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Longitudinal evaluation of milk type consumed and weight status in preschoolers

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Abstract

Objective—Evaluate relationships between type of milk consumed and weight status among preschool children.

Design—Longitudinal cohort study.

Setting—Early Childhood Longitudinal Study–Birth Cohort, a representative sample of U.S. children.

Participants—10,700 U.S. children examined at age 2 and 4 years.

Main Outcome Measures—BMI z-score and overweight/obese status as a function of milk type intake.

Results—The majority of children drank whole or 2% milk (87% at 2 years, 79.3% at 4 years). Across racial/ethnic and SES subgroups 1%/skim-milk drinkers had higher BMI z-scores than 2%/whole-milk drinkers. In multivariable analyses, increasing fat content in the type of milk consumed was inversely associated with BMI z-score ($p<0.0001$). Compared to those drinking 2%/whole milk, 2- and 4-year-old children drinking 1%/skim milk had an increased adjusted odds of being overweight (age 2 OR 1.64, $p<0.0001$; age 4 OR 1.63 $p<0.0001$) or obese (age 2 OR 1.57 $p<0.01$; age 4 OR 1.64, $p<0.0001$). In longitudinal analysis, children drinking 1%/skim milk at both 2 and 4 years were more likely to become overweight/obese between these time points (adjusted OR 1.57, $p<0.05$).

Conclusions—Consumption of 1%/skim milk is more common among overweight/obese preschoolers, potentially reflecting the choice of parents to give overweight/obese children low-fat milk to drink. Nevertheless, 1%/skim milk does not appear to restrain body weight gain between 2–4 years in this age range, emphasizing a need for weight-targeted recommendations with a greater evidence basis.

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Introduction

The current epidemic of childhood obesity is apparent before preschool[1], contributing to health consequences for the current generation.[2,3] This increases the need for evidence-based prevention and treatment approaches for effective weight control among preschoolers.

One point of emphasis has been restraining the fat content in milk. The American Academy of Pediatrics (AAP) and the American Heart Association (AHA) have advocated use of low-fat (1%) or skim milk for all children after 2 years of age to reduce saturated fat intake given potential effects on weight gain.[4,5] However, data linking milk type to weight gain in preschoolers are mixed. One cross-sectional study of preschoolers evaluated National Health and Nutrition Survey data 1999–2002 and reported no relationship between milk type and obesity status.[6] Another group reported higher body mass index (BMI) among children drinking 1%/skim milk[7] while a third group reported higher BMI among a cluster of preschoolers drinking 2%/whole milk.[8] Still other researchers have suggested low prevalence of preschoolers drinking low-fat/non-fat milk.[9] Thus the efficacy of the AAP recommendations and their overall adherence remain unclear.

Our goal was to evaluate relationships between milk fat consumption and BMI among a large cohort of preschool children studied as part of the Early Childhood Longitudinal Survey – Birth (ECLS-B) cohort, a prospective, representative survey of children born in the United States in 2001 and assessed at both 2 and 4 years old.[1] We assessed whether parental choices of milk type for their preschoolers comply with current AAP recommendations and whether milk-consumption patterns among U.S. two-year-olds would predict the development of overweight/obesity during two years of longitudinal follow-up. Our original hypothesis was that low-fat milk would be associated with lower BMI z-score and less weight gain over time.

Methods

Data Set

The ECLS-B is a large multi-source, multi-method study sponsored by the National Center for Education Statistics (NCES – United States Department of Education) to examine a large range of influences on childhood early experiences.[1] The NCES ethics review board approved the study. This nationally-representative sample of children born in 2001 was selected by randomly sampling >14,000 birth certificates, with a final sample of approximately 10,700 completed parent interviews—a 77% response rate. Parents gave informed consent. Longitudinal examinations were performed at ages 9 months and 2, 4 and 5 years. We utilized data from the 2-year-old and 4-year-old evaluations, enabling prospective analysis among preschoolers.

Measures

During the 2-year-old and 4-year-old waves, parents were interviewed in their home by trained assessors. The primary care-giver (most often the mother) completed a computer-assisted interview. Beverage intake was calculated from parental responses to several questions. At the 2-year visit parents were asked if their child usually drinks whole milk/2%

