A Cohort Analysis Between Artificially Sweetened Beverages' Consumption And Weight Gain Risk Among Uk Children: A Prospective Study

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Abstract

Objective: The modern lifestyle raises serious concerns about the quality and variety of food available, and it has been suggested that increased intake of sweetened and artificially sweetened beverages may be a contributing cause to obesity. The goal of this study was to look into the contentious claim that children in the UK who consume artificially sweetened drinks (ASB) had higher risk of overweight and obesity.

Method: Data were gathered from the Millennium Cohort Study (MCS), and secondary analysis was carried out, including bivariate analysis on 12,871 kids and multinomial regression for obesity on 8,838 kids. The consumption of ASBs was recorded as exposure, and overweight or obesity was chosen as the outcome variable. Children who were already overweight or obese at the beginning of data collection were not included in the regression analysis. This group of children was followed up prospectively for 5 years, ending with the MCS wave.

Results: Children who consumed ASB more than once a day had a 39% greater risk of being overweight compared to non-consumers (RRR=1.45; CI: 1.16-1.80), and an almost 4 times higher risk of being obese compared to children who did not drink ASB more than once per day (RRR=3.96; CI: 1.50-10.47).

Conclusion: This study concluded that there is significant relationship in ASB consumption and risk of getting overweight/obese when observed prospectively.

Keywords: Artificially Sweetened Beverages, Artificial Sweeteners, Childhood Obesity, Millennium Cohort Study.

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Introduction

Childhood obesity is titled as world-wide epidemic or pandemic and fosters an ever-expanding concern among public health professionals and health policy makers.[1] The phenomenon of increase in childhood obesity is observed not only among developed countries but also among developing countries[2,3] and this leads to enthralling emphasis on research in this domain. An extensive epidemiological study on obesity in children and young people estimated that approximately 10% of the school-aged children to be overweight or obese world-wide. Around the globe, 170 million children were considered to be classified either overweight or obese.[4] Large nationally representative surveys indicated high prevalence of obesity was found, as low as 11% and as high as 34%, in European countries.[5] Epidemiological evidence of Sugar sweetened beverages (SSB) related with the risk of obesity is well established. Obesity and related chronic diseases had shown an upsurge

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in prevalence globally.[6,7] Simultaneously, temporal patterns in increased global use of SSB showed a close parallel with these diseases.[8] However, the simultaneous rise in consumption of artificially sweetened beverages is also reported making their controversial role in obesity more questionable.[9] Artificial sugars were extensively consumed by diabetic patients and healthy individuals on doctors' and dietitians' recommended sugar restricted diets. Pharmacological names of commonly used artificial sweeteners are Saccharin, Cyclamate, Aspartame, Neotame and Sucralose etc. These compounds belong to multiple groups or categories of nutrition supplements with variety of routes of metabolization.[10] Pharmacologically, these artificial sweeteners do not have good safety profile as well.[11] Considering their involvement in risk of obesity, artificial sweeteners and weight gain are well connected[10,12,13] as evident by studies on albino rats and review articles. However, the longitudinal effect of artificial sweeteners on weight gain among human is not well established. These artificial sweeteners are added in beverages with the aim of furnishing the appetency of sweetness but not adding up the calories. However, their role in health stands controversial as large cross-sectional and longitudinal studies done on children have proclaimed positive association between their consumption and obesity but on the contrary, small scale Randomized Trials with insufficient strength, have found little association between ASB consumption and weight gain.[14] Current scientific literature is found deficient to provide consistent evidence about the association between ASBs and obesity. Most of the observational studies are show clear associations between ASB consumption and obesity. But observational studies are considered to be weaker in the hierarchy of evidence. On the other hand, most RCTs did not find causal role of ASBs in the development of obesity. Similarly, systematic reviews and meta-analysis provided mixed results because of researches with conflicted outcomes. This study was carried out with the aim of evaluating the evidence between ASB consumption and obesity among children, using cohort study design.

