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Consumption of soda and other sugar-sweetened beverages by 2-year-olds: findings from a population-based survey

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Abstract

Objective: To determine risk factors for consumption of soda and other sugar-sweetened beverages (SSB) among 2-year-old children.
Design: The analysis was performed using three linked data sets: the 2004–2005 Oregon Pregnancy Risk Assessment Monitoring Survey (PRAMS); its longitudinal follow-up, 2006–2007 Oregon PRAMS-2; and 2004–2005 Oregon birth certificates.
Setting: PRAMS is a surveillance programme supported by the federal Centers for Disease Control and Prevention and implemented by participating state health departments. Using mixed methods, PRAMS surveys women 2–6 months after a live birth. Oregon PRAMS-2 re-interviews respondents shortly after the index child's second birthday. Oregon PRAMS oversamples minority women.
Subjects: Using monthly cohorts, we randomly selected 5851 women from the 2004–2005 birth certificates. In total 1911 women completed both PRAMS and PRAMS-2. The weighted response rate of PRAMS-2 was 43·5 %.
Results: Almost half of mothers (49·9 %) reported that their child drank SSB on at least 1 d/week. Mothers whose children drank SSB at least once weekly were more likely to have low income (adjusted OR = 2·83, 95 % CI 2·09, 3·83) and to eat out on ≥2 d/week (OR = 2·11 %, 95 % CI 1·66, 2·70). Hispanic and non-Hispanic black women were most likely to report that their child drank SSB at least once weekly.
Conclusions: Half of mothers reported that their 2-year-old children drank SSB at least once weekly. Public health interventions and policies should address childhood SSB consumption including educating health-care providers and parents.

Keywords
Soda
Sugar-sweetened beverages
Child
PRAMS
Oregon

Consumption of sugar-sweetened beverages (SSB) among children of pre-school age has consistently been associated, in both cross-sectional and longitudinal studies, with dental caries[1], increased energy intake[2], displacement of consumption of milk and Ca, and sub-optimal diet quality[3]. Consumption of SSB has been implicated as a significant cause of obesity[4]. The percentage of obese pre-school children in the USA has doubled from 5 % in 1970 to an estimated 9·5 % in 2008[5]. Overweight children are at least twice as likely to become overweight adults compared with their healthy-weight peers[6].

Recent research has suggested sensitive periods for the development of food and taste preferences among children[7]. Although identification of a critical period of weight gain in childhood that would result in subsequent overweight status has not been codified[8], there is evidence suggesting that overweight status persists from infancy through pre-school years[9]. Although the effects of early exposure to SSB and preference for sweet or sugary foods have not been unequivocally established, patterning of food and dietary intakes initiates at a young age[10]. Therefore, patterns of SSB consumption among young children may be a predictor of future obesity.

In a recent analysis of the National Health and Nutrition Examination Survey (NHANES), Wang *et al.* documented a significant increase in daily energy intake from SSB in both children and adolescents[11]. Based on the aggregated NHANES data, pre-school children consumed an average of 15·5 oz (736 kJ/176 kcal) from SSB on a typical day; the majority of these kilojoules being attributed to fruit juices, fruit punches and other fruit drinks. However, carbonated sodas represented almost two-thirds of total SSB energy consumed among adolescents. Black and Mexican-American youth had significantly greater increases in SSB consumption[11], which is consistent with other

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studies documenting the disparate rates of SSB consumption across racial and ethnic categories[12].

Currently there is scant evidence regarding the distribution, prevalence and risk factors associated with soda and other SSB intakes among 2-year-olds. An Italian study described soda consumption among 3–5-year-old children exploring the association with dental caries[13]. The only study that has focused on SSB consumption specifically among 2-year-old children highlighted just soda consumption among Mexican Americans in California[14]. In that study more than half of the 2-year-olds drank soda and 12 % of them drank soda on one or more days per week. Additionally, 2-year-olds who drank soda had higher birth weight, watched more television and consumed more fast food.

