Association of Family Environment with Children's Television Viewing and with Low Level of Physical Activity

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Abstract

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Objective: This study examined associations between the family environment and children's television (TV) viewing and likelihood of being low-active.

Research Methods and Procedures: In 2001, children were recruited from 19 primary schools in Melbourne, Australia. Parents completed a questionnaire about their child's TV viewing and the family environment. Children also completed a questionnaire and wore an accelerometer for 8 days. Movement counts were used to identify low-active children (lowest quartile). Data were analyzed in May 2004.

Results: The sample consisted of 878 children (mean age = 11.5 ± 0.6 yrs). Multiple logistic regression revealed that socioeconomic status [adjusted odds ratios (AOR) = 0.4 boys], frequency families watched TV together (AOR = 2.0 boys), mothers' (AOR = 1.8 boys; AOR = 2.5 girls) and fathers' (AOR = 2.6 boys; AOR = 2.8 girls) TV viewing, and rules prohibiting TV during mealtimes (AOR = 0.6 boys; AOR = 0.6 girls) related to children watching TV ≥2 h/d. Variables associated with low-level physical activity included self-reported enjoyment of Internet use (AOR = 1.7 boys) and preference for watching TV (AOR = 2.3 girls), perception that mother uses computer a lot (AOR = 1.9 boys) and likes using the computer (AOR = 0.6 girls),

fathers' reported computer/electronic games use (AOR = 1.7 girls), frequency families used computer together (AOR = 0.4 girls), rules that TV viewing must be supervised (AOR = 1.9 boys; AOR = 0.6 girls), and having pay TV (AOR = 0.6 boys) and electronic games at home (AOR = 2.6 boys).

Discussion: These findings suggest that the relationships between the family environment and TV viewing and low-level activity are complex and that these behaviors are distinct.

Key words: accelerometer, social ecological models, sedentary behavior, computer use, electronic games

Introduction

Among children as young as 12 years of age, overweight and obesity and low levels of physical activity have been shown to be associated with increased risk of atherosclerosis and high blood pressure (1). In developed countries, overweight and obesity (2,3) and type 2 diabetes (4,5) among children and adolescents have increased at an alarming rate. These trends may be attributed, in part, to declines in physical activity and increases in a sedentary lifestyle.

In the U.S. in 2002, 61% of 9- to 13-year-old children did not participate in any organized physical activity outside of school hours, and 23% failed to engage in any physical activity during their free time (6). In Australia, a recent study of 9- to 13-year-old children has suggested that the frequency of walking and cycling to or from school per week and the frequency of physical education lessons per week declined between 1985 and 2001 (7). There have also been increases in access to sedentary recreation opportunities such as electronic games and computers. In Australia, access to pay television (TV)[1] has increased from 5% in 1996 to 19% in 2000 (8). Furthermore, 82% of adolescents

[1] Nonstandard abbreviations: TV, television; SES, socioeconomic status; ICC, intraclass correlation coefficient; OR, odds ratio; CI, confidence interval.

in Australia had a home computer in 2001 (an absolute increase of 13% since 1999), 61% of households owned two or more TV sets, and 87% of households owned one or more video cassette recorders (8,9). Intuitively, increased access to electronic entertainment media may contribute to increased participation in sedentary screen-based behaviors among children and adolescents. However, whether these new sedentary behaviors have displaced physical activity or have replaced more traditional sedentary pursuits, such as reading or listening to the radio, is unknown.

The physical and social health consequences among children who spend large amounts of time using computers and playing electronic games are largely unknown. Recent studies, however, have reported no relationship among computer use, playing electronic games, and risk of overweight or obesity status among children (10,11). Although there is some evidence that TV viewing is associated with overweight and obesity (12–14), a recent meta-analysis of previous studies reporting the relationship between TV viewing and obesity suggested that these associations were not clinically significant (15). However, there is some evidence of associations between TV viewing and social problems, aggressive behavior, and low school achievement among children (16). The American Academy of Pediatrics (17) and the recent Australian Physical Activity Recommendations (18) propose that children spend no more than 2 h/d watching TV and using other electronic entertainment media. Yet, a high proportion of children in many developed countries average more than 2 hours of TV viewing each day (8,9), with approximately two-thirds watching more than 2 h/d (19,20) and more than one-quarter watching more than 4 h/d (12).