milk (combined together as an option), 1%, skim, soy or other. At the 4-year visit parents were further able to choose between whole milk and 2% as separate options in addition to 1%, skim, soy, or other. During the 4-year visit parents were asked a more detailed set of questions regarding type and frequency of beverage intake, including: "During the past 7 days, how many times did your child drink milk?" Parents were instructed to include all types of milk and milk from glass or cup, from a carton or with cereal. They were instructed that the ½-pint of milk served at school equals one glass. Regarding juice and sugar-sweetened beverages (SSB), parents were asked how many times their child drank 100% fruit juices not including punch, Sunny Delight, Kool-Aid, sports drinks, or other fruit-flavored drinks, and how many times their child drank sugar soda pop, sports drinks or fruit drinks that are not 100% fruit juice. For each of these drinks—milk, juice and SSB—categories for frequency included no intake during the past 7 days, 1–3 times during the past 7 days, 4–6 times during the past 7 days, once daily, twice daily, 3 times daily, and ≥4 times daily. For purposes of reporting prevalence data, these quantities were converted to the recommendations of the AAP: juice and SSB ≤1 or >1 serving daily[4] and for milk <2, 2 and >2 servings daily.[4] To calculate daily intake of milk fat in grams for the 4-year wave was calculated by multiplying grams of fat per serving for each milk type (skim=0 g, 1%=2.4 g, 2%=4.8 g, whole=7.9 g[10]) by number of servings consumed daily, with children reported to drink >3 servings considered as having consumed 4 servings daily.

Direct measurements of height and weight were obtained by trained researchers using standardized protocols and equipment including a portable stadiometer and digital scale. Children were dressed in light clothing without shoes. Measurements were taken twice; if these were within 5% their average was used, otherwise a third measurement was taken and the three measurements averaged. BMI was calculated as weight (kilograms)/(height [meters])^2 and converted to age- and gender-specific percentiles and z-scores using the 2000 Centers for Disease Control and Prevention US growth charts.[11] Weight categories were normal weight (<85th%), overweight (>85th–95th%), and obese (>95th%). For the 2-year time point children <24 months old were excluded, as BMI is not a validated measure below this age.

Parents identified their child's gender and race/ethnicity. Race/ethnicity was grouped into 5 categories: white, black, Asian, Hispanic and other. NCES calculated socio-economic status (SES) based on 5 items: family income, maternal education, maternal occupation, paternal education and paternal occupation.[12,13] Participants were categorized into SES quintiles (lowest SES=1; highest SES=5). Caregivers identified if their child was predominantly at home during the day or away from the home at childcare or preschool.

Data Analysis

We performed all analyses using SAS software, Version 9.2 (SAS Institute Inc., Cary, NC, USA), utilizing survey procedures with sampling weights provided by the NCES to account for the complex sampling design. All statistical significance tests were two-sided with significance of alpha=0.05. Unweighted sample sizes were rounded to the nearest 50 in compliance with NCES rules. Using multivariable linear regression models, we performed both cross-sectional and longitudinal analyses as follows. First we regressed: i) age 2- and 4-

year BMI z-score on milk-type categories (skim, 1%, 2% or whole milk) cross-sectionally; and ii) longitudinal change in BMI z-score (4-year BMI z-score − 2-year BMI z-score) on baseline milk-type categories. Similarly, multivariable logistic regression models were used to examine odds of overweight/obese across the milk-type categories in both cross-sectional and longitudinal analyses. Regression coefficients, odds ratios, and confidence intervals are reported in tables. We adjusted 4-year multivariable models for sex, race, SES, juice and SSB intake,[14] number of glasses of milk daily and maternal BMI[15]. For juice, SSB and milk amounts, we used the amount of each of these reported by the parents as number of daily servings with 1–3 times weekly =0.29 servings/day; 4–6 times weekly =0.71 servings/day. We adjusted 2-year models for sex, race, SES and maternal BMI as the other measures were not available.

To assess longitudinal associations of milk type with weight gain over time, we selected children reported to drink 1%/skim (low-fat) at both 2 and 4 years and those reported to drink 2%/whole milk (high-fat) at both time periods. This approach obtained the purest contrast between milk-type and BMI change. For both groups of consistent low-fat or high-fat milk drinkers we assessed BMI z-score at both time points, as well as the intra-individual change in BMI-z score between times. Given known difficulties in the use of BMI z-scores over time at BMI extremes[16] and given matching ages at time of assessment, we also assessed longitudinal change in raw BMI. In assessing odds of becoming overweight between time points, we restricted the analysis to children who were normal weight at age 2 years and adjusted for baseline BMI-z-score, in addition to adjusting for the potential confounders listed above.

Results

Demographics

We analyzed data from 10,700 ECLS-B participants, of whom 7450 at the 2-year wave were >24 months with complete data on milk type (Supplementary Table 1) and BMI and 8300 at the 4-year wave had complete information (Table 1). An additional 200 non-milk drinkers at age 4 years were excluded. Compared to the original data set, the children remaining at the 4-year wave had a slightly higher prevalence in the upper 2 SES quintiles (41% vs. 43%, $p<0.05$). At both 2- and 4-year time points most children drank whole or 2% milk (86% at 2 years and 81% at 4 years). Among those who consistently drank either high-fat or low-fat milk at both time periods (as opposed to changing between milk types), 95% drank whole/2% while 5% drank 1%/skim.

