

Soft Drinks Consumption is Associated with Behavior Problems in Five-Year Olds

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ABSTRACT

Objective: Recent research suggests soda consumption is associated with aggression and depression among adolescents. However, this association has not been examined among younger children. We examine soda consumption and aggressive behaviors, attention problems and withdrawn behavior among five-year-old children.

Study Design: The Fragile Families and Child Wellbeing Study a prospective birth cohort study that follows a sample of mother-child pairs from 20 large cities in the US. Mothers reported the child's behaviors using the Child Behavior Checklist (CBCL) at age 5 and were asked to report how many servings of soda the child drinks on a typical day.

Results: In the sample of 2929 children, 52% were boys, 51% were African-American 43% consumed at least one serving of soda per day and 4% consumed 4 or more servings per day. In analyses adjusted for socio-demographic factors, consuming one (Beta 0.7 95% CI 0.1,1.4), two (Beta 1.8 95%CI 0.8,2.7), three (Beta 2.0 95%CI 0.6,3.4) or four or more (Beta 4.7 95%CI 3.2,6.2) servings was associated with a higher aggressive behavior score compared to consuming no soda. Furthermore, those who consumed four or more (Beta 1.7 95%CI 1.0,2.4) soda servings had higher scores on the attention problems subscale. Higher withdrawn behavior scores were noted among those consuming two (Beta 1.0 95%CI 0.3,1.8), or four or more (Beta 2.0 95%CI 0.8,3.1) soda servings compared to those who consumed no soda.

Conclusion: We note an association between soda consumption and behavior among very young children; future studies should explore potential mechanisms that could explain this association.

Keywords: Child behavior; soda drinks; soft drinks; sugar-sweetened beverages; child behavior

INTRODUCTION

Americans buy more soda per capita than people in any other country [1]. Even very young children consume soft drinks. For example, national surveys of children in the United States (US) aged 4 and 5 years from the mid-1990s found that on average they consumed 11 grams of added sugar per day from regular (i.e., non-diet) soft drinks alone, which corresponds to 0.25 of a 12-ounce can [2]. In California, a 2005 survey found that over 40% of children aged 2 to 11 drank at least one serving of soda per day [3].

Recent research has indicated that for adolescents, consuming soft drinks is associated with aggression [4, 5], depression, suicidal thoughts and suicidal behavior [5-8]. These studies, using data from national high school surveys and surveys of Boston and California adolescents, found a dose-response relationship between the amount of soft drinks consumed and both self-harm and aggression towards others. Despite the fact that young children are also consuming soft drinks, the relationship between soda consumption and behavior has not been assessed in this age group.

Many factors may affect both soda consumption and problem behaviors of children. Poor dietary behaviors, such as high soda consumption among young children, may be associated with other parenting practices, such as excessive TV viewing or high consumption of sweets in the child's diet. Furthermore, parenting practices may be associated with social factors known to be associated with child behavior. In stressful home environments, for example, a child's needs are likely to be unmet and unhealthy behavioral practices may be more prevalent. An extensive literature has documented a relationship between stressful home environments and child behavior. For example, children who are victims of violent acts or who witness violence have been found to have

more externalizing and internalizing behavior problems, more aggression problems and to show signs of posttraumatic stress disorder [9-11]. Furthermore, caretaker mental health can be a strong contributor to both behavioral and developmental problems in children through its effects, in part, on parenting quality and overall home environment [12]. Children of depressed mothers have been shown to develop more social and emotional problems during childhood, including higher internalizing and externalizing problems [13]. Thus, it is possible that observed associations between behavior and soda consumption among adolescents can be attributed to unadjusted social risk factors.

We sought to investigate the effect of soda consumption on the behavior of young children, specifically aggression, attention and withdrawal behaviors, utilizing a sample of nearly 3000 five-year-old children from urban areas across the US. As other dietary factors may be associated with both soda consumption and behavior we adjust our analyses for other dietary components as well as social risk factors which may be associated with parenting practices as well as child behavior.