It is, therefore, important to identify the influences on TV viewing to inform the development of intervention strategies. Most TV viewing occurs at home (9), and among children, the family environment is a critical source of influence on sedentary behavior and childhood obesity (21). Using social ecological and behavioral models such as social cognitive theory (22) and behavioral choice theory (23), children's health behaviors may be described as developing within an ecological niche (21,24), with the family environment playing a major role in this developmental process. Factors such as parenting practices and family characteristics, parents' modeling of health behaviors (22), access to sedentary pursuits at home, sibling influences, and family TV viewing habits, as well as individual child characteristics, including preference for being active or sedentary (23), may be important influences on children's sedentary behavior and low-level activity.

Although a small number of studies have investigated associations between the family environment and children's TV viewing, most of these studies have been atheoretical. Among children, high levels of TV viewing have been found to be associated with low levels of maternal education

(25) and with coming from a single-parent home (26). In addition, there appears to be some evidence of familial aggregation of TV viewing habits (19). Among preschool children (27) and youth (28), having a TV set in the bedroom has been found to be associated with higher levels of TV viewing. Conversely, rules and restrictions on children's electronic media use have been shown to be associated with lower levels of use (29). One of few studies that employed a theoretical approach examined influences on TV viewing based on an ecological model and identified that frequency of meals eaten while watching TV was the most important predictor of longitudinal increases in TV viewing time among children (30).

There is inconsistent evidence of the relationship between TV viewing and physical activity among children (31); however, studies among adults have suggested positive associations between TV viewing and weight status (32) and impaired glucose tolerance (33) that are independent of physical activity levels. In order to inform the development of strategies to promote increased physical activity, reduce TV viewing, and prevent unhealthy weight gain among children, it is important to study whether there are distinct relationships between ecological variables and the time children spend watching TV and the time children spend being inactive. The aim of the present study was to examine associations between family environment factors and TV viewing among boys and girls 10 to 12 years old and to assess whether these factors were also associated with the likelihood of being low-active.

Research Methods and Procedures

The data for this study were collected between July and December 2001. The parents' questionnaire and child and parent consent forms were sent home with each child. Those children who returned their consent form and parents' questionnaire by the specified date completed their questionnaire in class and were then fitted on the same day with an accelerometer, which they wore for 8 days. This study used an ecological framework to guide the development of items to assess the family environment (21–24). Parents and children were surveyed about family characteristics, individual child characteristics, parenting practices, sibling and family influences, and access in the home environment to sedentary pursuits. Parents also reported their child's usual TV viewing, computer use, and playing of electronic games (screen-based behaviors). Ethics clearance was received from the Deakin University Ethics Committee and the Department of Education and Training Victoria.

Sample Selection

Families of children 10 to 12 years old were recruited from 19 state primary schools in high (*n* = 10) and low (*n* = 9) socioeconomic status (SES) areas in Melbourne (eastern

and western suburbs). Schools were selected using stratified random sampling proportionate to school size (to ensure that chance of random selection was relative to school size). Five schools declined to participate and were replaced with the next schools on the randomly generated list. Data collection alternated between schools in high and low SES areas. In total, 2096 children enrolled in school grades 5 or 6 (between 10 to 12 years of age) were given information about the study and consent forms to take home to their parents inviting their family to participate. As ethically required in Australia, only those families who provided parental consent and consent on behalf of a minor (i.e., active consent) participated in the study. Existing privacy legislation does not permit access to any data on the non-respondents from the selected schools. No other eligibility criteria were applied. The overall response rate was 44% (51% for schools in high SES regions and 36% for schools in low SES regions).

Measures: Test-Retest Reliability

The 2-week test-retest reliability of newly developed items from the parents' questionnaire was assessed with a separate sample of 156 parents (mean age = 40.0 ± 5.2 yrs; 88% women) of 10- to 12-year-old children (49% boys). In addition, the 1-week test-retest reliability of newly developed items from the children's self-report questionnaire was assessed among a separate sample of 147 children (mean age = 11.8 ± 0.8 yrs; 45% boys). The test-retest findings are presented with the description of each of the questionnaire items.

Parents' Questionnaire

Sociodemographic Information. For all sociodemographic questions, the responding parent reported on behalf of themselves and, where applicable, on behalf of their partner. Parents reported their highest level of education, whether English was usually spoken at home, their relationship to the child in the study, and the child's date of birth. In this study, level of maternal education was used as the measure of family SES. Maternal education is recognized as one of the most important predictors of child health and child health behaviors and as an indicator of SES (34). Furthermore, previous studies have reported differences in children's TV viewing (25) and children's physical activity (35,36) by maternal education. For purposes of analysis, this variable was collapsed into three categories: some secondary school or less (low SES); completed secondary school, technical certificate, or apprenticeship (medium SES); and university/tertiary qualification (high SES).