Milk type and weight status

Overweight/obesity was highly prevalent at both waves, being 30.1% at 2 years and 32.2% at 4 years. The prevalence of 1%/skim milk consumption was higher among overweight/obese children (14% at 2 years, 16% at 4 years) vs. normal weight children (9% at 2 years, 13% at 4 years, $p<0.01$ at both years)(Table 1 and Supplementary Table 1).

Mean BMI z-scores varied significantly across milk type with lower mean BMI z-score among 2%/whole milk drinkers compared to 1%/skim drinkers (Figure 1). These patterns were consistent at both 2 and 4 years and among race/ethnic subgroups (Figure 1A&C) as well as across SES quintiles (Figure 1B&D). Similarly, linear regression revealed that consumption of higher fat content in milk was associated with lower BMI z-score, including after multivariable adjustment for sex, race/ethnicity, SES, intake of juice and sugar-sweetened beverages, and maternal BMI (all $p<0.0001$). These findings did not change when evaluated only among the subset of children in childcare or preschool (data not shown). A weaker inverse association was found in assessing relationships between total daily grams of milk fat consumed and BMI z-score at 4 years ($p<0.001$) (Supplementary Table 2). Finally, we assessed odds of overweight or obesity according to milk type (Table 2). Preschoolers drinking 1%/skim (vs. 2%/whole milk) had higher odds of being overweight or obese, findings that were strengthened after multivariable adjustment.

Longitudinal change in BMI by milk type group

We next assessed whether 1%/skim milk consumption was associated with increased weight gain over time. As seen in Figure 2, children consistently drinking 1%/skim milk at both 2- and 4-year time points had higher BMI z-scores at both evaluations than those drinking 2%/whole milk. Using linear regression and adjusting for sex, race/ethnicity and SES there was no significant difference between the low-fat group and the high-fat group in the change in BMI z-score over time ($p=0.6$). These results persisted when change in raw BMI was assessed between the time points (data not shown). However, consistent drinkers of 1%/skim milk who were not overweight/obese at baseline were more likely in a regression model adjusted for baseline BMI to become overweight/obese between 2 and 4 years (OR 1.57 CI 1.03–2.42)(Table 3).

Discussion

The American Academy of Pediatrics first started recommending low fat milk for all children >2 years old in 2005,[4,5] after the onset of the current epidemic of obesity.[17] While prior reports have since noted low adherence to these recommendations,[9] at least one report noted lower BMI between preschoolers drinking 2%/whole milk compared to 1%/skim.[6] Using a large, nationally-representative database, we found multiple associations between intake of 1%/skim milk and higher BMI z-scores in preschoolers. Across racial/ethnic and SES categories, children drinking 1%/skim milk had higher BMI-z scores than those drinking 2%/whole milk. Similarly, preschoolers drinking 1%/skim milk had elevated adjusted odds of overweight or obesity than those drinking 2%/whole milk. These data may reflect that parents of children with higher BMI's are more likely to adhere to recommendations of healthcare providers in selecting low-fat milk.

The logic behind these AAP recommendations is that if children drink reduced-fat milk, this results in overall fewer calories consumed.[4] It has been well established that as compared to traditional plant-based diets, Western diets high in saturated fat are associated with increased weight gain.[18] In both children and adults key contributors to the current obesity epidemic are high fat diets increasingly consumed worldwide.[19] Encouraging consumption of low-fat/skim milk instead of high-fat milk provides a means of eliminating

5.5–22.5 grams of fat (50–202 kcal) daily among children drinking 1–3 cups of milk per day.[10]

While the logic of low-fat milk consumption is sound, we are not aware of studies that have randomized preschoolers to low-fat vs. high-fat milk to test effects on weight status. Prospective observational studies in children[20] and adults[21] have associated whole milk intake with lower BMI than low-fat milk. At least theoretically the potential exists that high-fat milk may result in less weight gain should its consumption lead to an overall decrease in calories consumed. The presence of fat can induce satiety through release of cholecystokinin (CCK) and other factors.[22] This could potentially lower appetite for other calorically dense foods, as noted in preschoolers who drink excessive volumes of milk and concurrently eat less iron-containing food, contributing to iron deficiency anemia.[23,24] In addition, high-fat, low-carbohydrate diets have been associated with improved short-term weight loss —though much of this weight loss was either not sustained[25] or was not better than low-fat diets.[26]

After noting consistent trends of higher BMI among preschoolers drinking 1%/skim milk, we proceeded to test our original hypothesis that consumption of 1%/skim milk would be associated with decreased weight gain over time. We thus evaluated children drinking 1%/skim milk at both 2 and 4 years and compared them to children drinking 2%/whole milk at both time periods. Contrary to our original hypothesis, consistent drinkers of 1%/skim milk had a higher OR for becoming overweight between 2 and 4 years. This may have been related to residual confounding factors that we did not account for in our analysis. Overall, there were not significant differences in the absolute increase in BMI between groups, suggesting against low-fat milk consumption as a cause of additional weight gain beyond that seen for 2%/whole milk.