In an attempt to decrease consumption of sugar, a federal tax on all SSB was proposed recently and several state and local districts have moved forward with such proposed taxes[15–17]. However questions still persist regarding the consumption patterns, risk factors and prevalence of SSB consumption among young children. To help fill gaps in research and current knowledge regarding risk factors associated with early childhood consumption of SSB, the present study provides evidence from a large population-based sample using three linked data sets to explore risk factors for consumption of soda and other SSB.

Methods

The present analysis was performed using three linked data sets: the 2004–2005 Oregon Pregnancy Risk Assessment Monitoring Survey (PRAMS) and its longitudinal follow-up, 2006–2007 Oregon PRAMS-2, as well as 2004–2005 birth certificates. PRAMS is a surveillance programme supported by the federal Centers for Disease Control and Prevention (CDC) and implemented by participating state health departments[18]. Oregon PRAMS selects mothers using a stratified random sampling scheme. Minority mothers (Hispanic, non-Hispanic black, non-Hispanic American Indian/Alaskan Native and non-Hispanic Asian/Pacific Islander) are oversampled to ensure reliable estimates among these sub-populations[19]. Oregon PRAMS-2 re-interviews PRAMS respondents shortly after the index child's second birthday. PRAMS-2 includes questions on health insurance, breast-feeding, maternal smoking and alcohol consumption, maternal depression and social support, as well as questions regarding child nutrition and screen time. PRAMS-2 was administered to all mothers who responded to PRAMS with the exception of mothers who indicated that they did not wish to be contacted again or whose babies were deceased. Like PRAMS, PRAMS-2 is administered by mail with a telephone follow-up in both English and Spanish. Responses are weighted for oversampling of minorities by the original sampling design, non-response and non-coverage, accounting for the very few birth certificates that were never in the original PRAMS sampling frame. A detailed explanation of the three-stage sampling weight can be found elsewhere[20]. PRAMS-2 was re-weighted to account for loss to follow-up of the original PRAMS respondents to ensure that the results are generalizable to the original sampling frame. Using monthly cohorts, we randomly selected 5851 women from 2004–2005 births certificates, 1911 completed both PRAMS and PRAMS-2. The weighted response rate was 43·6 %, calculated using a formula as directed by the CDC PRAMS project. Weighted response rates are a widely used methodology in complex survey design and research to reduce sampling bias and to account for varying non-response based on different patterns of selection (e.g. racial/ethnic minority)[21]. The women who were lost to follow-up between PRAMS and PRAMS-2 were more likely to be a racial/ethnic minority (60·14 % *v.* 40·13 %, $P < 0{\cdot}001$), have less than or equal to a high school education (82·78 % *v.* 17·22 %, $P < 0{\cdot}001$) and were at or below 185 % of the federal poverty level (53·18 % *v.* 46·82 %, $P < 0{\cdot}001$). Mean child age at the time of survey completion was 3·5 months for PRAMS and 25·0 months for PRAMS-2. The Stata statistical software package version 11·0 was used to account for the complex survey design for both the bivariate and multivariate modelling. The SPSS statistical software package version 15·0 was used to produce χ^2 statistics and measures of association among selected variables of interest.

Definition of outcome measure

The main outcome measure in the present analysis was consumption of SSB on at least 1 d/week when the child was approximately 25 months old. Mothers were asked to 'circle the number of days in a typical week' that their child consumed each of the following: 'milk, fruit juices, fruit drinks/Kool-Aid, soda pop, plain water and sports drinks (e.g. Gatorade, PowerAde)'. Consumption of SSB was defined as consuming either fruit drink/Kool-Aid (FDK) or soda pop on at least 1 d/week. Mothers who did not answer the soda or the FDK question were excluded from the final analysis (*n* 126). Fruit juices were not included in our definition of SSB because the American Academy of Pediatrics does not recommend zero consumption of fruit juice for children of pre-school age[22,23]. Sports drinks were not included in this definition of SSB due to discrepancies in underlying characteristics of the population of sports drink consumers that differed from the population of soda and FDK consumers. Consistent with other studies examining the health effects of SSB among pre-school children, SSB was dichotomized to compare children who drank no SSB with children who drank SSB on at least 1 d/week[24].

