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Screen time and adiposity in adolescents in Mexico

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Abstract

Objective—To assess the association of time spent viewing television, videos and videogames with measures of fat mass [body mass index (BMI)] and distribution [triceps and subscapular skin folds (TSF, SSF)].

Design—Cross-sectional validated survey, self-administered to students to assess screen time (TV, videos and videogames) and lifestyle variables. Trained personnel obtained anthropometry. The association of screen time with fat mass and distribution, stratified by sex, was modeled with multivariable linear regression, adjusting for potential confounders and correlation of observations within schools.

Subjects and setting—3519 males and 5613 females aged 11 to 18 years attending urban and rural schools in the State of Morelos, Mexico

Results—In males, ≥5 hr/day compared with < 2 hr/day of screen time, was significantly associated with a 0.13 (95%CI 0.04, 0.23) higher BMI z score, 0.73 mm (95% CI 0.24, 1.22) higher SSF and 1.08 mm (95% CI 0.36, 1.81) higher TSF. The positive association of screen time with SSF was strongest in males 11–12 yr. Sexual maturity appeared to modify the association in females; a positive between screen time and SSF was observed in those who had not undergone menarche (p-trend 0.04) but not among sexually mature females (p-trend 0.75).

Conclusion—Screen time is associated with fat mass and distribution among adolescent males in Mexico. Maturational tempo appears to affect the relationship of screen time with adiposity in boys and girls. Findings suggest obesity preventive interventions in the Mexican context should explore strategies to reduce screen time among youth in early adolescence.

Introduction

Consistent with worldwide trends, prevalence of obesity is increasing in Mexico (1). Between 1999 and 2006, the proportion of adults who are overweight or obese increased from 67 to 72% in women and from 61 to 67% in men (2, 3). Using international cut-off points, the prevalence of obesity in 1999 was 5.5% in preschool children and 19.5% in children aged 5 to 11 years (4).

Understanding behavioral determinants of youth obesity trends is essential to developing effective public health approaches to prevention and control in different country contexts. In observational studies, television viewing in children and adolescents has been associated with increased adiposity and obesity (5–9) and predicted high BMI, smoking, low cardiorespiratory fitness and high serum cholesterol in early adulthood (10). Randomized trials to limit television time and computer use among children in the United States (US) found a significant reductions of BMI (11) and lower BMI, TSF, waist circumferences and waist-to-hip ratios (12). Decreases in television viewing also mediated the effect of a middle-school, interdisciplinary curriculum on obesity (classified as BMI and TSF >85 %tile) in young adolescent girls (13).

Previous studies of the association of screen time with youth obesity inconsistently have assessed the use of media other than TV. Limited information on demographic, lifestyle and reproductive factors for chronic disease also may undermine the interpretability of results due to confounding by unmeasured variables. Furthermore, assessment of fat distribution in early puberty through skin folds in addition to fat mass may unveil additional insights on chronic disease risk in Mexican youth. In this study, we examine the association between time spent viewing television, videos and videogames and anthropometric measures of fat mass and distribution in a large survey of adolescents in the State of Morelos in Mexico.

Research Methods and Procedures

Study population

The data presented here derive from a large, representative survey conducted in 1999 to assess the prevalence of chronic disease risk factors in youth in the State of Morelos, Mexico. The methods are described elsewhere (14). Briefly, the study included a sample of youth aged 11 to 24 attending public junior high schools, high schools and the State University. The sampling unit was the school. The study population comprised 13,293 individuals, 56% of whom were female. The response rate was 98.6%. An imbalance between males and females in the sample was due to both an underlying distribution that favors females and a higher response rate in this group. Signed informed consent forms were obtained separately from the study participants and from their parents prior to collection of information. Participants were asked to complete a self-administered questionnaire on general lifestyle, frequency of food consumption, physical activity, drug use, and healthcare use. The survey was conducted in classrooms during school hours; anthropometry on all participants was obtained by trained staff in school settings. The study was approved by the Human Subjects Committee of the National Institute of Public Health of Mexico.

