Published in final edited form as:

Int J Pediatr Obes. 2008 ; 3(3): 168–176. doi:10.1080/17477160801915935.

Association between television viewing and poor diet quality in young children

Sonia A. Miller¹, Elsie M. Taveras^{1,2}, Sheryl L. Rifas-Shiman¹, and Matthew W. Gillman^{1,3}

¹Obesity Prevention Program, Department of Ambulatory Care and Prevention, Harvard Medical School and Harvard Pilgrim Health Care, Boston, MA

²Division of General Pediatrics, Children's Hospital Boston, Boston, MA

³Department of Nutrition, Harvard School of Public Health, Boston, MA

Abstract

Objective—To examine the association between television/video (TV) viewing and markers of diet quality among 3-year-old children.

Methods—We studied 613 boys and 590 girls, age 3 years old, who were participants in Project Viva. Each mother reported the number of hours her child watched TV on an average weekday and weekend day in the past month, from which we calculated a weighted mean. The main outcomes were intakes of selected foods and nutrients from a validated food frequency questionnaire. In linear regression models we adjusted for mother's sociodemographic information, parental body mass index (BMI), and child's age, sex, race/ethnicity, BMI z-score, sleep duration, and breast feeding duration.

Results—Mean (standard deviation, SD) age of subjects was 3.2 (0.2) years; 372 children (31%) were non-white and 151 (13%) had a household income <\$40 000, and 330 mothers (28%) had completed less than a college degree. Mean (SD) TV viewing was 1.7 (1.0) hours per day. For each 1-hour increment of TV viewing per day, we found higher intakes of sugar-sweetened beverages (0.06 servings/day [95% CI 0.03, 0.10]), fast food (0.32 servings/month [95% CI 0.16, 0.49]), red and processed meat (0.06 servings/day [95% CI 0.02, 0.09]), total energy intake (48.7 kcal/day [95% CI 18.7, 78.6]), and percent energy intake from trans fat (0.05 [95% CI 0.03, 0.07]). We found lower intakes of fruit and vegetables (−0.18 servings/day [95% CI −0.32, −0.05]), calcium (−24.6 mg/day [95% CI −41.0, −8.1]), and dietary fiber (−0.44 g/day [95% CI −0.65, −0.22]).

Conclusions—Among 3-year-olds, more TV viewing is associated with adverse dietary practices. Interventions to reduce TV viewing in this age group may lead to improved diet quality.

Keywords

Cross-sectional; diet quality; fast food; preschool children; television

Introduction

Television viewing is a pervasive source of entertainment among children. The Kaiser Family Foundation indicates that most preschool children in the United States are exposed to screen media; two-thirds of US children aged 0 to 6 years live in a household in which the television is reportedly on at least half of the time (1). The time children spend watching television exceeds the time they spend in any other single activity except for sleeping (2,3). Television viewing of greater than two hours per day is associated with an increased risk for overweight among 3-year-old children (4) as well as among the adolescent population (5). Television viewing is also associated with greater systolic blood pressure among adolescents (6).

Food advertisements during children's television programming have raised concern regarding their prevalence and content. An Institute of Medicine report indicated that food advertising influences food preferences and short-term consumption and is likely to contribute to a more unhealthy diet among children and youth (7). Most of the content of food advertisements is inconsistent with dietary recommendations, as they commonly depict items such as snack foods, candy, soft drinks, processed or prepared foods, and fast foods (8–11). Snacking while viewing television or videos has also been implicated in the association between television viewing and diet quality (12).

Previous studies have found that television viewing is associated with unhealthy dietary behaviors among older children and adolescents, including consumption of high fat foods, fast foods, and sugar-sweetened beverages, and consumption of fewer fruit and vegetables (9–11). Also, television viewing is associated with a lesser intake of those foods rarely appearing in advertisements and a greater intake of highly-advertised food items, suggesting that food advertisements promote unhealthy consumption patterns (13,14). The few studies that have examined the behavioral effects of television viewing on dietary patterns in children as young as 3 years of age have found a positive correlation between television viewing and children's requests for unhealthy foods (13–16) and fast food consumption (17). However, no study has examined the association between television viewing and intakes of a broad variety of foods and nutrients that are related to risks of obesity and chronic disease.

The purpose of this study was to examine the association between television and video viewing among the preschool population and diet quality, indicated by selected food and nutrient intakes. We hypothesize that greater frequency of television/video viewing among the preschool population will be associated with a greater intake of unhealthy foods and nutrients, as well as a lesser intake of healthy foods and nutrients.

Methods

Subjects and study design

Study subjects were participants in Project Viva, a cohort study of mothers and their children (18). Research assistants recruited women at their initial prenatal visits at eight urban and suburban obstetric offices of a multi-specialty group practice located in eastern

Massachusetts between April 22, 1999 and July 31, 2002. Eligibility criteria included fluency in English, gestational age <22 weeks at the initial prenatal clinical appointment, and singleton pregnancy. We previously reported details of recruitment and subsequent retention (18).