Certainly there remained among consistent 1%/skim drinkers an overall increase in BMI z-score over time—potentially emphasizing that obesity is a multi-factorial disorder, with contributions of genetic and environmental factors of which dietary patterns are just one component.[18] Healthcare practitioners seeing children are faced with limited clinical time to make numerous health recommendations and need to select advice most likely to be efficacious—in this case in protecting against excessive gain in BMI. Our data reveal that intake of 1%/skim milk did not achieve the control of weight gain (compared to 2%/whole milk) that logic would have predicted—though it may be that drinkers of 1%/skim would have gained even more weight had they not been drinking low-fat milk. Nevertheless, national scientific societies—and practitioners following their recommendations—may need to reconsider current recommendations regarding low-fat milk intake without further dietary guidance as a means of weight control, choosing to instead emphasize other noted interventions such as decreased television viewing,[27] increased physical activity[28,29] and decreased juice and sugar-sweetened beverage intake,[14,30] as well as a focus on non-Western diets with higher vegetable content.[18] This focus on more efficacious recommendations is particularly true when one considers data that the simpler a set of recommendations parents are given, the more likely they are to retain and follow these recommendations.[31]

This study had several weaknesses. We employed secondary analysis of data from ECLS-B using measures that were not themselves primary outcome measures. The type of milk consumed for children in the study was reported by parents and not directly observed. Also, we lacked data on other forms of food intake, which could have enabled assessment of the association of milk type with total calorie consumption, and we lacked data on physical and sedentary activities that may have represented important confounders. Further research will be needed to assess whether these associations persisted when accounting for these other measures. However, this study also had significant strengths, particularly its use of a large, nationally-representative database to address concerns related to AAP guidelines and use of prospectively-gathered observational information to assess effects of lifestyle factors on measured BMI over time.

In conclusion, we found that among preschoolers, consumption of 1%/skim milk was associated with overweight and obesity. While uncertain, these findings may reflect an increase in adherence to recommendations of physicians and the AAP among families of children who are overweight/obese. Nevertheless, the prevalence of consumption of 1%/skim milk in this age range remains low, as less than 20% of overweight or obese children drink 1% or skim milk. Our data do not support 1%/skim milk consumption as the sole way to restrain gains in BMI among preschoolers. This may mean that efforts toward weight control among overweight/obese preschoolers would be better directed at other interventions with established efficacy.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Bibliography

1. Anderson SE, Whitaker RC. Prevalence of obesity among US preschool children in different racial and ethnic groups. Arch Pediatr Adolesc Med. 2009; 163:344–8. [PubMed: 19349563]
2. Bibbins-Domingo K, Coxson P, Pletcher MJ, Lightwood J, Goldman L. Adolescent overweight and future adult coronary heart disease. N Engl J Med. 2007; 357:2371–9. [PubMed: 18057339]
3. Narayan KM, Boyle JP, Thompson TJ, Sorensen SW, Williamson DF. Lifetime risk for diabetes mellitus in the United States. JAMA. 2003; 290:1884–90. [PubMed: 14532317]
4. Gidding SS, Dennison BA, Birch LL, et al. Dietary recommendations for children and adolescents: a guide for practitioners. Pediatrics. 2006; 117:544–59. [PubMed: 16452380]
5. Gidding SS, Dennison BA, Birch LL, et al. Dietary recommendations for children and adolescents: a guide for practitioners: consensus statement from the American Heart Association. Circulation. 2005; 112:2061–75. [PubMed: 16186441]
6. O'Connor TM, Yang SJ, Nicklas TA. Beverage intake among preschool children and its effect on weight status. Pediatrics. 2006; 118:e1010–8. [PubMed: 17015497]
7. Huh SY, Rifas-Shiman SL, Rich-Edwards JW, Taveras EM, Gillman MW. Prospective association between milk intake and adiposity in preschool-aged children. J Am Diet Assoc. 2010; 110:563–70. [PubMed: 20338282]
8. LaRowe TL, Moeller SM, Adams AK. Beverage patterns, diet quality, and body mass index of US preschool and school-aged children. J Am Diet Assoc. 2007; 107:1124–33. [PubMed: 17604741]