METHODS

Study Population

Analyses were conducted using public-use data available from the Fragile Families and Child Wellbeing Study, a prospective birth cohort study that follows a sample of mother-child pairs from 20 large cities in the US. Non-marital births were over-sampled relative to marital births in a ratio of 3 to 1. The study is a joint effort by Princeton University's Center for Research on Child Wellbeing (CRCW) and Center for Health and Wellbeing, Columbia University's Social Indicators Survey Center, and the

National Center for Children and Families (NCCF). Details on the study design can be found in Reichman et al. [14]. In brief, 4898 women were recruited from 75 hospitals at the birth of the child between 1998-2000 in 20 US cities with populations over 200,000. Mothers completed a baseline interview at delivery and participated in follow-up interviews when the children were approximately 12, 36 and 60 months of age. In this analysis we focus on data collected at the 60 month follow-up. Approximately three thousand (3001) mothers completed the in-home assessment at the 60-month follow-up; the 2929 children included in final analyses had complete information on soda consumption and behavior. Those who did not participate in the 60-month in-home assessment differed significantly by race/ethnicity from those who participated (Blacks, 46% non-participants vs. 50% participants $p < .0001$; Hispanics 28% non-participants vs. 24% participants $p < .0001$).

Child Behavior

To assess child behaviors, mothers were asked to complete the Child Behavior Checklist (CBCL) based on their child's behavior in the past two months [14-16]. The CBCL is one of the most widely-used standardized measures in research and clinical settings for evaluating behavioral and emotional problems in preschool and school aged children, and the validity and reliability of the scales have been documented.[15, 16] The CBCL measures a series of constructs, which include withdrawal, attention problems and aggressive behaviors. Items assessing specific behaviors were read to the mother who was asked to indicate whether the statement was (0) not true, (1) sometimes or somewhat true, or (2) very true or often true. In these analyses we focus on the CBCL aggressive (includes 20 items), withdrawn (includes 9 items) and attention (11 items) subscales. Raw

scores were converted to age-standardized scores (T scores having a mean = 50 and SD = 10) that can be compared with scores obtained from normative samples of children within the same age range. Soda Consumption

To assess beverage consumption, mothers were asked: “On a typical day how many servings of soda does the child drink?” Possible answers were none, one, two, three, four or five or more sodas in a typical day. In our analyses the ‘four’ and ‘five or more’ categories were collapsed into one group; thus, soda consumption was categorized as 0, 1, 2, 3, or 4 or more servings of soda per day.

TV viewing

Mothers were asked to report the amount of hours the child watched TV on a typical weekday as well as the amount of hours the child watched TV on a typical weekend. We calculated the average daily hours of TV the child watched during the week and categorized hours spent watching TV as less than two, between two and four, or four or more hours per day.

Other Dietary Factors

To assess whether other dietary factors had a similar effect on behavior we include two measures of diet, candy/sweets consumption and fruit juice consumption. To assess frequency of candy or sweets consumption mothers were asked: “On a typical day how many servings of candy or sweets does the child eat? Possible answers were none, one, two, three, four or five or more times per day. In the analyses eating candy or sweets was categorized as none, once or twice per day, or three or more times per day. To assess fruit juice consumption mothers were asked: “On a typical day how many servings of fruit juice does the child drink?” Mothers were asked to indicate whether the child drank

none, one, two, three, four or five or more servings of fruit juice in a typical day.

Social Risk Factors

In order to characterize the home environment, which may be correlated with parenting practices and child behavior, three social risk factors obtained from the 60-month assessment were included in our analysis.