Of the 2 128 women who delivered a live infant, 1 579 were eligible for 3-year in-person follow-up by virtue of having completed prenatal nutritional assessments and providing consent for their children to be followed up. We collected follow-up information on 1 414 participants (89% of 1 594). For this analysis, we excluded 166 participants with missing data on television viewing and 45 participants on dietary intake at 3 years, leaving a cohort for analysis of 1 203.

Comparison of the 1 203 participants in this analysis with 2 128 who delivered a live infant showed a higher proportion of maternal white race (73% vs. 66%), college or graduate education (73% vs. 65%), and annual household income exceeding \$70 000 (65% vs. 61%) but no difference on mean maternal pre-pregnancy body mass index (BMI) or birth weight.

After obtaining informed consent, we collected demographic and health history information via interviews and self-administered questionnaires. We performed in-person study visits with the mother during her pregnancy and with both the mother and child immediately after delivery, at 6 months, and at 3 years after delivery. Mothers completed mailed questionnaires at 1 and 2 years post-partum. We obtained data on child's television/video viewing and dietary intake from 3-year questionnaires. We also collected covariate data, such as household income and education, through in-person visits and from mailed questionnaires, as outlined above. Human subjects committees of Harvard Pilgrim Health Care, Brigham and Women's Hospital, and Beth Israel Deaconess Medical Center approved the study protocols. All procedures were in accordance with the ethical standards for human experimentation established by the Declaration of Helsinki.

Measurements

Television/video viewing—Our exposure of interest was the number of hours of television and video (TV) viewing on average weekdays and weekend days at age 3 years old. As part of the 3-year questionnaire, we asked mothers the following question: "In the past month, on average, how many hours a day does your child spend sitting still watching TV/videos?" Response categories, which included: "None", "Less than one hour a day", "1–3 hours a day", "4–6 hours a day", "7–9 hours a day", and "10 or more hours a day", were given separately for both weekdays and weekend days. Mothers denoted a separate category for weekdays and weekend days. This measure of TV viewing, adapted from that used in the National Longitudinal Study of Youth Child Data (19), is linked in a dose-response manner with overweight among children (20) and demonstrates considerable tracking with TV viewing over the infancy and toddler years (21). Parental report, while overestimating child's TV viewing in comparison to both diaries and direct observation, appears to be well correlated with videotaped observation (22).

Diet quality and energy intake—We chose our diet quality variables on the basis of current knowledge of food groups, nutrients, and dietary behaviors that are associated with

increased or decreased risk for diseases of adolescence and adulthood, including weight gain, iron-deficiency anemia, diabetes, osteoporosis, cardiovascular disease, and cancer (23–28). At the 3-year visit, mothers completed a semiquantitative food frequency questionnaire, validated for use in preschool-age children, regarding their child's diet during the previous month to estimate food and nutrient intake (29). Response categories for foods, except for drinks and snack foods, included: "Never", "Less than once per week", "Once per week", "Nearly daily or daily", and "2 or more times per day" and for drinks and snack foods included: "Never", "Less than once per week", "Once per week", "2–4 times per week", "Nearly daily or daily", "2–4 times per day", and "5 or more times per day". It included questions regarding usual frequency of intake of specific food and drink items during the past month. Using nutrient composition databases, food portion sizes, and each child's reported intake of each food, we estimated daily intakes of dietary fiber, dietary calcium, fruit and vegetables, sugar-sweetened beverages, red and processed meats, and snack food; monthly intakes of fast food; percent of total energy intake from total fat, trans fat, saturated fat, polyunsaturated fat, carbohydrate, and protein; the ratio of polyunsaturated to saturated fat; total energy intake (kcal/day and kJ/kg body weight); and multivitamin use. We defined snack food as chips, crackers, Jello, cookies or brownies, cake or cupcake, pie, chocolate candy, and other candy. To calculate intake of nutrients, we used the Harvard nutrient composition database used for the Nurses' Health Study and other large cohort studies (27).

Other measures—During the first trimester of pregnancy, the women reported their age, education, height, and pre-pregnancy weight. Women also reported biological father's weight and height, from which we calculated his body mass index. At 6, 12, and 24 months, we asked mothers if they were still breastfeeding. If they had stopped, we asked them the children's age at cessation. At 3 years, we measured children's heights and weights using a calibrated stadiometer (Shorr Productions, Olney, MD) and scale (Seca model 881; Seca Corp., Hanover, MD). We calculated age- and sex-specific BMI z-scores using US national reference data (30). As part of the 3-year questionnaire, mothers reported their current marital status, household income, and whether or not they currently smoked cigarettes. Additionally, mothers reported child's race/ethnicity and average sleep duration over a 24-hour period at 3 years. We selected child's sleep duration as a covariate because the literature demonstrates an association between short sleep duration and childhood overweight (31–33).