Definition of covariates

Maternal race/ethnicity, maternal age at birth, maternal education, county of maternal residence at the time of birth

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and parity were derived from birth certificates. For the present analysis maternal race/ethnicity was classified as: Hispanic, non-Hispanic white, non-Hispanic black, non-Hispanic American Indian/Alaskan Native or non-Hispanic Asian/Pacific Islander. Maternal pre-pregnancy BMI was calculated using self-reported height and weight from the original PRAMS following the CDC calculation for BMI[25]. Maternal pre-pregnancy BMI was classified as 'underweight' ($<18{\cdot}5\,kg/m^2$), 'normal weight' ($18{\cdot}5–24{\cdot}9\,kg/m^2$), 'overweight' ($25{\cdot}0–29{\cdot}9\,kg/m^2$) and 'obese' ($\geq 30{\cdot}0\,kg/m^2$). Exclusive breast-feeding at 10 weeks was calculated from PRAMS. Research has documented that mothers introduce complementary food earlier than recommended[26] and this contributes to excessive child weight gain and to the patterning of childhood taste preferences[27,28].

Federal poverty line was calculated using annual household income and the number of household dependants from PRAMS-2 to determine the percentage at or above 185 % of the federal poverty line. Also from PRAMS-2, mothers were asked to 'circle the number of days per week' that their child ate 'restaurant, fast food or take-out food? Take out could be food from a restaurant, supermarket or deli counter'. Eating out was classified as responding as either 0–1 d/week or ≥2 d/week. This question was not categorized as 0 d *v.* ≥1 d/week because it included alternative food venues in addition to fast food.

Finally, frequency of family meals together was determined by responses to 'Does your family eat meals together? Check one answer: always, usually, sometimes and never'. This variable was dichotomized to capture families that ate meals together always/usually *v.* sometimes/never.

Statistical techniques

Descriptive statistics were computed using unweighted data to provide interpretable sample size information among the stratification variables. Weighted data were used in all other analyses. Cross-tabulations and χ^2 statistics were generated to check sufficient cell counts within each of the variable categories to be eligible for inclusion in the multivariate model in addition to providing preliminary measures of association among sample characteristics. Simple logistic regression models were constructed to examine the unadjusted odds ratios to determine significant risk factors for consuming SSB on at least 1 d/week. All correlations were examined at $P<0{\cdot}05$ to be eligible for inclusion in the multivariate model. Multivariate logistic regression was used to determine adjusted odds ratios and 95 % confidence intervals. SSB consumption was analysed as both a dichotomous (0 d/week *v.* ≥1 d/week) and continuous variable in the bivariate analyses and similar results were found. In addition to significant variables from the unadjusted odds ratios, other potential cofounders were included in the final multivariate models that have been previously identified in the child SSB literature. To compare regression coefficients across the multivariate logistics regression models, we used post-estimate Wald tests in the Stata suest package.

Ethical approval

The Oregon PRAMS study protocols and informed consent procedures were approved by the Oregon State Public Health/Multnomah County Public Health Institutional Review Board.

Results

Table 1 shows the distribution of SSB consumption by d/week among 2-year-olds in the PRAMS-2 sample. Overall, 49·9 % of mothers surveyed reported that their 2-year-old drank SSB at least once weekly. Mothers reported that 2-year-olds were slightly more likely to consume FDK (37·9 %) than soda (35·9 %) on at least 1 d/week.