Material and Methods

The Millennium Cohort Study (MCS) was carried out as prospective cohort study of UK children. This study was essentially Prospective Cohort in its nature as the children were first assessed on baseline and then they were followed up after five years. This study followed multiple life aspects of over 13,000 children with the consent of parents of the children. Ethical clearance from Research Ethical Committee (REC) was acquired for collection of data of main surveys[15] and it was obtained from University of London. The data was available in anonymized state and freely available for academic use, which doesn't need any copy-write approval[22]. The data was obtained from MCS and secondary analysis was done using STATA 12.0. Data collection was done using face-to-face interviews, house-hold questionnaires, cognitive assessments and physical measurements taken by experts. Overweight/Obesity was selected as outcome variable. This variable was derived from Body Mass Index (BMI) which was calculated from cohort members' weights and heights. The apparatus used to measure Height was Leicester Stadiometer and the appliance used to measure weight and body fat percentage was Tanita BF-522W. Children's BMI is classified as overweight or obese utilizing thresholds that change according to child's age and sex. The thresholds are deduced from a reference population called Child Growth Reference. It consisted of 3 categories: Healthy weight, Over-weight and Obese. These categories were graded using BMI which was calculated from cohort members' weights and heights. Exposure of ASBs' consumption was recorded and categorized into 7 categories. This measure encompasses the frequency of sugary drink consumption in cohort members as reported by the main respondent and confirmed by parents. Following covariates were included in the analysis: Gender, Ethnicity, Equalized Income Quantiles, Mothers' education level, Physical activity of cohort member. Income data was collected through information on multiple measures of main carer's and partner's total take-home income and savings. Some of these measures were gross earning, net earnings, earning from second job or occasional work, housing benefits, net benefits, state pensions, income support, working tax credits etc. Modified OECD scales were applied to equivalise the family income. Modified OECD scales adjust take-home income according to family size (1 parent and one child under 14). This variable has been categorized into 5 quintiles of equivalized family income.

Bivariate analysis was carried out between the outcome and exposure and multiple covariates to assess the crude association. This analysis was executed to find out the prevalence of overweight and obesity among different categories of variables without adjustment. Chi square test was used for test of significance in bivariate analysis. To over-rule under-representation bias and over-

representation bias in sampling methods, survey weights were administered before running this analysis.[16] Regression analysis was done to evaluate the effects of beverage consumption for children who had been a healthy weight at early childhood and start of MCS sweep. This analysis excluded the children who were already overweight or obese at the start of data collection. This subsample of children was observed prospectively over the period of 5 years and by the end of wave of MCS, observations were taken again. P-value of less than 0.05 was set for significance level testing.

Results

The prevalence of obesity among different categories of exposure variables and covariates are shown in Table 1. Bivariate analysis was conducted on 12,871 partici-pants using survey weights to account for the complex sampling design. Bivariate analysis showed that girls were significantly more likely to be overweight or obese than boys. ASB consumption showed a strong association with obesity. The prevalence of overweight and obese grew considerably as frequency of ASB consumption increased. Chi-squared test showed significant trend in obesity associated with ASB. Mothers' education appeared to be a significant protective factor against obesity. Analysis showed that on average, obesity was less prevalent in the higher the mother's education level. Socio-economic factors (ethnicity, equivalised income quintiles and parental social class) were significantly associated with obesity in bivariate analysis. Physical activity was also significantly associated with obesity. Children frequently involved in physical activity were less likely to be overweight and obese. Among children involved in 5 or more days of physical activity only 3.18% were obese, while obesity percentage among physically inactive children was 8.36%.

Table 2 presents multi-nominal regression analysis of children who were not overweight or obese at the age of 7. This analysis was carried out to reduce the possibility of reverse causation, as it might be that parents bought artificially sweetened drinks for children who were already overweight to reduce their sugar intake. After removing overweight and obese children in the sample, 8,838 children were included in this analysis.

Table presents the fully adjusted multinomial regression models. The Relative Risk Ratio (RRR) of being overweight or obese increased with increased exposure to ASB consumption frequency. ASB consumption was associated with an increased relative risk of being over-

Table 1: *Bivariate Analysis between Covariates and overweight/ obesity and BMI; Total Observations (N): 12,871*

Variables	Categories	Overweight/Obesity		
		Overweight n (Weighted %)	Obese n (Weighted %)	P-Value
Child's Gender	Male	1,273 (19.18)	417 (6.22)	<0.001
	Female	1,444 (22.91)	443 (6.65)	
Child's Age	10 Years	936 (21.57)	293 (6.77)	0.136
	11 Years	1,764 (20.61)	561 (6.25)	
	12 Years	17 (31.12)	6 (6.02)	
ASB Consumption	Never	466 (17.63)	117 (4.21)	<0.001
	1-2 days/week	417 (22.01)	119 (6.73)	
	3-6 days/week	243 (22.78)	80 (6.68)	
	Once a day	449 (21.85)	173 (7.59)	
	>Once a day	606 (23.44)	241 (8.84)	
	Missing	127 (21.53)	42 (6.06)	
Mother's Education	Post Grad Level	184 (18.09)	42 (3.15)	<0.001
	Degree Level	639 (17.95)	163 (3.97)	
	A Levels	241 (22.11)	57 (4.60)	
	GCSE Grade A-C	879 (22.95)	267 (6.60)	
	GCSE Grade D-E	265 (21.25)	112 (9.71)	
	Missing	12 (23.52)	6 (14.57)	
Child Ethnicity	White	2,194 (20.43)	669 (5.93)	<0.001
	Mixed	8 (23.66)	31 (9.79)	
	Asian	283 (23.53)	98 (6.59)	
	Black	117 (27.14)	52 (13.22)	
	Other Ethnic groups	40 (19.07)	9 (4.18)	
	Missing	0 (0)	1 (27.77)	
Equivalised IncomeQuintiles	Top Quintile	403 (17.84)	74 (3.09)	
	2nd Quintile	519 (20.56)	116 (4.23)	
	3rd Quintile	601 (22.62)	179 (6.48)	<0.001
	4th Quintile	585 (22.58)	252 (9.33)	
	Bottom Quintile	609 (20.99)	239 (8.25)	
Parental Social Class (Current Job)	Managerial & Professional	639 (19.88)	162 (4.23)	
	Intermediate	385 (19.24)	98 (4.96)	
	Small employer	175 (22.08)	54 (7.37)	
	Low Supervisory & Technical	60 (23.78)	23 (7.15)	<0.001
	Semi-routine & routine	546 (22.29)	149 (6.79)	
	Missing	1,002 (21.45)	374 (8.00)	
Frequency of Physical Activity	5 or more days/week	178 (17.20)	36 (3.18)	<0.001
	4 days/week	184 (17.37)	42 (4.09)	
	3 days/week	368 (18.91)	98 (4.61)	
	2 days/week	507 (18.98)	160 (6.25)	