9. Fox MK, Condon E, Briefel RR, Reidy KC, Deming DM. Food consumption patterns of young preschoolers: are they starting off on the right path? J Am Diet Assoc. 2010; 110:S52–9. [PubMed: 21092769]
10. USDA National Nutrient Database for Standard Reference, Release 24. https://www.ars.usda.gov/SP2UserFiles/Place/12354500/Data/SR24/nutrlist/sr24a204.pdf. Accessed 4/9/2012
11. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, et al. CDC growth charts: United States. Adv Data. 2000:1–27. [PubMed: 11183293]
12. Choi Y, Bishai D, Minkovitz CS. Multiple births are a risk factor for postpartum maternal depressive symptoms. Pediatrics. 2009; 123:1147–54. [PubMed: 19336374]
13. Nord, C.; Edwards, B.; Andreassen, C.; Green, J.; Wallner-Allen, K.; Early, Childhood; Longitudinal, Study; Birth, Cohort. (ECLS-B), User’s Manual for the ECLS-B Longitudinal 9-Month-2-Year Data File and Electronic Codebook. Vol. 2006. Washington, DC: National Center for Education Statistics; p. 2006Publication NCES 2006–046vol
14. Kavey RE. How sweet it is: sugar-sweetened beverage consumption, obesity, and cardiovascular risk in childhood. J Am Diet Assoc. 2010; 110:1456–60. [PubMed: 20869483]
15. Olson CM, Demment MM, Carling SJ, Strawderman MS. Associations Between Mothers’ and Their Children’s Weights at 4 Years of Age. Child Obes. 2010; 6:201–207. [PubMed: 21743836]
16. Woo JG. Using body mass index Z-score among severely obese adolescents: a cautionary note. Int J Pediatr Obes. 2009; 4:405–10. [PubMed: 19922058]
17. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. Jama. 2012; 307:483–90. [PubMed: 22253364]
18. James WP. The fundamental drivers of the obesity epidemic. Obes Rev. 2008; 9(Suppl 1):6–13. [PubMed: 18307693]
19. Gupta N, Goel K, Shah P, Misra A. Childhood obesity in developing countries: epidemiology, determinants, and prevention. Endocr Rev. 2012; 33:48–70. [PubMed: 22240243]
20. Berkey CS, Rockett HR, Willett WC, Colditz GA. Milk, dairy fat, dietary calcium, and weight gain: a longitudinal study of adolescents. Arch Pediatr Adolesc Med. 2005; 159:543–50. [PubMed: 15939853]
21. Mozaffarian D, Hao T, Rimm EB, Willett WC, Hu FB. Changes in diet and lifestyle and long-term weight gain in women and men. N Engl J Med. 2011; 364:2392–404. [PubMed: 21696306]
22. Samra, RA. Fat Detection: Taste, Texture, and Post Ingestive Effects. Boca Raton, FL: CRC Press; 2010.
23. Baker RD, Greer FR. Diagnosis and prevention of iron deficiency and iron-deficiency anemia in infants and young children (0–3 years of age). Pediatrics. 2011; 126:1040–50. [PubMed: 20923825]
24. Ziegler EE. Consumption of cow’s milk as a cause of iron deficiency in infants and toddlers. Nutr Rev. 2011; 69(Suppl 1):S37–42. [PubMed: 22043881]
25. Foster GD, Wyatt HR, Hill JO, et al. A randomized trial of a low-carbohydrate diet for obesity. N Engl J Med. 2003; 348:2082–90. [PubMed: 12761365]
26. Sacks FM, Bray GA, Carey VJ, et al. Comparison of weight-loss diets with different compositions of fat, protein, and carbohydrates. N Engl J Med. 2009; 360:859–73. [PubMed: 19246357]
27. Robinson TN. Reducing children’s television viewing to prevent obesity: a randomized controlled trial. JAMA. 1999; 282:1561–7. [PubMed: 10546696]
28. Waters E, de Silva-Sanigorski A, Hall BJ, et al. Interventions for preventing obesity in children. Cochrane Database Syst Rev. 2011:CD001871. [PubMed: 22161367]
29. Taylor RW, McAuley KA, Williams SM, Barbezat W, Nielsen G, Mann JI. Reducing weight gain in children through enhancing physical activity and nutrition: the APPLE project. Int J Pediatr Obes. 2006; 1:146–52. [PubMed: 17899632]
30. Davis JN, Whaley SE, Goran MI. Effects of breastfeeding and low sugar-sweetened beverage intake on obesity prevalence in Hispanic toddlers. Am J Clin Nutr. 2012; 95:3–8. [PubMed: 22170357]
31. Winnick S, Lucas DO, Hartman AL, Toll D. How do you improve compliance? Pediatrics. 2005; 115:e718–24. [PubMed: 15930200]

What is already known on this topic

- The American Academy of Pediatrics recommends that children ≥2 years old consume low-fat milk.

What this study adds

- Consumption of low-fat milk did not restrain weight gain in preschoolers over time and in fact was associated with an increase risk of becoming overweight or obese between 2 and 4 years old.
- Healthcare practitioners seeing preschool children may wish to focus on weight-control practices with a greater evidence basis than is present for consumption of low-fat milk.