Table 2 represents the characteristics of the mothers of 2-year-old children in the study, divided into four overlapping groups including: (i) all children in the study; (ii) children who drank soda; (iii) children who drank FDK; and (iv) children who drank SSB (i.e. either soda or FDK). Although SSB consumption was the main outcome in the present study and was used in the multivariate model, we explored the consistency of risk factors and covariates across soda, FDK and SSB consumption as this may better inform targeted interventions and policies. Table 2 therefore enumerates each of these outcomes. There was a clear pattern between several demographic variables and the outcome variables (soda, FDK and SSB). The women who were more likely to have children who drank SSB were Hispanic, non-Hispanic black or American Indian/Alaskan Native, low income, less educated, less than 25 years old when the child was born, lived in a rural country type when the child was born and were

Table 1 Distribution of SSB consumption by d/week for 2-year-old children, Oregon PRAMS-2, 2004–2005 births (*n* 1785)

	Soda		FDK		Soda or FDK (SSB)†	
d/week	*n*‡	%§	*n*	%	*n*	%
0	1163	64·1	1074	62·1	878	50·1
1	296	17·3	209	11·8	278	15·6
2	160	7·9	163	7·6	208	9·9
3	73	4·9	113	6·4	137	8·7
4	45	2·6	70	3·9	89	5·0
5	18	1·5	43	2·7	54	3·6
6	6	0·3	26	1·1	32	1·4
7	24	1·4	87	4·4	109	5·7
1–7	622	35·9	711	37·9	907	49·9
Total	1785		1785		1785	

SSB, sugar sweetened beverages; PRAMS-2, Pregnancy Risk Assessment Monitoring Survey longitudinal follow-up; FDK, fruit drink/Kool-Aid.
†SSB was created using children whose mothers reported that they drank either soda or FDK.
‡Unweighted number of respondents (excluding those who did not know or did not respond).
§Weighted percentages to account for survey oversampling, non-response and non-coverage.

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Table 2 Selected sample characteristics of children according to beverage consumption on at least 1 d/week, Oregon PRAMS-2, 2004–2005 births (*n* 1785)

	Total		Soda		FDK		SSB	
	n†	%‡	*n*	%	*n*	%	*n*	%
Total	1911	100·0	622	35·9	711	37·9	907	49·9
Maternal race/ethnicity								
NH white	830	70·4	215	30·4	231	31·6	321	43·4
Hispanic	366	19·8	182**	59·3	185**	60·6	234**	74·9
NH AI/AN	226	1·6	85**	38·5	110**	50·0	130**	58·4
NH black	191	2·2	72*	42·4	98**	58·5	113**	66·4
NH Asian/PI	292	5·5	68	28·9	87	36·2	109	46·1
Household income								
≤185 % FPL	946	48·4	419**	49·7	490**	53·5	597**	66·9
>185 % FPL	901	51·6	178	21·5	187	20·4	271	31·2
Maternal age at birth								
≤25 years	637	36·1	282**	48·1	333**	55·0	395**	66·3
>25 years	1274	63·9	340	29·1	378	28·4	513	40·7
Maternal education								
<12th grade	280	14·3	148**	59·0	161**	64·9	196**	79·5
≥12th grade	1623	85·7	471	32·1	547	33·5	708	45·1
Pre-pregnancy BMI								
Normal/underweight	1116	62·5	296**	29·2	355**	32·2	449**	42·3
Overweight/obese	636	37·5	250	42·4	273	42·3	354	56·7
Child TV & screen time								
<2 h/d	1471	80·5	442**	33·5	526**	36·6	666**	47·6
≥2h/d	401	19·5	174	45·9	179	43·2	235	59·8
Eating out§								
≤1 d/week	1119	60·3	311**	29·9	386**	36·1	488**	45·2
≥2 d/week	758	39·7	310	44·9	325	40·6	418	56·8
County type								
Urban	1497	75·9	454**	32·8	512**	35·0	661**	46·3
Rural	414	24·1	168	45·4	199	46·6	246	60·9
EBF for 10 weeks								
Yes	736	53·3	213**	30·7	219**	27·0	293**	39·7
No	802	46·7	282	39·0	300	44·4	382	55·9