Statistical analysis

Our exposure was defined as the number of hours of TV viewing at age 3 years. We first performed descriptive analyses of our exposure (TV viewing), covariates, and outcomes (food and nutrient intakes) to assess for normality of their distributions. We then examined the bivariate relationship between the number of hours of TV viewing, both categorically and continuously, and our covariates, as well as our outcomes. We examined the exposure as a continuous variable by first assigning the following hr/day values to the weekend and weekday TV response categories: None (0), Less than one hour a day (0.5), 1–3 hours a day (2), 4–6 hours a day (5), 7–9 hours a day (8), and 10 or more hours a day (10). Next we calculated a weighted average of hours per day of TV viewing ($[\text{weekend hr/day} \times 2 + \text{weekday hr/day} \times 5]/7$). Also, we divided the continuous exposure into a categorical

variable with the following four categories: 0–½ hour/day, >½–<2 hours/day, 2 hours/day, and >2 hours/day.

We then used multiple linear regression models to assess the independent association between number of hours of TV viewing per day and selected diet quality indicators at 3 years of age. We assessed the confounding effect of covariates by examining the association between TV viewing with outcomes before and after adding the covariates to the model. The final model adjusted for mother's age, household income, education, marital status, and smoking; pre-pregnancy maternal and paternal BMI; and child's race/ethnicity, BMI z-score, sleep duration at 3 years, and breast feeding duration, in addition to child's age and sex. We selected these covariates because bivariate results demonstrated their association with both child's TV viewing and dietary intake or the literature supported their importance. We report regression estimates (β) and 95% confidence intervals (CIs) for the main predictor. We conducted all analyses using SAS, version 9.1 (SAS Institute, Cary, NC).

Results

Participants' mean (standard deviation, SD) age was 3.2 (0.2) years. Participants viewed TV for an average of 1.7 (1.1) hours per day and consumed an average of 1 663 (492.8) kcal/day. Approximately 13% of participants had a household income <\$40 000, and 28% of mothers had less than a college degree. The cohort was 31% non-white. Mean (SD) BMI z-score was 0.45 (1.00) at age 3 years.

In bivariate analyses, children who lived in homes with higher household incomes, higher maternal educational attainment, and children whose parents were married or cohabitating spent fewer hours viewing TV (Table I). Children whose mothers currently smoked cigarettes spent a greater amount of time viewing TV (Table I). We also observed that child's sleep duration was inversely associated with hours of television viewing (Table I).

Table II demonstrates intakes of selected foods by amount of TV viewing per day. We found that children who spent more time viewing TV demonstrated higher intakes of sugar-sweetened beverages, fruit juice, whole or 2% milk, fast food, snack food, and red and processed meats. Children who spent more time viewing TV also reported lower intakes of fruit and vegetables.

Table III shows bivariate results for nutrients. Participants who viewed more TV had higher total energy intake (kcal/day) and higher percent of total energy intake from total fat, trans fat, and polyunsaturated fats. Children who viewed more TV reported lower intakes of calcium, dietary fiber, and percent of total energy intake from carbohydrates and proteins. TV viewing was not associated with percent of total energy intake from saturated fat, the ratio of polyunsaturated to saturated fat, or multivitamin use.

In multiple linear regression analyses (Table IV), each additional hour of TV viewing was associated with higher intake of sugar-sweetened beverages, fruit juice, whole fat or 2% milk, fast food, snack food, red or processed meats, total energy (kcal/day and kJ/kg body weight), and percent of total energy intake from total fat and trans fat (Table IV). Each additional hour of TV viewing was also associated with lower intake of skimmed or 1%

milk intake, fruit and vegetables, dietary fiber, and calcium (Table IV). A one-hour increment of TV viewing was associated with a lower percentage of total energy intake from protein (-0.19 ; 95% CI: $-0.33, -0.05$) (Table IV). The association with higher polyunsaturated fat observed in bivariate analysis was attenuated after adjustment (0.06 ; 95% CI: $-0.02, 0.15$) (Table IV). TV viewing was not associated with multivitamin use (OR 1.05 ; 95% CI: $0.92, 1.20$) or the ratio of polyunsaturated to saturated fats ($\beta -0.0005$; 95% CI: $-0.01, 0.01$).

Multiple regression analyses performed with the categorical TV viewing variable demonstrated results similar to those demonstrated with continuous TV viewing (data not shown).

Discussion

In this study, we found that among 3-year-old children, more time spent viewing TV was associated with unhealthy dietary patterns. These associations were characterized by higher intakes of sugar-sweetened beverage, fast food, snack food, red and processed meat, total energy, and trans fat, as well as lower consumption of fruit and vegetables, dietary fiber, and calcium.

Our results confirm and extend findings of a previous study in preschool children that found a positive association between television viewing and fast food consumption (17). In that study of 240 parents of children between the ages of 2.0 and 5.9 years, television and video viewing was directly associated with fast food consumption among boys and girls. Our study examined a wide range of indicators of diet quality in addition to fast food consumption. Our results also extend findings from previous studies involving adolescents and the association between TV viewing and lower intake of fruit and vegetables (13) and higher intake of fast food (14). This extension to a younger age emphasizes the impact of TV viewing on diet quality even at an early age, providing preventive implications.