Eligible individuals for this analysis were 11 to 18 years of age with complete questionnaire and anthropometric information. We excluded young adults aged 19 and 24 years because we considered adolescence the developmental stage most biologically relevant to the emergence of chronic disease in early adulthood. To reduce potential confounding by underlying conditions associated with disability and related inactivity, we excluded underweight individuals, defined as being below the 15th percentile for BMI (15) and for TSF (16, 17). The final analytic sample comprised 9132 participants, 62% of whom were female. This sub sample did not differ significantly from the original sample with respect to major socio-demographic characteristics.

Data collection

Screen viewing and physical activity were measured using a questionnaire validated in Mexican youth (18). Individuals were asked about their usual daily hours viewing television, videos and videogames (never, <1, 1–2, 2–3, 3–4, 4–5, 6–7 or >7); on weekdays, Saturdays and Sundays. Computer use was not collected because home computer use is uncommon in this population. Eighteen percent of participants reported total daily screen time greater than 12 hours. A weighted average of hours of screen viewing (weekdays, Saturday and Sunday) was computed to obtain an overall average screen time. We categorized screen time as < 2, 2–2.9, 3–3.9, 4–4.9 and ≥ 5 hours/day in order to limit the error introduced by multitasking (e.g. playing videogames while watching TV) and the influence of outliers. Total TV and total video/videogames were similarly categorized. A weighted average of hours of inactivity was calculated using weekday and weekend hours of sitting down, using private or public transportation, doing homework and sleeping. The questionnaire also included eleven items to evaluate weekly hours of recreational physical activities (never, < 0.5, 0.5–2, 2–4 and 4–6) (17). Weekly expenditure of metabolic equivalents (MET) of moderate and vigorous physical activity was estimated by multiplying the responses to questions by the activity-specific energy expenditure as reported by Ainsworth et al (19). Energy-intake was estimated from a 103-item food frequency questionnaire adapted from a questionnaire validated for the Mexican adult population (20). Socioeconomic status (SES) was assessed using an index derived from a principal components analysis for the Mexican population that includes number of rooms in the house, people living in the household, municipal services, sanitary conditions, educational level of the mother's most recent sexual partner, ownership of home, car, television, VCR and telephone. Three categories were constructed using tertiles of the principal component score. (21)

Height, weight, TSF and SSF were measured using standardized procedures by trained personnel. Height and weight were measured using daily gauged portable stadiometers and portable Tanita scales (Tanita Corp., Itabashini-Ku, Tokyo, Japan), respectively. For skin folds, the average of three measurements using Lange calipers (Beta Technology, Inc., Santa Cruz, CA, USA) was used and expressed in millimeters. BMI was calculated as weight (kg)/height^2 (m^2) using the measured anthropometric data. Age and sex-specific standard deviation scores (z-scores) for BMI were calculated using the CDC 2000 guidelines (15). The International Obesity Task Force (IOTF) age-specific cut off points for overweight and obesity were used to estimate their prevalence. These cut-off points use an international reference population comprising children and adolescents from six different countries (22). These cut-offs were used for descriptive purposes only, to permit comparisons of BMI distribution with other countries.

Statistical Analysis

We analyzed females and males separately. Mean and standard deviation were estimated for screen viewing time within categories of selected participant characteristics and the distribution was compared across categories with the Kruskal-Wallis test. For ordinal predictors, we tested for linearity using linear regression. Next, we constructed linear regression models to explore the association of BMI z-scores, TSF and SSF with screen time, using the SAS SURVEYREG procedure to account for the non-independence of the observations given that the primary sampling unit was the school and that observations within schools may be correlated (SAS version 8, SAS Institute Inc., Cary, NC). Potential confounders of these associations considered in the multivariable model included age, height, SES tertile, single-parent family, birth in a hospital, father's educational level, mother's educational level, family income, family health insurance, weekly METs of moderate to vigorous physical activity, daily hours of inactivity excluding screen time, type of community (urban, suburban, rural), total energy intake, diagnosis of asthma, dieting and frequency of restaurant dining. Given the rapid change in adipose tissue distribution, linear growth, metabolic and hormonal environment during adolescence, we hypothesized age would modify the relationship of screen time with adiposity. Based on the results of this analysis we considered *post hoc* sexual maturity as another potential effect modifier. Sexual maturity was also considered a confounder. Females who had undergone menarche and males who reported having had an ejaculation were considered sexually mature. We also considered living in a rural environment and moderate-to-vigorous physical activity to be modifiers of this relation because physical activity affects adipose tissue and individuals in a rural environment may be more active. Results are presented as age-adjusted and multivariate adjusted.