PRAMS-2, Pregnancy Risk Assessment Monitoring Survey longitudinal follow-up; FDK, fruit drink/Kool-Aid; SSB, sugar sweetened beverage; NH, non-Hispanic; AI, American Indian; AN, Alaskan Native; PI, Pacific Islander; FPL, federal poverty level; TV, television; EBF, exclusive breast-feeding.
Significant *P* value generated from χ^2 statistic: *$P < 0{\cdot}05$, **$P < 0{\cdot}01$.
†Unweighted number of respondents (excluding those who did not know or did not respond).
‡Weighted percentages to account for survey oversampling, non-response and non-coverage.
§Eating out refers to restaurant take out, deli, supermarket and fast food.

overweight/obese before their child was born. Children who watched television for ≥2 h/d and who ate out more frequently were more likely to consume any category of SSB at least once weekly. For soda, FDK and SSB consumption, children of Hispanic mothers had disproportionately higher rates of SSB consumption than children of non-Hispanic white mothers. Using multivariate logistic regression, we examined the risk factors for consumption of soda, FDK and SSB (either soda or FDK) on at least 1 d/week, separately.

Table 3 displays the adjusted odds ratios and the 95 % confidence intervals from the multivariate analyses of risk factors for soda, FDK and SSB. After controlling for household income, maternal age at birth, maternal education, maternal pre-pregnancy BMI, child screen time, frequency of meals consumed outside the home, county type and breast-feeding, there were significant racial/ethnic disparities in consumption of SSB where Hispanic mothers and non-Hispanic black mothers were significantly more likely to report that their child drank SSB on at least 1 d/week compared with non-Hispanic white mothers (OR = 1·85, 95 % CI 1·19, 2·87 and OR = 1·64, 95 % CI 1·02, 2·64, respectively). Lower household income was the strongest predictor of SSB consumption (OR = 2·83, 95 % CI 2·09, 3·83) in the multivariate model. Similar to SSB, maternal Hispanic ethnicity was a significant predictor for soda consumption (OR = 1·85, 95 % CI 1·20, 2·87), while all other racial and ethnic groups sampled were not significant after adjustment for other covariates. Unlike soda and SSB consumption, there were significant racial/ethnic differences across all groups represented compared with their non-Hispanic white counterparts in regard to FDK consumption on at least 1 d/week after controlling for all relevant covariates and confounders.

In order to compare the magnitude of the regression coefficients of interest across the three outcomes, post-estimation Wald tests were computed to assess whether there was a global difference across the three separate outcomes. Overall, there were no significant differences

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Table 3 Comparison of risk factors for consumption of soda, FDK and SSB on at least 1 d/week, Oregon PRAMS-2, 2004–2005 births (*n* 1785)