One possible explanation for the manner in which TV viewing is associated with an unhealthy diet pattern is that children may snack while viewing television or videos. Previous studies have indicated that TV viewing is associated with both higher intakes of snack foods (34) and snacking between meals (35) in children older than those in our study. While we found a positive association between TV viewing and consumption of snack foods, we did not assess when or where these snack foods were consumed. Therefore, we are unable to determine if snacking is taking place while watching television.

Another possible explanation is that advertisements for unhealthy foods lead to altered food preferences and increases in consumption. While our study did not involve examination of the content of the children's TV programming, we did show associations between TV viewing and higher consumption of highly-advertised items, like sugar-sweetened beverages, fast food, and snack food, and lower consumption of foods rarely appearing in advertisements, like fruit and vegetables (9–11,36). Similarly, previous studies among adolescents have found that TV is associated with a greater consumption of highly-

advertised foods, like fast food and snack food, and a lesser consumption of poorly-advertised foods, like fruit and vegetables (13,14).

A previous study indicated that only one or two exposures to a short food commercial are necessary to influence a preschool-age child's food preferences (15). Another study reported that children's amount of TV screen time alone is associated with requests for advertised items (16). In the context of findings that brief exposure to advertisements is sufficient to influence a preschool child's preferences (15), our findings suggest that food advertisements may explain at least in part why greater amounts of TV viewing are related to unhealthy dietary patterns.

Confounding may also explain our results. However, we did not observe a material change in our results when we adjusted for several environmental or lifestyle factors that may contribute to dietary patterns, such as child's race/ethnicity, and BMI z-score; maternal sociodemographic information; and child's sleep duration and duration of breast feeding.

Young children's TV and eating habits often reflect those of their parents or caregivers. For instance, children who watch greater amounts of TV may do so because those caring for them may frequently watch TV. Therefore, the association we found between young children's television/video viewing and poorer diet quality could, in fact, reflect an association between parents' television viewing and diet quality. These two associations may not be distinguished in the results of our study, though it is likely our results reflect at least some combination of the two. Therefore, decreasing children's screen time may not be sufficient, but rather a household adjustment of screen time may be necessary.

We chose our diet quality indicators based on their known associations with various health outcomes of children and adults. For instance, sugar-sweetened beverage intake is associated with weight gain in children (37,38). Also, calcium intake is associated with decreased blood pressure among children (39,40), as well as increased bone mineral density among children (24). Fruit and vegetables may play a protective role against the development of cancer and coronary heart disease (23,25). A positive relationship exists between trans and saturated fat consumption and coronary heart disease risk (23,27,41). Diet quality indices are often used to provide a summary of diet quality rather than observing single food and nutrient items (42,43). However, we chose to not utilize such a summary score to allow for examination of single food and nutrient items as well as the trends seen among them. Additionally, we are unaware of a diet quality index that has been validated for use in the preschool-age population. While individual differences in food and nutrient intake associated with each one-hour increment increase in TV viewing may seem small, the overall pattern demonstrates that TV viewing is associated with poor diet quality. When interpreting our results, the overall trend of food and nutrient intakes is most important to observe, rather than each food or nutrient item individually.

The strengths of our study include collection of television/video viewing as well as detailed dietary information using validated tools. The cross-sectional design is a limitation, but it is more likely that television viewing leads to poor diet quality than vice versa. However, a prospective look at the association between television viewing with diet quality assessed at

some future point in time would provide a directionality to the association that our study is unable to provide. Should the association be sustained in such a prospective study after adjustment for appropriate confounders, we could draw the conclusion that television viewing leads to poor diet quality. Generalizability may be somewhat limited as subjects reside only in eastern Massachusetts and are largely not of low income. Our study combined television and video viewing into one variable and did not involve the assessment of the content of the television or videos viewed by study participants. Therefore, we were unable to assess directly any association between exposure to food advertisements appearing in television or videos and diet quality.

Our data suggest that our study population watches a mean of 1.7 hours of television/videos per day, which is slightly below the mean for the general preschool-age population (approximately 2.1 hours/day). Our cohort in general includes insured and educated families, which may partly explain why averages were less among our cohort than the general population. However, this difference may limit the generalizability of our study to the wider preschool-age population and emphasizes the importance of the repetition of similarly-designed studies among different populations in order to assess to what extent our results may be generalized. Additionally, we acknowledge that the possibility of underreporting of children's television/video viewing does exist, impacting the results of our study. However, underreporting of child's television/video viewing would result in our underestimation of the association between television/video viewing and diet quality. In the future, though, a more accurate measure of children's television/video viewing could include parental daily diaries, videotaped observation, and direct observation. Finally, videos tend to contain fewer advertisements in comparison to television programs, making the role of advertisements even more difficult to assess from our results.

In summary, our results indicate that greater time spent viewing television and videos is associated with adverse dietary patterns. The results of our study suggest that further research in this area needs to be performed to assess the association between television/video viewing and diet quality both prospectively, as well as potentially in a case-controlled manner in the future. Further studies are necessary to confirm and solidify the results we obtained. Finally, the results of our study suggest that parents, policymakers, and clinicians should encourage limitations on children's television and video viewing in an effort to improve diet quality among young children.