Results

Table 1 shows the characteristics of the study population. Male adolescents reported a higher energy intake and greater METs of moderate and vigorous physical activities than females. After transforming questionnaire categories on media use to continuous variables, among males, a greater amount of total daily hours of screen time was spent watching TV [2.7 (SD 1.9)] hours as compared to watching videos [1.9 (SD 1.8)] and playing videogames [1.8 (SD 1.9) hours]. On average, females spent 2.8 (SD 1.9) hours every day watching TV and 1.6 (SD 1.8) on videos and played videogames 1.3 (SD 1.8) hours every day. Menarche was reported by 5,229 (93.2%) of female participants. The prevalence of obesity was slightly higher in males; approximately one-third of males and females were overweight.

Total daily screen time by different socio-demographic characteristics is described in Table 2. Significant differences in the mean daily screen time were observed for age, type of community, SES and medical insurance in males and females (p-value <0.01). Adolescent girls who reported they were dieting to lose weight reported significantly less screen time than those who said they wanted to gain weight. Mean screen time significantly increased with the level of urbanicity and in females, screen time increased with increasing SES (p-value <0.01). Energy intake significantly increased with increasing screen time in males and females (p-value <0.001). The mean daily energy intake in males in kilojoules for <2 hours of screen time was 15,305 and 18,759 for ≥ 5 hours. Females had a mean daily energy intake in kilojoules of 15,166 for <2 hours of screen time and for 17,581 for ≥5 hours.

In males, screen time was positively related to BMI-z scores in age-adjusted and multivariate-adjusted analyses. In the multivariate-adjusted model, males with ≥5 hours of screen time per day had a 0.13 (95%CI 0.04, 0.23) higher BMI-z score compared to males with <2 hours (p-trend <0.003). In females, screen time was positively related with BMI z-scores in age-adjusted analyses but not in multivariate-adjusted analyses (Table 3).

Screen time was positively related to TSF and SSF in males. After adjusting for confounding variables, males with ≥5 hours of screen time had a 1.08 mm (95% CI 0.36, 1.81) greater TSF, compared with males reporting <2 hours per day (p-trend 0.01). Similarly, after adjusting for confounding variables, males with ≥5 hours of screen time had a 0.73 mm (95%CI 0.24, 1.22) greater SSF compared with males with less than 2 hour of screen time (p-trend= 0.006). In females, screen time was positively related to TSF and SSF in age-adjusted but not multivariate adjusted analyses.

Age did not modify the association between screen time and BMI z-score or TSF in males or females. Nevertheless, the association between screen time and SSF differed significantly by age categories in males (p-value for interaction =0.005). A significant linear trend of increasing SSF with greater screen time was found in younger but not older males (Figure 1). In females, age did not modify the association between screen time and SSF. The association was however modified by sexual maturity; screen time was positively related to SSF among females who had not undergone menarche (p-trend 0.04) but not among sexually mature females (p-trend=0.75) (Figure 2).

Males spent 54% of their screen time on videos and videogames, while females spent 48%. For males, we found a significant increasing trend only in BMI-z scores when we analyzed videos and videogames independently of TV (p-value=0.03). No association with TV by itself was found. In females, no associations were observed when TV and videos and videogames were analyzed independently.

Discussion

This study evaluated the association between time spent viewing television, videos and videogames and measures of fat mass and distribution in a large, survey of Mexican adolescents in the State of Morelos. In males, BMI-z score, TSF and SSF thicknesses were directly associated with time spent viewing TV, videos and videogames. The association of screen time with SSF seemed to be stronger in 11 and 12-year old males, compared to older youth. Conversely, no overall association of screen time and anthropometric measures was observed among Mexican female adolescents. An association between SSF thickness and screen time was observed in sexually immature females.

Our results are consistent with previous cross-sectional and longitudinal findings on TV viewing and increased adiposity and obesity in Mexican and other populations (5–9, 23–30). Nevertheless, others have reported weak or no associations between TV viewing and physical inactivity and adiposity (31–34). Disparate results may be explained in part by differences in the age distribution of participants, the cross-sectional nature of some studies and the use of less comprehensive measures of media use. Nevertheless, two randomized controlled trials of interventions that reduced TV and computer use lend strong support to a causal relation between screen time and increased adiposity in younger children (11, 12). And a recent analysis on the combined influence of not meeting the current physical activity and screen time recommendations of 11 to 13 thousand pedometer steps/day and less than 2 hours/day found that overweight children were more likely to be non-compliant with these recommendations (35).