(a) Probable Maternal Depression: Mothers answered the Composite International Diagnostic Interview – Short Form (CIDI-SF), [17] a screening tool for depression which is based on one of the most widely used structured diagnostic interviews to assess adult psychiatric disorders in epidemiological studies [18]. To ascertain probable depression, mothers were initially asked if they experienced dysphoria (depression) or anhedonia (lack of enjoyment of what is often experienced as pleasurable) in the past year for at least two weeks and if so, whether such symptoms lasted most of the day and occurred every day. If symptoms were present and persistent, mothers were asked about seven other symptoms, such as losing interest in hobbies, work or activities, trouble sleeping and thinking about death. A probable depression score is calculated by summing the answers to these seven symptoms plus the first symptom of dysphoria, if present, with the variable ranging from 0 to 8. A score of three or more is considered a probable case of depression. Also, a mother who reported taking antidepressants is considered a probable case of depression. We classified probable maternal depression as either Yes or No.

(b) Intimate Partner Violence (IPV): Maternal IPV was assessed using previously validated questions.[19, 20] Mothers were asked to think about their relationship with the child’s father or current partner and were then asked: 1) “How often does he slap or kick you?”; 2) “How often does he hit you with a fist or object that could hurt you?”; 3)

“How often does he try to make you have sex or do sexual things you don’t want to?”; and 4) “Were you ever cut or bruised or seriously hurt in a fight with the baby’s father or current partner?” Mothers who responded ‘often’ or ‘sometimes’ as opposed to ‘never’ to any of the first three questions or who responded ‘yes’ to the last question were categorized as experiencing IPV.

(c) Paternal Incarceration: Mothers were asked whether the father of the child was currently incarcerated (Yes/No).

Socio-demographic Factors

Data on the mother’s (but not the child’s) race/ethnicity were collected in the baseline survey. Race/ethnicity was classified as White Non-Hispanic, African-American or Hispanic/Other race/ethnic group. Other explanatory variables were collected from the most recent survey: marital status of the parents (married/cohabitating or not married at child’s birth), maternal education (less than high school, high school graduate, or some college/college graduate) and receipt of public assistance in the past year (yes/no). The child’s body mass index (BMI) is calculated from height and weight measured at the 60 month follow-up. The Center for Disease Control and Prevention (CDC) BMI growth reference [21] was used to determine age- and gender-specific BMI percentiles (BMI_p). Obesity was defined as BMI at or above the 95th percentile at the 5-year assessment.

Data Analysis

We performed bivariate analyses (ANOVA) to examine the association between the aggressive, withdrawal and attention subscales of the Child Behavior Checklist (CBCL) and each level of soda consumption. Next, we used linear regression models to estimate the association between soda consumption and child behavior subscales.

Analyses were first adjusted for socio-demographic factors: child gender, maternal race/ethnicity (White, Hispanic/Other or African-American), maternal education (less than high school, high school graduate or some college/college graduate), maternal marital status (married/cohabitating or single) and current receipt of public assistance (yes/no). A second set of models was further adjusted for socio-demographic factors and in addition, TV watching (less than two hours, two to four hours or more than four hours), and two dietary factors, fruit juice consumption (none, one, two, three, four or five or more servings) and eating candy/sweets (none, once, twice or three times per day). Lastly, models were further adjusted for three additional social risk factors: probable case of maternal depression (yes/no), mother's report of IPV (yes/no) and father's incarceration (yes/no) among participants with available social risk data (N=2597). BMI information was missing for more than 1/4 of the children, and therefore we ran a separate regression for the 1,868 children with complete information. Since studies of adolescents have found a relationship between soft drink consumption and physical aggression (e.g., fights), we also examined the adjusted association between soda consumption and three specific items from the aggressive behavior scale that we selected *a priori* for being the strongest indicators of physical aggression towards others: (a) destroys things belonging to family or others; (b) gets in many fights; and (c) physically attacks people. For ease of exposition, we collapse "sometimes" and "very" true together and compare these children with children whose mothers reported that the statement was not true. All analyses were conducted in SAS version 9.0 (SAS Institute, Cary, NC).

RESULTS

Table 1 shows the distribution of demographics, soda consumption and study covariates. In the sample of 2929 children, 52% were boys, 51% of mothers were African-American and 28% were Hispanic/Other (Table 1). Forty-three percent of children consumed at least one soda serving and 4% consumed 4 or more servings per day. In bivariate analyses (data not shown), child aggressive and withdrawn behaviors as well as attention problems were associated with socio-demographic factors, maternal depression, maternal report of IPV and father's incarceration status (all $p < 0.05$).