	Soda		FDK		SSB†	
	Adjusted OR	95 % CI	Adjusted OR	95 % CI	Adjusted OR	95 % CI
Maternal race/ethnicity						
NH white	Ref.		Ref.		Ref.	
Hispanic	1·85	1·20, 2·87	1·79	1·14, 2·81	1·85	1·19, 2·87
NH AI/AN	1·01	0·65, 1·56	1·61	1·08, 2·42	1·22	0·81, 1·84
NH black	1·16	0·73, 1·84	2·07	1·27, 3·37	1·64	1·02, 2·64
NH Asian/PI	1·00	0·66, 1·51	1·56	1·05, 2·32	1·20	0·82, 1·75
Household income						
≤185 % FPL	2·11	1·53, 2·91	2·93	2·15, 3·99	2·83	2·09, 3·83
>185 % FPL	Ref.		Ref.		Ref.	
Eating out‡						
≥2 d/week	2·36	1·79, 3·13	1·81	1·37, 2·41	2·11	1·66, 2·70
≤1 d/week	Ref.		Ref.		Ref.	
Maternal age at birth						
≤25 years	1·60	1·17, 2·19	1·66	1·22, 2·27	1·43	1·09, 1·88
>25 years	Ref.		Ref.		Ref.	
Maternal education						
<12th grade	1·67	1·03, 2·79	1·52	0·92, 2·48	1·74	1·03, 2·96
≥12th grade	Ref.		Ref.		Ref.	
County type						
Rural	1·30	0·92, 1·82	1·58	1·11, 2·20	1·61	1·15, 2·26
Urban	Ref.		Ref.		Ref.	
Child TV & screen time						
≥2 h/d	1·73	1·07, 2·81	1·07	0·77, 1·49	1·38	0·99, 1·91
<2 h/d	Ref.		Ref.		Ref.	
Maternal pre-pregnancy BMI						
Overweight/obese	1·49	1·11, 1·99	1·20	0·90, 1·61	1·50	1·13, 1·99
Normal/underweight	Ref.		Ref.		Ref.	
EBF for 10 weeks						
No	1·27	0·97, 1·68	1·45	1·10, 1·91	1·37	1·05, 1·78
Yes	Ref.		Ref.		Ref.	

FDK, fruit drink/Kool-Aid; SSB, sugar sweetened beverage; PRAMS-2, Pregnancy Risk Assessment Monitoring Survey longitudinal follow-up; NH, non-Hispanic; AI, American Indian; AN, Alaskan Native; PI, Pacific Islander; FPL, federal poverty level; TV, television; EBF, exclusive breast-feeding; Ref, referent category.
†SSB refers to drinking either soda or FDK on at least 1 d/week.
‡Eating out refers to restaurant take out, deli, supermarket and fast food.

across the regression coefficients between soda and SSB consumption ($P = 0{\cdot}07$). The global test comparing SSB and FDK was significant ($P = 0{\cdot}01$) and after computing individual Wald tests on the regression coefficients, the association between eating out and beverage consumption was statistically significantly greater for the SSB model compared with the FDK model (OR = 2·11 *v.* OR = 1·81, $P = 0{\cdot}04$). The global test comparing FDK and soda was also significant ($P = 0{\cdot}007$) and after computing individual Wald tests on the regression coefficients, the association between maternal race/ethnicity (specifically non-Hispanic black, American Indian/Alaskan Native and Asian/Pacific Islander in comparison to non-Hispanic white mothers) and beverage consumption was statistically significantly greater for the FDK model compared with the soda model ($P = 0{\cdot}036$, 0·046, 0·046, respectively).

Discussion

We found that almost half of mothers reported that their 2-year-old child drank soda or other SSB in the past week. The consumption of SSB by young children probably contributes to children's patterning of taste preferential for sweet and sugary foods, less adequate diet quality and is most likely a robust contributor to the epidemic of childhood obesity[29–31]. Children and adults who consume soda also have a greater amount of added sugars in their diet than adults and children with a healthier beverage consumption profile[32,33]. Compared with non-consumers of soda, 5-year-old girls who consumed soda at baseline had lower milk intake across a 10-year study period which was associated with a diet lower in vitamin D and Ca at follow-up[34]. Young children's drinking of soda and other SSB: (i) tracks over time with increased exposure[35]; (ii) leads to weight gain[31] and is associated with poor diet quality; and (iii) has deleterious ramifications on oral health[33].

Lower household income was the single strongest predictor of infant consumption of SSB. This finding is consistent with other evidence documenting the inverse association between SSB consumption and income[36,37]. Burgeoning evidence highlights the low cost of energy-dense foods, unequal and affordable access to healthy foods and the high palatability of sugary and fatty foods as formidable causal factors producing this income–diet gradient[38–40]. The early introduction of soda and other sugary foods may be a coping mechanism of food insecurity

and utilized as a vehicle to quell satiety and behavioural agitation among toddlers[41], but little empirical evidence has been generated that supports this assertion.