There are several indications that screen time plays a different role within age and sex groups due to differences in the tempo of physical development. Most studies where the link between screen time and increased adiposity or obesity included children younger than 10 years of age (7–9, 11, 12, 25, 28–30) Studies that did not find the association had a mean age closer to 13 years (31–34). In the current study, age did not appear to modify the association between screen time and BMI and TSF. However, screen time was directly associated with SSF among 11 and 12-year old males, who were unlikely not to have undergone sexual maturation. In line with previous reports (31, 32), we observed a null overall association of screen time with adiposity in female adolescents. However, we explored whether sexual maturity modified the associations by stratifying on menarcheal status and observed a significant increasing trend in SSF thickness in sexually immature females (p-value for interaction=0.053). SSF velocity and distance curves diverge markedly in males and females during maturation. Results of these *post hoc* analyses should be interpreted with caution. Nevertheless, given null findings in studies with older adolescents, the association of sedentary behavior inactivity with measures of central fat distribution may be partially explained by maturity and different maturational tempos between males and females.

When we evaluated TV and videos/videogames independently, we did not find an association with anthropometric measures of adiposity and obesity. Nevertheless, videos and videogames represent close to 50% of total screen time in this sample of Mexican adolescents. The association with measures of fat mass and distribution appeared to be driven by the combined effects of these three activities, underscoring the importance of measuring the use of all electronic media.

Mechanisms thought to underlie the relationship between screen time and adiposity are low energy expenditure due to the substitution of physical activity by television viewing and an increase in the consumption of energy-dense foods advertised on television. Recent data lends stronger support to energy intake as mediator of the effect of screen time on adiposity

(36, 37, 38). A reduction in TV viewing and computer use was reported to significantly reduce caloric intake by close to 300 calories over two years, while no significant increase in physical activity was observed over the same period (11).

In the current study, we evaluated the association of screen time and adiposity in a large sample of adolescents using measures of both fat mass (BMI) and central (SSF) and peripheral (TSF) fat distribution. We closely captured recreational inactivity by using a questionnaire validated in Mexican children (9) that estimates time spent on TV, video and videogames on weekdays, Saturday and Sunday. Height, weight, TSF and SSF thickness were reliably measured with calibrated equipment by trained personnel using standardized procedures. SSF thickness, a measure of central fat distribution, rarely has been available in population-based studies of this magnitude and our findings provide an interesting insight into its association with screen time during maturation. Consistency in results across different anthropometric measures with independent measurement errors may further support the presence of the associations found in this report.

Our study has some limitations that temper interpretation of findings. First, causal inference is limited by the cross-sectional design of this study. We hypothesized that screen time was a determinant of increased adiposity, but we were unable to assess whether a reverse effect existed. Prior reports based on longitudinal data support the directionality of the observed association. Second, data on screen time and potential confounders are self-reported, creating a potential for recall bias. However, we believe that participants in this study population were unaware that screen time could be a cause of increased adiposity, so it is unlikely that obese or overweight adolescents would have reported screen time differently from their leaner counterparts. We are more concerned with the potential for inaccurate reporting that would attenuate of the associations. Third, our questionnaire did not include computer use. At the time the survey was conducted, the contribution of computer use to overall hours spent in front of a screen was probably very limited in this population. As in any observational study, our results may be explained by the influence of unmeasured confounders. However, we were able to reduce this possibility by adjusting for numerous socioeconomic and lifestyle variables.

We conclude that screen time is associated with increased adiposity in Mexican adolescent males. The association may be partly influenced by maturation; screen time may be more important in younger adolescents and be more influential in determining central fat stores, as indicated by SSF. Our results underscore the importance of understanding modifiable determinants of adolescent obesity in the context of trends in Mexico. High prevalence of obesity and overweight in adolescents may foreshadow an even greater surge in cardiovascular disease and diabetes in Mexico as these adolescents enter young adulthood. Preventive interventions to promote physical activity and limit screen time have been explored in similar populations and have shown to be effective (39). A seen in other populations (35), a thorough evaluation of recommendations on physical activity and screen time in the Mexican context would be important to support public policy. Future research should focus on accurately assessing screen time and physical activity and their association with adiposity at the national level and on identifying culturally-tailored strategies to modify these behaviors in Mexican youth.

