69% and 19.13% and obesity prevalence of 5.68% and 3.08% for males and females, respectively (Moreno et al., 2005). There is no doubt that the cause of obesity during childhood is multidisciplinary.²⁰

Nevertheless have single foods such as SSD been proposed to contribute importantly to the calorie intake excess and to represent an important factor underlying the development of obesity. This hypothesis is enforced by the fact that the obesity epidemic has gone parallel with the increasing trend of sugar-sweetened beverage consumption between 1977 and 1997 (68% for carbonated soft drinks and 42% for fruit juices).^{21,22} To test this hypothesis, several studies have investigated this association among older children, adolescents and adults but have obtained inconsistent results.²³⁻²⁹ Addressing this inconsistency in published results, at least two recent meta analysis^{30,31} and several comprehensive reviews have been published.³²⁻³⁴ Generally the conclusion was that scientific evidence that consumption of sweetened beverages makes a unique contribution to the risk of weight gain and obesity is weak or

Table IV
Mean descriptive characteristics of the adolescents tested according to gender, anthropometric parameters and SSD consumption

		Non-consumer	Moderate consumer	High consumer
Age (years)	Boys	15.42 ± 1.5	15.16 ± 1.4	15.25 ± 1.4
	Girls	15.45 ± 1.4	15.37 ± 1.5	15.40 ± 1.5
BMI (kg/m ²)	Boys	21.8 ± 3.6	21.9 ± 3.7	21.7 ± 3.6
	Girls	21.6 ± 3.4	21.4 ± 2.9	21.3 ± 3.7
Waist circumference (cm)	Boys	76.8 ± 9.5	77.9 ± 9.9	77.6 ± 9.6
	Girls	71.6 ± 8.1	70.6 ± 6.8	71.5 ± 8.9
Sum of 6 skinfolds (mm)	Boys	75.1 ± 36.36	76.3 ± 38.0	73.7 ± 37.1
	Girls	102 ± 32.4	98.1 ± 30.1	98.5 ± 32.2
Body fat (%)	Boys	19.8 ± 9.7	20.3 ± 10	18.9 ± 9.4
	Girls	26.1 ± 6.5	24.9 ± 6.1	24.1 ± 6.5

Figures are means ± standard deviation.

equivocal.^{31,32,34} Very recently a quantitative meta-analysis and qualitative review concluded that the association between sugar-sweetened beverage consumption and BMI was near zero.³¹

We found no differences in BMI between subjects having a moderate or even high consumption of SSD compared to the non-consumers in our study. This observation is in consonance with several other studies,^{11,31,35-37} while in discordance to others which did report a significant positive association between this type of drinks and obesity.^{24-27,38}

It is important to identify the causal relationship, and this can not be done in a cross-sectional study. Furthermore, not all positive studies reported a dose-response relation between the outcome and exposure³⁸. In another study, children who consumed > 492 g/day of sweetened drink gained more weight (1.12 ± 0.7 kg) than did children who consumed 186-492 g/day of sweetened drink ($0.32-0.48 \pm 0.4$ kg) but none of these differences were statistically significant.²³ In regard to body fat percentages, this value was not either associated with SSD consumption in our study, which is in consonance with the results from a soft drink consumption study.²⁶

In all age groups we found that males consumed more SSD than females. It is to note that overweight and obesity prevalences are higher in males than in females, in our study sample,¹⁴ but this is not a recurring result as the consumption of non-alcoholic carbonated beverages was higher in male adolescents in a population with higher overweight prevalence in females.³⁹

On the other hand, SSD group tended to increase in males reaching the highest consumption at the age of 15-16 years and then to decrease. In females this increase is significant at the age of 16 years. We suggest that this age group of 15-16 years is the most critical period during adolescence, when the teens decide more themselves and start to make changes in their dietary patterns.

Our study has limitations. While the sample size is large and the statistical power assures high quality of data, we should acknowledge the difficulties and methodology biases that self-reported data present. Difficulty in assessing food intake especially in young people is a fact.⁴⁰ As well it's a fact that overweight and obese people tend to under-report their food consumption, and especially what they believe is considered unhealthy foods.⁴¹

Conclusion

Our results conclude that in the studied population no association seems to be present between SSD consumption and obesity, and we suggest that a dietary pattern approach is more convenient in order to investigate the associations between diet and obesity. Not only dietary patterns are important, but also dietary habits and physical activity should always be taken into account when examining cross-sectional or longitudinal

relationships with obesity, and intervention studies are crucial when trying to identify solutions of the increasing obesity epidemic.

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AM, SG-M and JR contributed to the study design; SG-M and JR performed the data collection; all authors were involved in data analysis and interpretation of results and to writing the manuscript. We thank Laura Barrios for her valuable assistance with the statistical analysis of the data.

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