In unadjusted analysis, (Table 2) the overall aggression score was significantly higher with increasing levels of soda consumption, rising from 56 for no servings to 62 for 4 or more servings per day ($p < 0.05$). Higher levels of soda consumption were also associated with significantly higher scores for withdrawn behavior, rising from 54 for no servings to 57 for 4 or more servings per day and attention problems rising from 51 for no servings to 53 for 4 or more servings per day (both $p < 0.05$).

In analyses adjusted for socio-demographic factors, soda consumption was associated with the global measure of aggressive behavior in a dose-response manner (p for trend < 0.05) (Table 3, Model 1). Children who consumed at least one soda per day had a 0.74 point significant higher aggressive behavior scores (95%CI 0.1,1.4) compared to children who consumed none. Those who consumed 4 or more soft drinks had a 4.74 point higher aggressive score (95%CI 3.2, 6.2), a 1.70 (95%CI 1.0, 2.4) point higher attention problem score and a 1.95 (95%CI 0.8,3.0) point higher withdrawn score compared to those who consumed no soda (Table 3 Model 1; $p < .05$ for all three differences). A statistically significant trend was also noted for the soda consumption and attention score relation (p for trend < 0.05) but not for withdrawal behaviors (p for trend

> 0.05). Interaction terms between gender and soda consumption were not statistically significant. Adjusting for fruit juice consumption, TV watching and consumption of candy/sweets (Table 3 Model 2) did not substantially change the results. We note an association between watching TV between 2 and 4 hours as well as watching more than 4 hours per day and higher scores in the attention (0.4 95%CI 0.1,0.7 and 0.6 95%CI 0.2, 1.0), aggression (1.0 95%CI 0.4, 1.6 and 2.2 95%CI 1.4, 2.0) and withdrawal scales (0.7 95%CI 0.2, 1.2 and 1.1 95%CI 0.5,1.7) (all $p < 0.05$) (not shown in tables). Consuming candy/sweets three or more times per day was associated with a 1.4 higher aggressive behavior score (95% CI 0.4, 2.4, $p < 0.05$) (not shown in tables). Consuming one serving of fruit juice per day was associated with lower attention (-0.7 95%CI -1.3, -0.05) scores ($p < 0.05$). Further adjustment for mother's probable depression, intimate partner violence and father's incarceration did not substantially change the results (Table 3, Model 3).

In a separate analysis we adjusted for all previously mentioned factors and further adjusted for obesity (N=1868). The results were slightly attenuated; those who consumed 4 or more soft drinks had a 2.62 (95%CI 0.7, 4.5) point higher aggressive score, a 1.75 (95%CI 0.9, 2.6) point higher attention problem score and a 0.88 (95%CI -0.6, 2.3) point higher withdrawn score compared to those who consumed no soda (not shown in tables).

Logistic regression analyses, adjusted for socio-demographic factors, for three specific aggressive behaviors showed a dose-response relationship between soda consumption and (a) destroying other people's possessions (b) getting into fights and (c) physically attacking people. Children who consumed 4 or more servings of soda per day were more than twice as likely to destroy things belonging to others (OR 2.54 95%CI 1.7,

3.8), to get into fights (OR 2.12 95%CI 1.3, 3.5) and to physically attack people (OR 2.28 95%CI 1.3, 3.9) than children who did not drink soda (not shown in tables).

DISCUSSION

In this sample of nearly 3000 five-year-old children from cities across the US, 43% consumed a serving of soda at least once a day, with 4% consuming 4 or more servings daily. Soda consumption was associated with higher aggressive behavior scores in a dose-response pattern. These results remained significant after adjusting for the child's gender, maternal race, education, marital status, receipt of public assistance, fruit juice consumption, candy/sweets consumption, TV watching, probable maternal depression, maternal report of IPV and paternal incarceration. We found a significant relation with soda consumption with the overall measure of aggression and with the three specific behaviors we felt were most indicative of aggression: destroying things belonging to others, getting into fights and physically attacking people. Children who consumed the highest quantities of soft drinks were also more likely to exhibit higher scores for attention problems and withdrawn behavior, both in simple comparisons and when controlling for the aforementioned factors.