Acknowledgments

Funding was provided by NIH (HD 034568, HL 069425, HL 068041); and Harvard Medical School Division of Nutrition, PASTEUR, and Office of Enrichment Programs. E. M. Taveras was supported in part by the Harold Amos Medical Faculty Development Program of the Robert Wood Johnson Foundation.

References

1. Rideout, VJ.; Vandewater, EA.; Wartella, EA. Zero to Six: Electronic Media in the Lives of Infants, Toddlers, and Preschoolers. Menlo Park, CA: Henry J. Kaiser Family Foundation; 2003.
2. Christakis DA, Ebel BE, Rivara FP, Zimmerman FJ. Television, video, and computer game usage in children under 11 years of age. *J Pediatr*. 2004; 145:652–656. [PubMed: 15520768]

3. Dietz WH, Strasburger VC. Children, adolescents, and television. *Curr Probl Pediatr Adolesc Health Care*. 1991; 21:8–32.
4. Lumeng JC, Rahnema S, Appugliese D, Kaciroti N, Bradley RH. Television exposure and overweight risk in preschoolers. *Arch Pediatr Adolesc Med*. 2006; 160:417–422. [PubMed: 16585488]
5. Gortmaker SL, Must A, Sobol AM, Peterson K, Colditz GA, Dietz WH. Television viewing as a cause of increasing obesity among children in the United States, 1986–1990. *Arch Pediatr Adolesc Med*. 1996; 150:356–362. [PubMed: 8634729]
6. Sugiyama T, Xie D, Graham-Maar RC, Inoue K, Kobayashi Y, Stettler N. Dietary and lifestyle factors associated with blood pressure among U.S. adolescents. *J Adolesc Health*. 2007; 40:166–172. [PubMed: 17259057]
7. McGinnis, JM.; Appleton Gootman, J.; Kraak, VI. Food Marketing to Children and Young: Threat or Opportunity?. Washington DC: Committee on Food Marketing and the Diets of Children and Youth. Institute of Medicine of the National Academies; 2005.
8. Epstein LH, Paluch RA, Consalvi A, Riordan K, Scholl T. Effects of manipulating sedentary behavior on physical activity and food intake. *J Pediatr*. 2002; 140:334–339. [PubMed: 11953732]
9. Harrison K, Marske AL. Nutritional content of foods advertised during the television programs children watch most. *Am J Public Health*. 2005; 95:1568–1574. [PubMed: 16118368]
10. Taras HL, Gage M. Advertised foods on children's television. *Arch Pediatr Adolesc Med*. 1995; 149:649–652. [PubMed: 7767420]
11. Dietz WH, Strasburger VC. Children, adolescents, and television. *Curr Probl Pediatr*. 1991; 21:8–31. [PubMed: 2022120]
12. Gore SA, Foster JA, DiLillo VG, Kirk K, Smith West D. Television viewing and snacking. *Eat Behav*. 2003; 4:399–405. [PubMed: 15000965]
13. Boynton-Jarrett R, Thomas TN, Peterson KE, Wiecha J, Sobol AM, Gortmaker SL. Impact of television viewing patterns on fruit and vegetable consumption among adolescents. *Pediatrics*. 2003; 112:1321–1326. [PubMed: 14654604]
14. Wiecha JL, Peterson KE, Ludwig DS, Kim J, Sobol A, Gortmaker SL. When children eat what they watch. *Arch Pediatr Adolesc Med*. 2006; 160:436–442. [PubMed: 16585491]
15. Borzekowski DLG, Robinson TN. The 30-second effect: An experiment revealing the impact of television commercials on food preferences of preschoolers. *J Am Diet Assoc*. 2001; 101:42–46. [PubMed: 11209583]
16. Chamberlain LJ, Wang Y, Robinson TN. Does children's screen time predict requests for advertised products? *Arch Pediatr Adolesc Med*. 2006; 160:363–368.
17. Taveras EM, Sandora TJ, Shih MC, Ross-Degnan D, Goldmann DA, Gillman MW. The association of television and video viewing with fast food intake by preschool-age children. *Obesity*. 2006; 14:2034–2041. [PubMed: 17135621]
18. Gillman MW, Rich-Edwards JW, Rifas-Shiman SL, Lieberman ES, Kleinman KP, Lipshultz SE. Maternal age and other predictors of newborn blood pressure. *J Pediatr*. 2004; 144:240–245. [PubMed: 14760269]
19. Baker PC, Keck CK, Mott FL, Quinlan SV. NLYS Child Handbook, revised edition: A guide to the 1986–90 National Longitudinal Survey of Youth Child Data. Columbus, Ohio. 1993
20. Gortmaker SL, Must A, Sobol AM, Peterson K, Colditz GA, Dietz WH. Television viewing as a cause of increasing obesity among children in the United States, 1986–1990. *Arch Pediatr Adolesc Med*. 1996; 150:356–362. [PubMed: 8634729]
21. Certain LK, Kahn RS. Prevalence, correlates, and trajectory of television viewing among infants and toddlers. *Pediatrics*. 2002; 109:634–642. [PubMed: 11927708]
22. Anderson DR, Field DE, Collins PA, Lorch EP, Nathan JG. Estimates of young children's time with television: a methodological comparison of parent reports with time-lapse video home observation. *Child Dev*. 1985; 56:1345–1357. [PubMed: 4053746]
23. Willett WC. Diet and health: what should we eat? *Science*. 1994; 264:532–537. [PubMed: 8160011]
24. Johnston CC, Miller JZ, Slemenda CW. Calcium supplementation and increase in bone mineral density in children. *N Engl J Med*. 1992; 237:82–87. [PubMed: 1603140]