We found that Hispanic mothers were the most likely to report that their toddlers drank SSB. Of the Hispanic mothers in Oregon, 77·5 % are foreign-born (most born in Mexico). These data highlight the need for culturally tailored and targeted interventions among the Hispanic population in Oregon regarding soda and other SSB consumption among toddlers. Soda and other high-fat foods may symbolize economic success and improved circumstances[42] for recent Mexican immigrants with little recognition of adverse health effects associated with overweight infants[41]. Further qualitative research should be undertaken to explore acculturation, influences of extended family members on infant diet and cultural perception of healthy infant weight, which have previously been identified as major factors contributing to disparate rates of overweight among Mexican-American children[43,44].

To the authors' knowledge, the present study is the first one to partition the risk factors unique to soda, FDK and SSB among a population-based sample of 2-year-olds. Almost half of mothers reported that their child drank SSB on at least 1 d/week. Interesting patterns of association across the three outcomes emerged utilizing post-estimation techniques. While the regression coefficients of soda and SSB consumption are comparable, the association between maternal race/ethnicity and beverage consumption was significantly greater for FDK than for soda consumption, where non-Hispanic black, American Indian and Asian/Pacific Islander mothers were more likely to report that their child consumed FDK at least once weekly compared with non-Hispanic white mothers. Even at age 2 years, there are stark racial and ethnic disparities in SSB consumption that persist even after controlling for demographic characteristics and other associated covariates. This evidence supports tailored and targeted programmes, policies and initiatives by both maternal race/ethnicity and beverage type, as it appears that fruit drinks are more universally consumed compared with soda among toddlers in Oregon.

Parents, physicians and teachers should be educated about the dangers of SSB and mobilized to change patterns of SSB use by children. The American Dietetic Association has stated that sweetened beverages and added sugar should be avoided or used sparingly in the case of consumption among children[45] but no formal recommendation from the American Academy of Pediatrics has yet been released regarding young children drinking SSB. Healthcare providers should be reminded of the importance of counselling parents to not give SSB to young children. Additional taxes on soda and other SSB might have the most impact in decreasing SSB consumption as evidence indicates that soda and other SSB are more sensitive to price changes[46]. National experts have estimated that an excise tax of 1 cent per ounce for beverages containing added caloric sweetener would raise an estimated $US 14·9 billion of revenue in the first year of implementation and at a minimum would lead to a reduction of 10 % in energy consumption[15].

Strengths and limitations

The present study's main strength is that the data are derived from a longitudinal, population-based survey of mothers. The main limitation is that the measurement of consumption of SSB was imprecise because it was based on mothers' report. Other limitations include: underestimation of SSB consumption, especially if the child is in child care; lack of information about quantity of SSB consumption; and lack of information about maternal dietary behaviours, which have been associated with child dietary behaviour[47,48]. In addition, we were not able to assess the children's BMI. Finally, the PRAMS-2 weighted response rate, 43·6 %, was low and there were significant differences between the PRAMS responders and PRAMS-2 responders that may bias the estimates of these analyses. Given that soda and other SSB consumption is higher among low-income and non-white youth[11,49], these findings may have underestimated the consumption of SSB in the present sample given that PRAMS-2 non-responders were more likely to be non-white, of lower income and lower education levels.

Conclusions

The identification of significant risk factors for soda and other SSB consumption by young children may act as an impetus for policy recommendations, future research and interventions targeting parents of young children. Although prevention of childhood obesity has emerged as a national priority and has received unprecedented emphasis by the White House[50], there has been limited attention directed towards understanding the early-life risk factors for childhood obesity and successful interventions that target intergenerational predictors of excess weight of poor diet quality. Furthermore, recent state and federal legislations calling for increased taxes on soda and other SSB[16,51,52] have omitted discussions and projections of the potential positive and health-promoting effect that these policies could have on the nutritional profile of low-income and minority mothers and young children[16].

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