This study is not able to identify the nature of the association between soft drinks and the problem behaviors. One possibility is a direct cause-and-effect relationship. Soft drinks are highly processed products containing carbonated water, high fructose corn syrup, aspartame, sodium benzoate, phosphoric or citric acid, and often caffeine, any of which might affect behavior. Unfortunately, studies focusing on the impact of any of these ingredients on the behavior of young children are rare. Caffeine has been linked to insufficient sleep, nervousness and jitters, impulsivity and risk taking in children and

adolescents [22], while a study of 9-12 year old children in Brazil found that those who were depressed were more likely to consume caffeine [23]. Hence caffeine may explain or contribute to our results. Although sugar is often thought to affect children's behavior, the scientific literature to date is not definitive [24]. In our study, high consumption of fruit juice was associated with lower levels of aggressive behaviors scores; while candy/sweets consumption was associated with higher levels of aggressive behavior. Another possibility is that underlying organic condition such as low blood sugar could lead children both to want soda and to be aggressive or withdrawn. High soda intake may affect blood sugar levels.[25] Unfortunately we did not have a direct measure of blood sugar.

This study has a variety of limitations. First, due to the cross-sectional nature of our analyses we cannot determine causality. However, a yearly time series might also not be appropriate if the effect of soda on behavior is short-lived. Second, data on both soft drink consumption and behavior are based on the mother's report. Furthermore, the size of a soda serving was never defined. This can potentially introduce some level of misclassification of exposure, though we have no reason to expect it to be related to the parent's report of the child's behavior. Third, we have no information on what type of soft drinks were consumed, particularly whether they were regular or diet, sugar sweetened or artificially sweetened, cola or non-cola, or whether they were caffeinated or caffeine-free. Fourth, there are other potential confounders that we cannot adjust for which may be related to both soda consumption and child behavior, such as physical activity, watching violent video games or other dietary factors. For example, food coloring has also been examined as a potential negative influence on child behavior. [26]

Finally, the sample is not representative of all US five-year-old children and may have limited generalizability.

Nevertheless, in this large sample of urban five-year-old children we found a strong and consistent relationship between consuming soft drinks and a range of problem behaviors, consistent with other studies' findings among adolescents [4-8]. Those who drank soft drinks more frequently had higher scores for aggression and were more likely to destroy other people's belongings, to get into fights and to physically attack people. Children who drank high levels of soda were more likely to exhibit withdrawn behavior and attention problems. These effects were present even after accounting for an array of socio-demographic factors and psychosocial stressors. We believe our study is the first to focus on the association between soft drink consumption and behavior among young children. Studies in other populations of children and of a longitudinal nature may provide further insight into the relationship between soda consumption and child behavior.

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Table 1: Demographics, soda consumption and other characteristics, Fragile Families and Child Wellbeing Study (N=2929)

Variable	N	%
Child's Gender		
Boy	1527	52.1
Girl	1402	47.9
Mother's Race/Ethnicity		
White	624	21.3
African American	1483	50.6
Hispanic/Other	822	28.0
Mother's Highest Education Attained		
Less than High School	1121	38.3
High School Graduate	760	26.0
Some College/College Grad	1048	35.8
Mother's Marital Status: Married or Cohabiting	1729	59.0
Income from Public Assistance	700	23.9
Probable Maternal Depression	337	11.5
Maternal Report of IPV	316	11.1
Father Incarcerated	168	6.5
Soda Consumption (servings per day)		
None	1667	56.9
1 Serving	730	24.9
2 Serving	293	10.0
3 Servings	129	4.4
4 or more servings	110	3.8
Candy/Sweets Consumption (servings per day)		
None	699	23.6
Once	1353	46.2
Twice	497	17.0
Three or more	409	14.0
Fruit Juice Consumption (servings per day)		
None	164	5.6
1 Serving	562	19.0
2 Serving	781	26.4
3 Servings	682	23.1
4 servings	327	11.1
5 or more Servings	440	14.9
TV Watching (hours per day)		
Less than 2 hours	1108	37.8
Between 2 and 4 hours	1220	41.7
More than 4 hours	601	20.5
Obesity >=95th Percentile (N=1868)	367	17.3
	Mean	SD
CBCL Attention subscale	51.5	3.5