25. Gillman MW. Enjoy your fruit and vegetables: eating fruit and vegetables protects against the common chronic diseases of adulthood. *BMJ*. 1996; 313:765–766. [PubMed: 8842060]
26. Salmeron J, Manson JE, Stampfer MJ, Colditz GA, Wing AL, Willett WC. Dietary fiber, glycemic load, and risk of non-insulin-dependent diabetes mellitus in women. *JAMA*. 1997; 277:472–477. [PubMed: 9020271]
27. Hu FB, Stampfer MJ, Manson JE, et al. Dietary fat intake and the risk of coronary heart disease in women. *N Eng J Med*. 1997; 337:1491–1499.
28. Posner B, Cobb JL, Belanger A, Cupples LA, D'Agostino RB, Stokes J. Dietary lipid predictors of coronary heart disease in men. The Framingham study. *Arch Intern Med*. 1991; 151:1181–1187. [PubMed: 2043019]
29. Blum RE, Wei EK, Rockett HR, et al. Validation of a food frequency questionnaire in Native American and Caucasian children 1 to 5 years of age. *Matern Child Health J*. 1999; 3:167–172. [PubMed: 10746756]
30. National Center for Health Statistics [homepage on the Internet]. Hyattsville, MD: Department of Health and Human Services; [updated 2007 Feb 12]. Available from <http://www.cdc.gov/growthcharts/>
31. Lumeng JC, Somashekar D, Appugliese D, Kaciroti N, Corwyn RF, Bradley RH. Shorter sleep duration is associated with increased risk for being overweight at ages 9 and 12 years. *Pediatrics*. 2007; 120:1020–1029. [PubMed: 17974739]
32. Chaput JP, Brunet M, Tremblay A. Relationship between short sleeping hours and childhood overweight/obesity: Results from the 'Quebec en Forme' project. *Int J Obes (Lond)*. 2006; 30:1080–1085. [PubMed: 16534525]
33. Taheri S. The link between short sleep duration and obesity: we should recommend more sleep to prevent obesity. *Arch Dis Child*. 2006; 91:881–884. [PubMed: 17056861]
34. Campbell KJ, Crawford DA, Ball K. Family food environment and dietary behaviors likely to promote fatness in 5–6 year-old children. *Int J Obes (Lond)*. 2006; 30:1272–1280. [PubMed: 16491108]
35. Gorely T, Marshall SJ, Biddle SJ. Couch kids: correlates of television viewing among youth. *Int J Behav Med*. 2004; 11:152–163. [PubMed: 15496343]
36. Kotz K, Story M. Food advertisements during children's Saturday morning television programming: Are they consistent with dietary recommendations? *J Am Diet Assoc*. 1994; 94:1296–1300. [PubMed: 7963175]
37. Welsh JA, Cogswell ME, Rogers S, Rockett H, Mei Z, Grummer-Strawn LM. Overweight among low-income preschool children associated with consumption of sweet drinks; Missouri, 1999–2002. *Pediatrics*. 2005; 155:223–229.
38. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet*. 2001; 357:505–508. [PubMed: 11229668]
39. Gillman MW, Oliveria SA, Moore LL, Ellison RC. Inverse association of dietary calcium with systolic blood pressure in young children. *JAMA*. 1992; 267:2340–2343. [PubMed: 1564773]
40. Gillman MW, Hood MY, Moore LL, Nguyen US, Singer MR, Andon MB. Effect of calcium supplementation on blood pressure in children. *J Pediatr*. 1995; 127:186–192. [PubMed: 7636641]
41. Oh K, Hu FB, Manson JE, Stampfer MJ, Willett WC. Dietary fat intake and risk of coronary heart disease in women: 20 years of follow-up of the nurses' health study. *Am J Epidemiol*. 2005; 161:672–679. [PubMed: 15781956]
42. Patterson RE, Haines PS, Popkin BM. Diet quality index: capturing a multidimensional behavior. *J Am Diet Assoc*. 1994; 94:57–64. [PubMed: 8270756]
43. Kranz S, Hartman T, Siega-Riz AM, Herring AH. A diet quality index for American preschoolers based on current dietary intake recommendations and an indicator of energy balance. *J Am Diet Assoc*. 2006; 106:1594–1604. [PubMed: 17000192]

Parental and child characteristics by television/video viewing at 3 years of age. Data from 1 203 Mother-Child pairs participating in Project Viva.