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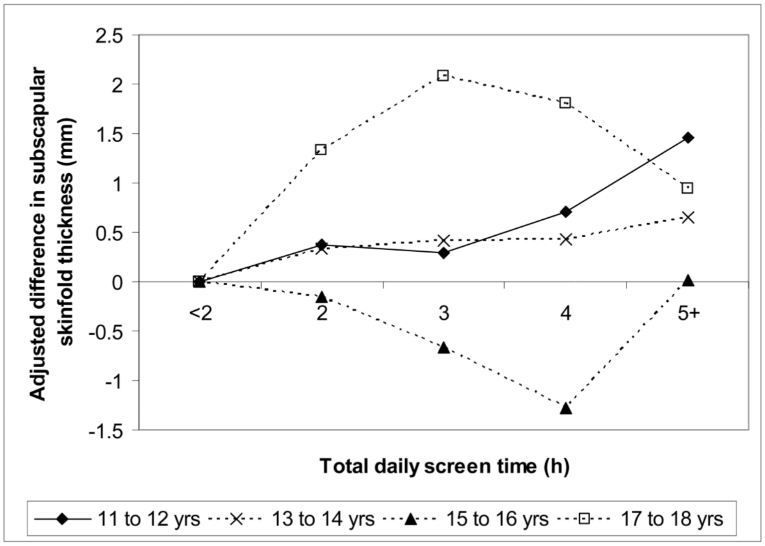

Figure 1.
Adjusted difference in sub scapular skin fold thickness (mm) by age group in Mexican males adolescents from public schools in Morelos, Mexico (1999).

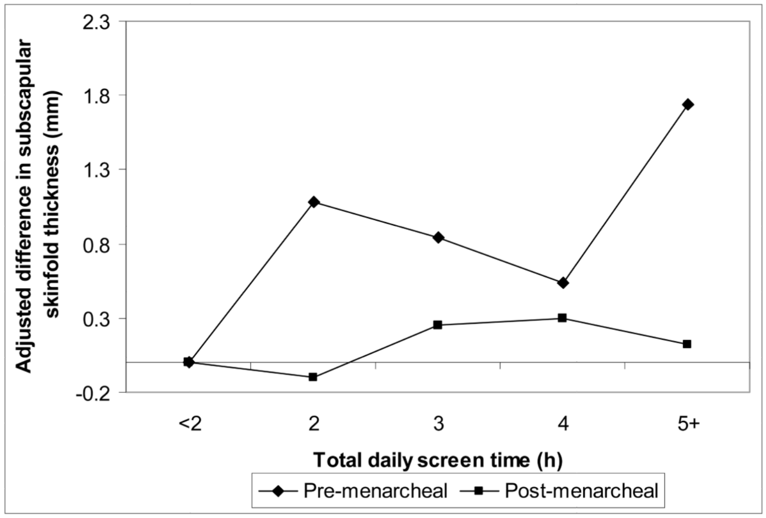

Figure 2.
Adjusted difference in subscapular skin fold thickness (mm) by sexual maturity in Mexican female adolescents from public schools in Morelos, Mexico (1999).

Table 1

Characteristics of 9132 Mexican adolescents from public schools in Morelos, Mexico (1999)

Variable	Males (*n* = 3,519)	Females (*n* = 5,613)
Age (years) *	13.8 (1.8)	13.9 (1.7)
Energy Intake (kJ/day)*	17,975 (5,306)	16,670 (5,332)
Moderate-to-vigorous activity (MET/wk)*	110(42)	90.8 (47.3)
Total screen time† (hr/day)	5.9 (3.0)	5.4 (3.0)
Body Mass Index (*z*-score) *	0.48 (0.97)	0.58 (0.84)
Triceps skinfold thickness (mm) *	14 (7)	22 (7)
Subscapular skinfold thickness (mm) *	11 (5)	15 (5)
Obesity (%)‡	6.7	6.0
Overweight (%)‡	30.0	30.5
Mean age at menarche (years)*	-	11.4 (1.1)

*Data expressed as Mean (Standard Deviation)

†Average daily hr viewing TV, video and videogames combined.