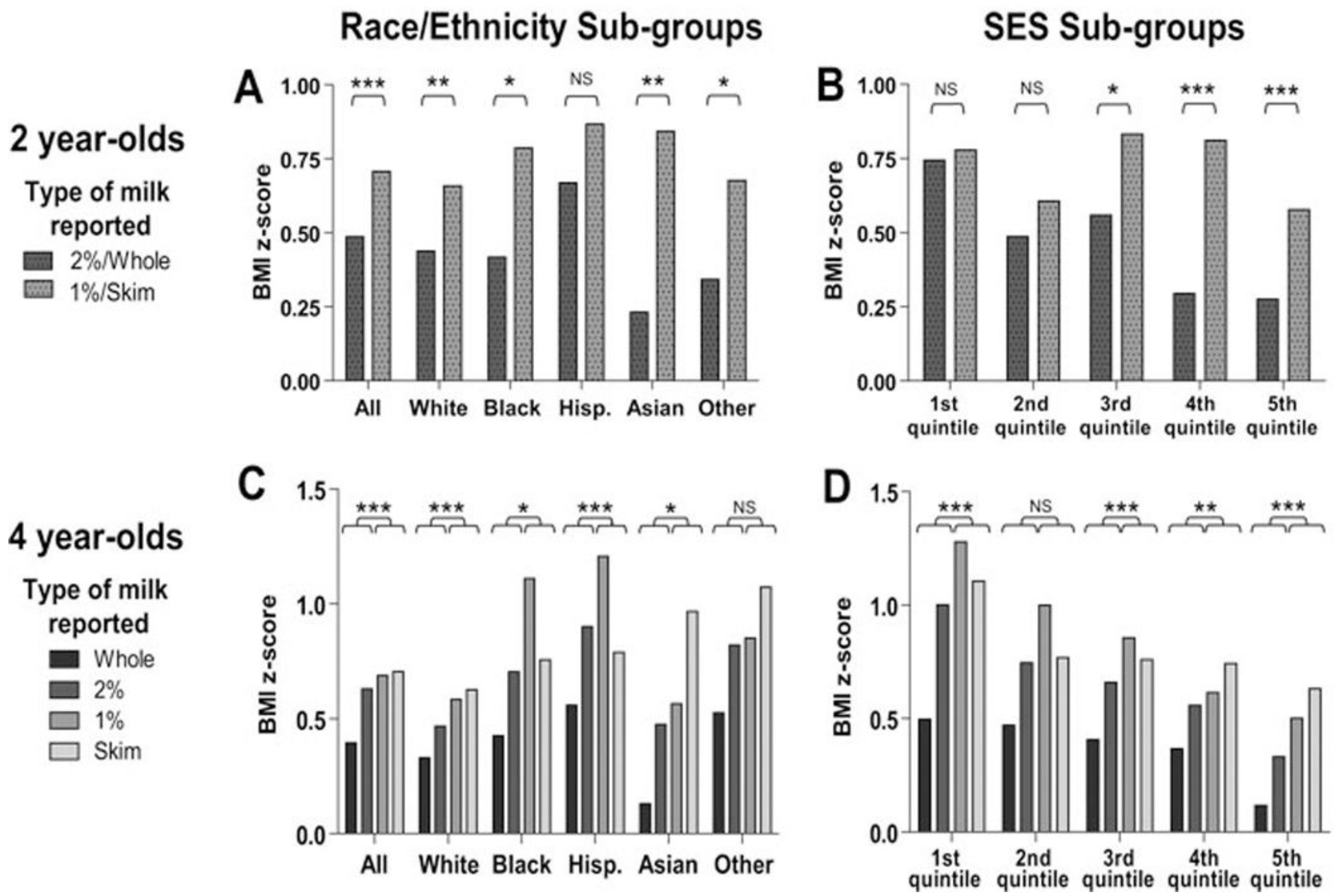

Figure 1. Mean BMI z-scores by milk-type, race/ethnicity and socioeconomic status at age 2 and 4 years

Data shown reflect mean BMI z-scores for 7450 2 year-old (A and B) and 8300 4 year-old (C and D) participants of the Early Childhood Longitudinal Study – Birth Cohort, broken down by racial/ethnic (A and C) and socioeconomic status (SES) (B and D) groups. P values for comparisons of mean BMI z-scores for drinkers of 1%/skim milk and 2%/whole milk: *** p<0.001, ** p<0.01, * p<0.05, NS not significant (p≥0.05).