CBCL Withdrawn subscale	54.5	6.0
CBCL Aggression subscale	57.0	7.8

Table 2: Mean and standard deviation of CBCL attention, withdrawn and aggressive scales in five levels of soft drink consumption among 5 year olds in the Fragile Families and Child Wellbeing Study

	Soft Drink Consumption in a Typical Day				
	None	1 serving	2 servings	3 servings	4+ servings
Total attention score ^a	51.4 (3.4)	51.4 (3.2)	51.6 (3.6)	51.8 (3.6)	53.3 (5.9)
Total withdrawn score ^a	54.1 (5.7)	54.7 (6.2)	55.5 (6.1)	55.3 (6.1)	56.7 (7.2)
Total aggression score ^a	56.2 (7.5)	57.2 (7.6)	58.4 (8.6)	58.7 (8.5)	62.0 (9.0)

^ap < 0.05 ANOVA

Table 3: Adjusted linear regression analyses of CBCL subscales and soda consumption, Fragile Families and Child Wellbeing Study

Soda Consumption	Withdrawn Estimate (95% CI)		
	Model I^a	Model II^b	Model III^c
None	Reference	Reference	Reference
1 Serving	0.44 (-0.05,1.0)	0.42 (-0.1,0.9)	0.49 (-0.07,1.1)
2 Serving	1.03 (0.3,1.8)*	0.73 (-0.03,1.5)	1.00 (0.1,1.8)*
3 Servings	0.70 (-0.4,1.7)	0.29 (-0.8,1.4)	0.25 (-0.9,1.4)
4 or more servings	1.95 (0.8,3.1)*	1.23 (0.02,2.4)*	1.20 (-0.11,2.5)

Soda Consumption	Attention Estimate (95% CI)		
	Model I^a	Model II^b	Model III^c
None	Reference	Reference	Reference
1 Serving	0.04 (-0.3,0.3)	0.02 (-0.3,0.3)	0.04 (-0.3,0.4)
2 Serving	0.15 (-0.3,0.6)	0.03 (-0.4,0.5)	0.17 (-0.3,0.7)
3 Servings	0.38 (-0.2,1.0)	0.21 (-0.4,0.9)	0.19 (-0.5,0.9)
4 or more servings	1.70 (1.0, 2.4)*	1.48 (0.8, 2.2)*	1.52 (0.8, 2.3)*

Soda Consumption	Aggression Estimate (95% CI)		
	Model I^a	Model II^b	Model III^c
None	Reference	Reference	Reference
1 Serving	0.74 (0.07,1.4)*	0.58 (-0.1,1.3)	0.69 (-0.01, 1.4)
2 Serving	1.77 (0.8,2.7)*	1.07 (0.07,2.07)*	1.22 (0.2,2.3)*
3 Servings	2.00 (0.6,3.4)*	1.11 (-0.3, 2.5)	0.95 (-0.5, 2.4)
4 or more servings	4.74 (3.2,6.2)*	3.28 (1.7,4.9)*	3.00 (1.3,4.7)*

^a Model I adjusted for gender, maternal race/ethnicity, maternal education, marital status, and receipt of public assistance.

^bModel II further adjusted for covariates in model I and TV watching, candy/sweet consumption and fruit juice consumption

^cModel III further adjusted for covariates in model I and II, and probable maternal depression, maternal report of IPV and father's incarceration.

^dSample size for Model III is 2596

* $p < .05$