‡IOTF cut-off points for BMI for age and sex (20).

Table 2

Daily hours of TV, video and videogame use by socio-demographic characteristics of Mexican adolescents from public schools in Morelos, Mexico (1999).

	Males		Females	
Variable	**Mean**	**SD**	**Mean**	**SD**
Age (years)				
11 – 12	5.9	2.9	5.6	3.0
13 – 14	5.7	3.1	5.3	3.0
15 – 16	6.0	2.9	4.7	2.9
17 – 18	6.6	2.7	6.1	3.0
Community type				
Rural	5.3	3.1	5.1	3.0
Suburban	5.9	2.9	4.9	3.0
Urban	6.6	2.8	6.1	2.9
Socio-economic status				
Low	6.2	2.9	5.1	3.1
Medium	5.3	3.1	5.2	3.0
High	6.6	2.7	5.8	2.9
Medical insurance				
Uninsured	6.2	2.9	5.5	3.0
Insured	5.7	3.0	5.3	3.0
Dieting				
To lose weight	6.1	3.1	5.0	3.0
To gain weight	6.1	3.1	6.2	2.8
Not on a special diet	5.9	3.0	5.4	3.0

Table 3

Adjusted difference (95% CI) in body mass index (BMI) standard deviation scores, triceps and sub scapular skin fold by TV, video and videogame use among Mexican adolescents from public schools in Morelos, Mexico (1999).

	zBMI				Triceps Skin Fold				Sub scapular Skin Fold			
	Males		Females		Males		Females		Males		Females	
TV, video and videogame (hrs/day)	Age- adjusted	Multivariate *	Age- adjusted	Multivariate *	Age- adjusted	Multivariate *	Age- adjusted	Multivariate *	Age- adjusted	Multivariate *	Age- adjusted	Multivariate †
<2	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
2–2.9	0.09 (−0.08, 0.25)	0.04 (−0.10, 0.17)	−0.01 (−0.08, 0.06)	−0.02 (−0.09, 0.05)	0.98 (−0.07, 2.02)	0.72 (−0.25, 1.70)	−0.09 (−0.61, 0.43)	−0.34 (−0.87, 0.20)	0.46 (−0.26, 1.18)	0.38 (−0.20, 0.95)	0.22 (−0.17, 0.62)	0.08 (-0.33, 0.48)
3−3.9	0.16 (0.03, 0.29)	0.03 (−0.09, 0.15)	0.04 (−0.03, 0.12)	0.02 (−0.06, 0.10)	1.11 (0.31, 1.90)	0.47 (−0.40, 1.34)	0.68 (−0.05, 1.41)	0.28 (−0.46, 1.02)	0.84 (0.21, 1.47)	0.26 (−0.36, 0.88)	0.54 (0.05, 1.02)	0.29 (-0.29, 0.77)
4−4.9	0.22 (0.10, 0.33)	0.05 (−0.06, 0.15)	0.08 (−0.01, 0.18)	0.04 (−0.05, 0.14)	1.67 (0.64, 2.70)	0.93 (−0.09, 1.95)	0.94 (0.17, 1.71)	0.28 (−0.49, 1.06)	1.20 (0.53, 1.87)	0.39 (−0.20, 0.98)	0.72 (0.08, 1.35)	0.33 (-0.27, 0.94)
≥5	0.35 (0.22, 0.48)	0.13 (0.04, 0.23)	0.09 (0.00, 0.17)	0.02 (−0.07, 0.10)	2.01 (1.30, 2.72)	1.08 (0.36, 1.81)	1.32 (0.62, 2.03)	0.35 (−0.29, 0.98)	1.73 (1.09, 2.36)	0.73 (0.24, 1.22)	0.85 (0.32, 1.38)	0.22 (-0.22, 0.68)
p-trend	<0.001	0.003	0.026	0.64	<0.001	0.011	<0.001	0.14	<0.001	0.006	0.003	0.45

* Adjusted for age, height, socio-economic status, single-parent family, birth in hospital, parental education level, family income, family health insurance, physical activity, inactivity excluding TV, video and videogames, community type, diagnosis of asthma, dieting and frequency of restaurant dining. Sexual maturity, history of pregnancy and spontaneous abortion also included in females.