Table 1

Characteristic	Television/Video viewing at age 3 years (hrs/day)				P for trend
	0-1/2 hr/day (N=252)	>1/2-1 hr/day (N=295)	2 hrs/day (N = 537)	> 2 hrs/day (N = 119)	
Parental characteristic		Mean (SD)			
Maternal age (years)	32.9 (4.4)	32.3 (5.1)	32.6 (4.8)	30.7 (6.0)	0.006
Maternal BMI (kg/m ²)	23.7 (4.1)	24.5 (5.3)	24.8 (5.3)	26.0 (6.0)	0.0001
Paternal BMI (kg/m ²)	25.7 (3.6)	25.8 (3.5)	26.7 (3.9)	27.6 (4.5)	<0.0001
		No. of subjects (%)			P for trend
Household income					
>\$70 000	179 (71.0)	208 (70.5)	344 (64.0)	51 (42.9)	<0.0001
\$40 001-\$70 000	42 (16.7)	45 (15.3)	122 (22.7)	30 (25.2)	
(\$40 000	19 (7.5)	34 (11.5)	61 (11.4)	37 (31.1)	
Don't know or missing	12 (4.8)	8 (2.7)	10 (1.9)	1 (0.8)	
Maternal education					
Some college or less	38 (15.1)	61 (20.8)	170 (31.8)	61 (51.3)	<0.0001
College graduate or more	214 (84.9)	233 (79.3)	365 (68.2)	58 (48.7)	
Marital status					
Married/cohabitating	242 (96.0)	267 (90.8)	510 (95.0)	99 (83.2)	0.01
Single/divorced/widowed	10 (4.0)	27 (9.2)	27 (5.0)	20 (16.8)	
Maternal smoking at 3 yrs					
Yes	8 (3.2)	19 (6.5)	36 (6.7)	15 (12.6)	0.002
No	244 (96.8)	275 (93.5)	500 (93.3)	104 (87.4)	
Child characteristics		Mean (SD)			P for trend
Child's age (years)	3.2 (0.2)	3.2 (0.2)	3.2 (0.2)	3.2 (0.2)	0.15
Child's BMI (kg/m ²)	16.3 (1.2)	16.3 (1.2)	16.6 (1.6)	16.8 (1.9)	<0.0001
Child's BMI z-score	0.33 (0.94)	0.31 (0.87)	0.53 (1.05)	0.66 (1.12)	0.0002
Breast feeding duration (months)	7.6 (4.3)	6.8 (4.5)	6.2 (4.6)	4.1 (4.1)	<0.0001
Sleep duration (hrs/day)	11.3 (1.0)	11.2 (1.1)	11.2 (1.1)	10.9 (1.4)	0.002
		No. of subjects (%)			P for trend
Child's sex					

Characteristic	Television/Video viewing at age 3 years (hrs/day)			
	0-1/2 hr/day (N=252)	>1/2-2 hrs/day (N=295)	2 hrs/day (N = 537)	> 2 hrs/day (N = 119)
Boy	121 (48.0)	153 (51.9)	278 (51.8)	61 (51.3)
Girl	131 (52.0)	142 (48.1)	259 (48.2)	58 (48.7)
Child's race/ethnicity				
White	197 (78.2)	196 (66.4)	384 (71.5)	54 (45.4)
Black	18 (7.1)	31 (10.5)	61 (11.4)	33 (27.7)
Hispanic	8 (3.2)	14 (4.8)	15 (2.8)	10 (8.4)
Other	29 (11.5)	54 (18.3)	77 (14.3)	22 (18.5)

SD: standard deviation; BMI: body mass index.

Table II

Intakes of selected foods by television/video viewing at age 3 years. Data from 1 203 Mother-Child pairs participating in Project Viva.

Foods or Food Groups	Television/Video viewing at age 3 years (hrs/day)				P for trend
	0-1/2 hr/day (N = 252)	>1/2-2 hrs/day (N=295)	2 hrs/day (N = 537)	> 2 hrs/day (N = 119)	
	Mean (SD)				
Sugar-sweetened beverages (svgs/day)	0.20 (0.39)	0.32 (0.61)	0.37 (0.60)	0.56 (0.79)	<0.0001
Fruit juice (svgs/day)	1.51 (1.36)	1.69 (1.40)	1.86 (1.37)	1.85 (1.41)	0.001
Skimmed or 1% milk (svgs/day)	0.92 (1.33)	0.76 (1.31)	0.77 (1.30)	0.44 (0.98)	0.01
Whole or 2% milk (svgs/day)	1.10 (1.35)	1.43 (1.44)	1.39 (1.48)	1.41 (1.51)	0.03
Fast food intake (svgs/mo)	1.74 (2.49)	2.19 (2.64)	2.72 (2.81)	3.60 (3.40)	<0.0001
Snack food intake (svgs/day)	1.34 (0.80)	1.49 (0.97)	1.70 (0.95)	1.71 (1.23)	<0.0001
Fruit and vegetable intake (svgs/day)	4.53 (2.10)	4.52 (2.29)	4.21 (2.22)	3.91 (2.47)	0.004
Red/processed meats (svgs/day)	0.71 (0.55)	0.84 (0.50)	0.92 (0.58)	1.02 (0.74)	<0.0001
	No. of subjects (%)				P for trend
Multivitamin use					
Yes	152 (60.3)	170 (57.6)	329 (61.3)	68 (57.1)	0.98
No	100 (39.7)	125 (42.4)	208 (38.7)	51 (42.9)	

SD: standard deviation; "Svgs": servings.