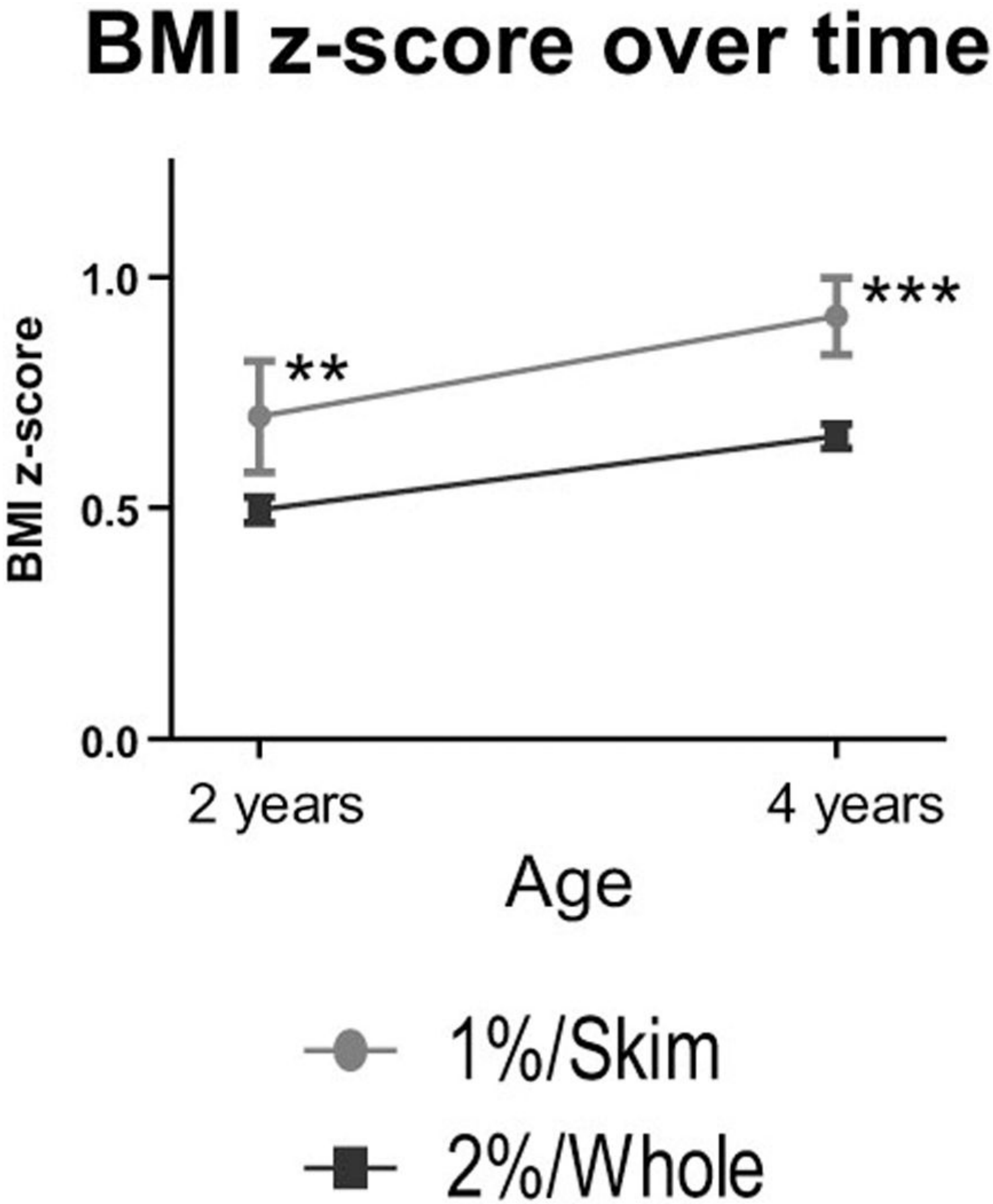

Figure 2. Longitudinal analysis of BMI z-score among consistent drinkers of 1%/skim and 2%/whole milk at age 2 and 4 years

Mean BMI z-score among children reported to drink 1%/skim (n=250) and 2%/whole (n=4900) at both time points shown. Significance is following adjustment for sex, race/ethnicity and socio-economic status. BMI z-scores were higher at 4 years than 2 years for both groups ($p<0.001$) but change in BMI z-score over time was not different between groups. P values: BMI z-score for consistent drinkers of 1%/skim milk vs. 2%/whole milk at each time point: ** $p<0.01$, ***$p<0.001$.

Table 1

Descriptive statistics overall and by type of milk consumed among 8,300 4-year-olds in the Early Childhood Longitudinal Study- Birth Cohort.