weight and obese also among the children with healthy weight. Children consuming ASB more than once a day had a 45% increased risk of being overweight (RRR= 1.45; CI: 1.16-1.80), and an almost 4 times higher risk of being obese compared to non- consumers (RRR= 3.96; CI: 1.50-10.47).

Table 2: *Subsample Analysis Multinomial Regression for Obesity after Adjusting for all Variables. Observations N: 8,838*

Categories	ASB ConsumptionRRR (95% CI)	P-Value
Not Overweight+ Underweight		
Ref RRR: 1		
Overweight		
Never	Ref RRR: 1	
1-2 days/week	1.21 (0.65-1.54)	>0.05
3-6 days/week	1.33 (0.97-1.81)	>0.05
Once a day	1.34 (1.03-1.75)*	<0.05
>Once a day	1.45 (1.16-1.80)***	<0.001
Constant	0.07 (0.04-0.11)***	<0.001
Obesity		
Never	Ref RRR: 1	
1-2 days/week	3.89 (1.52-9.98)**	<0.01
3-6 days/week	1.66 (0.35-7.87)	>0.05
Once a day	2.39 (0.86-6.67)	>0.05
>Once a day	3.96 (1.50-10.47)***	<0.001
Constant	0.003 (0.00-0.02)***	<0.001

Discussion

The associations between ASB and overweight/ obesity were robust when tested in multi-nominal analysis which included only children who were not overweight or obese at the beginning of the study. The aim of this analysis was to see the impact of beverage consumption in healthy weight children in an attempt to rule out the possibility of reverse causation. The analysis showed that healthy weight children who consumed ASB more than once a day were approximately 50% more at risk of being overweight. The risk of being obese under exposure of frequent ASB consumption was 4 times higher than no ASB consumption. The plausible explanation behind weight gain in response to ASB consumption may be given by research studies revealing that childhood weight gain is attributed to developmental programming of metabolism and metabolic hormone secretion by direct or indirect exposure to artificial sweeteners[17]. However, more research is needed to fully understand the effects of artificially sweetened beverages on weight gain risk. The findings of reviews on link between artificial sweeteners and obesity also confirm that artificial sweeteners utilization leads to metabolic syndrome and obesity[18]. Study on metabolic effects of diet cola consumption in blood showed a similar rise in the blood glycemic levels as with consumption of glucose consumption and sweetened beverage consumption[19]. Another explanation behind the results of our study is that this weight gain may be due to a phenomenon called "compensation," where individuals who consume these types of beverages may feel they have "saved" calories and then overcompensate by consuming more calories later on. Additionally, some research suggests that artificial sweeteners may disrupt the body's natural ability to regulate calorie intake, leading to weight gain[21]. However, contrary to other studies, one study also reported contrasting results of showing no long term effects of aspartame consumption on glycaemia and appetite[20]. However, small sample size and study duration and not including regression analysis to neutralize the effects of confounding factors were the weaknesses of above mentioned study. This study's strengths included a large sample size of UK children and analyzing the impacts ASB consumption on a longitudinal and prospective pattern and use of multi-nominal regression modelling technique. In summary, our study provided a substantial evidence of effects of ASB consumption on risk of getting obese among the UK children.

Conclusion

This study indicated that among UK children in the Millennium Cohort Study, there was a significant positive correlation between the frequency of artificially sweetened beverages and a rise in the risk of getting overweight and obese. The frequency of physical exercise and maternal education were discovered to be protective factors against the UK children's BMI growth.

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Authors Contribution

MBA: Conceptualization of Project
MBA: Data Collection
AR: Literature Search
MUS : Statistical Analysis
YL,SP: Drafting, Revision
MA: Writing of Manuscript