Nutrient intakes by television viewing at age 3 years. Data from 1 203 Mother-Child pairs participating in Project Viva.

Table III

Nutrients	Television/Video viewing at age 3 years (hrs/day)				P for trend
	0-1/2 hr/day (N = 252)	>1/2-2 hrs/day (N = 295)	2 hrs/day (N = 537)	> 2 hrs/day (N = 119)	
	Mean (standard deviation)				
Total energy intake (kcal/day)	1574 (447)	1658 (495)	1695 (498)	1720 (537)	0.001
Total energy intake (kJ/kg body weight)	442 (133)	465 (154)	462 (157)	455 (154)	0.285
% energy intake from total fat	29.0 (5.1)	30.1 (4.9)	30.2 (4.9)	31.1 (5.2)	0.0001
% energy intake from trans fat	1.04 (0.33)	1.13 (0.32)	1.18 (0.34)	1.26 (0.40)	<0.0001
% energy intake from saturated fat	12.2 (2.8)	12.8 (3.0)	12.7 (2.8)	12.7 (2.9)	0.07
% energy intake from polyunsaturated fat	6.16 (1.52)	6.15 (1.45)	6.27 (1.34)	6.72 (1.41)	0.002
% energy intake from carbohydrates	56.7 (6.2)	55.8 (5.8)	55.9 (6.1)	54.9 (6.4)	0.02
% energy intake from protein	16.3 (2.2)	16.0 (2.1)	15.8 (2.3)	15.7 (2.3)	0.001
Dietary fiber (g/day)	14.9 (3.9)	14.0 (3.4)	13.6 (3.4)	13.0 (4.0)	<0.0001
Calcium (mg/day)	1015 (282)	989 (273)	963 (260)	869 (277)	<0.0001

Table IV

Increment in selected food and nutrient intakes associated with an additional hour of daily television/video viewing at age 3 years. Data from 1203 Mother-Child pairs participating in Project Viva.

Food/Nutrient	Unadjusted* (95% Confidence Interval)	Adjusted** (95% Confidence Interval)
Sugar-sweetened beverage (svgs/day)	0.09 (0.06, 0.12)	0.06 (0.03, 0.10)
Fruit juice intake (svgs/day)	0.11 (0.04, 0.18)	0.09 (0.003, 0.17)
Fast food intake (svgs/months)	0.49 (0.34, 0.64)	0.32 (0.16, 0.49)
Snack food intake (svgs/day)	0.12 (0.07, 0.17)	0.14 (0.08, 0.20)
Red or processed meats (svgs/day)	0.08 (0.05, 0.11)	0.06 (0.02, 0.09)
Whole or 2% milk intake (svgs/day)	0.08 (0.004, 0.16)	0.13 (0.04, 0.22)
Skimmed or 1% milk intake (svgs/day)	-0.11 (-0.18, -0.04)	-0.09 (-0.17, -0.01)
Fruit and vegetable intake (svgs/day)	-0.17 (-0.29, -0.05)	-0.18 (-0.32, -0.05)
Total energy intake (kcal/day)	41.1 (14.6, 67.5)	48.7 (18.7, 78.6)
Total energy intake (kJ/kg body weight)	3.40 (-5.2, 12.0)	11.2 (2.4, 20.0)
% energy intake from total fat	0.39 (0.12, 0.66)	0.43 (0.12, 0.74)
% energy intake from trans fat	0.05 (0.04, 0.07)	0.05 (0.03, 0.07)
% energy intake from saturated fat	0.07 (-0.09, 0.22)	0.14 (-0.04, 0.32)
% energy intake from polyunsaturated fat	0.11 (0.04, 0.19)	0.06 (-0.02, 0.15)
Ratio of polyunsaturated to saturated fat	0.01 (-0.003, 0.02)	-0.001 (-0.01, 0.01)
% energy intake from carbohydrates	-0.25 (-0.58, 0.08)	-0.33 (-0.70, 0.05)
% energy intake from protein	-0.23 (-0.35, -0.11)	-0.19 (-0.33, -0.05)
Dietary fiber, energy adj. (g/day)	-0.44 (-0.64, -0.25)	-0.44 (-0.65, -0.22)
Calcium intake, energy adj. (mg/day)	-37.9 (-52.3, -23.4)	-24.6 (-41.0, -8.1)

"Svgs": servings.

* Adjusted for child age and sex only.

** Adjusted for child age, sex, race/ethnicity, breastfeeding duration, and 3 year BMI z-score and daily sleep duration; maternal age, body mass index (BMI), education, marital status, and smoking; household income and paternal BMI.