	Total number[†] (weighted % by category)	Milk-Type (weighted %)					
Variable		**Whole**	**2%**	**1%**	**Skim**	**Soy[‡]**	**Other[‡]**
Gender							
Male	4200 (51.2)	41.5%	38.3	8.1	6. 8	2.2	3.3
Female	4100 (48.8)	39.2	39.7	8.6	8.0	1.4	3.0
Weight status							
Normal weight	5650 (67.7)	43.9	37.4	7.4	6.1	1.9	3.3
Overweight	1350 (16.3)	37.9	40.7	8.6	7.3	2.0	3.4
Obese	1350 (15.9)	36.9	42.6	8.8	7.0	1.9	2.8
Race/Ethnicity							
White	3600 (53.7)	29.5	41.2	12.4	11.5	1.8	3.7
Black	1250 (13.7)	64.3	27.1	2.2	1.3	2.3	2.8
Hispanic	1650 (25.3)	49.9	40.7	3.7	2.2	1.7	1.9
Asian	850 (2.6)	56.7	30.5	5.4	2.0	2.0	3.4
Other	950 (4.7)	33.1	44.5	6.7	9.1	1.8	4.9
Socioeconomic Status							
1. High	1500 (20.0)	21.0	38.9	13.4	17.0	4.0	4.5
2. Medium High	1600 (20.1)	29.7	42.8	12.8	9.5	1.8	3.4
3. Medium	1650 (19.9)	40.2	41.4	7.8	6.5	1.3	2.8
4. Medium Low	1650 (20.0)	52.1	38.3	4.3	2.8	1.2	1.1
5. Low	1950 (20.0)	58.8	33.5	3.3	1.2	0.8	2.5
Juice Consumption							
≤1 drink/day	5050 (60.5)	35.5	39.9	9.4	8.8	2.0	3.4
>1 drinks/day	3300 (39.5)	46.2	37.6	6.7	5.2	1.5	2.8
SSB Consumption							
≤1 drink/day	7250 (86.4)	37.6	39.7	9.2	8.1	2.0	3.4
>1 drinks/day	1100 (13.6)	57.9	34.1	3.0	2.8	0.0	1.8

Variable	Total number† (weighted % by category)	Milk-Type (weighted %)					
		Whole	2%	1%	Skim	Soy‡	Other‡
Maternal BMI category							
Normal weight	3300 (39.0)	41.9	36.5	8.8	6.8	2.3	3.6
Overweight	2200 (28.2)	44.0	36.9	7.7	5.4	2.1	3.8
Obese	2650 (32.9)	40.8	42.6	6.8	6.0	1.5	2.4
Milk servings/day							
<2	2400 (28.5)	44.3	35.7	7.5	6.8	2.0	3.8
2	2550 (30.8)	37.3	40.9	8.8	7.8	1.7	3.5
>2	3350 (40.8)	39.9	39.9	8.6	7.5	1.7	2.5

† All N's are rounded to the nearest 50 in compliance with NCES guidelines.

‡ Soy and "other" drinkers were not included in the regression analyses.

Table 2

Logistic regression of milk type on obesity status at 2 and 4 years old

Shown are odds of overweight or obesity among drinkers of 1%/skim compared to whole/2%, in adjusted models.

	Overweight OR, CI	**p-value**	**Obese OR, CI**	**p-value**
Age 2 years[†]				
Model 0 (no adjustments)	1.434 (1.181–1.742)	0.0003	1.359 (1.048–1.763)	0.02
Model 1 (adjusted for sex, race/ethnicity, SES)	1.618 (1.313–1.994)	<0.0001	1.563 (1.185–2.062)	0.002
Model 1′ (Model 1 adjustments plus mom’s BMI)	1.639 (1.324–2.029)	<0.0001	1.569 (1.181–2.085)	0.002
Age 4 years				
Model 0 (no adjustments)	1.22 (1.031–1.444)	0.02	1.212 (0.998–1.473)	0.05
Model 1 (adjusted for sex, race/ethnicity, SES)	1.535 (1.256–1.876)	<0.0001	1.669 (1.342–2.076)	<0.0001
Model 2 (Model 1 adjustments plus juice, SSB intake)	1.550 (1.26–1.907)	<0.0001	1.695 (1.355–2.120)	<0.0001
Model 3 (Model 2 adjustments plus number of glasses of milk daily, mom’s BMI)	1.6332 (1.229–1.856)	<0.0001	1.646 (1.312–2.064)	<0.0001

[†]Additional information regarding juice, sugar sweetened beverages and number of glasses of milk consumed daily not available at 2 years old.

Table 3

Odds of children who were normal weight at 2 years becoming overweight/obese by 4 years among consistent drinkers of 1%/skim milk (n=250) compared to consistent drinkers of 2%/whole milk (n=4900).

	Odds ratio (CI)[†] for becoming overweight/obese between 2 and 4 years old: consistent drinkers of 1%/skim vs. 2%/whole	P value
Model 0 (no adjustments)	1.27 (0.83–1.95)	0.3
Model 1 (adjusted for sex, race/ethnicity, SES)	1.61 (1.02–2.54)	0.04
Model 2 (Model 1 adjustments plus juice, SSB intake)	1.64 (1.04–2.60)	0.03
Model 3 (Model 2 adjustments plus mom's BMI)	1.69 (1.09–2.61)	0.02
Model 4 (Model 3 adjustments plus daily glasses of milk (age 4), baseline BMI (age 2))	1.57 (1.03–2.42)	0.04

[†]Odds ratio for becoming overweight/obese between 2 and 4 years old for consistent drinkers of 1%/skim vs. 2%/whole.