Family Structure. Parents were asked to report details about their marital status (defined as a husband/wife or de facto living in the home). Dual or single parent (or guardian) status was derived based on the marital status question and on whether the parent reported details of a partner. Parents were asked how many children <18 years old were living in their house, excluding the child in the study. This variable was dichotomized into only child and siblings.

Child's Preferences/Beliefs. Parents were asked how much they agree or disagree with the statement "My child would prefer to watch TV or play electronic games" as a reason for their child not doing more physical activity than they already do. The following response categories were provided: strongly agree, agree, neither, disagree, strongly disagree, and don't know. The test-retest reliability [intraclass correlation coefficient (ICC)] of this item was 0.83. For analyses, the categories of strongly agree and agree were combined. All other responses were collapsed into a second category.

Rules and Restrictions. Rules and restrictions that parents apply to their child's screen-based behaviors were assessed. For each of the screen-based behaviors, parents were asked "How often do you restrict the amount of time your child spends in the following?" Using the following scale, parents reported: don't know/doesn't apply, never/rarely, sometimes, often, and very often. The test-retest reliability of these items ranged from ICC = 0.71 to 0.88. Responses were collapsed into two categories: often and very often and all other responses. Parents were also asked about rules regarding TV viewing during mealtimes and after homework and supervision of their child's use of internet electronic games and TV viewing. For example, "During mealtimes, I do not allow the TV to be on"; "My child is not allowed to watch TV/play Playstation/Nintendo until his/her homework is done"; "My child must be supervised when playing the Playstation/Nintendo"; "My child must be supervised when he/she is watching TV"; and "My child must be supervised on the Internet." Responses were provided on the following scale: strongly agree, agree, neither, disagree, strongly disagree, and don't know. The test-retest reliability of these items ranged from ICC = 0.77 to 0.90. For analyses, the categories of strongly agree and agree were combined. All other responses were collapsed into a second category.

Parents' Screen-Based Behaviors. Parents were asked to estimate the total time (hours/minutes) they and their partner, respectively, spent watching TV, playing electronic games, and using the computer during their leisure-time in a typical week. These items have been previously shown to be reliable and valid (37). Average minutes per day spent in these behaviors were computed. For consistency with TV viewing recommendations (17,18) and to enable comparison with children's TV viewing, time spent watching TV was dichotomized at <2 h/d or ≥2 h/d. However, because few parents played electronic games, this sedentary behavior was combined with computer use and dichotomized at the median (<30 min/d or ≥30 min/d).

Family Influences. Parents were asked "How often do you do the following activities together as a family with at

least one family member?" Parents responded to this question in relation to watching TV/videos and playing computer/electronic games. The following response categories were provided: don't know/doesn't apply, never/rarely, 1 to 2 times/mo, once a week, several times a week, and daily. Both items had acceptable test-retest reliability (ICC = 0.80). The response options were collapsed into two categories: less than several times per week and several times per week or more.

Sedentary Opportunities at Home. Parents completed an inventory of items in their home that may encourage or support children's screen-based behaviors or low-level activity: pay TV, free-to-air TV, video/DVD player, electronic games (e.g., Playstation, Nintendo, Gameboy), computer, Internet access, and a TV set in the child's bedroom. The test-retest reliability of these categorical items was high (percentage agreement, 91% to 99%; κ, 0.6 to 0.9). Parents also reported the number of TV sets in the home (ICC = 0.99). Responses were collapsed into two categories: 0 to 1 TV and $\geq$2 TVs.

Children's Screen-Based Behaviors. Parents reported how much time (hours/minutes) their child usually spends watching TV, playing electronic games, and using the computer in a typical week (Monday to Friday) and on a typical weekend (Saturday and Sunday). To compute the average, daily minutes in each of the screen-based behaviors during the week and on the weekend were summed and divided by seven. Test-retest reliability (ICC) of the proxy-reported time (minutes per day) spent in each of these screen-based behaviors ranged from 0.6 to 0.8. The convergent validity between the parents' proxy-report data and the children's self-report data (using identical survey items) was reasonable (TV viewing, ρ = 0.61; computer use, ρ = 0.47; playing electronic games, ρ = 0.44). Because proxy-reported sedentary time was more reliably reported, these items were used in analyses rather than the children's self-reports. Consistent with TV viewing recommendations, time spent watching TV was dichotomized at $<$2 h/d or $\geq$2 h/d (17,18).

Children's Questionnaire

Preferences/Beliefs. Children were asked how much they agree or disagree with the statement "I prefer to watch TV or play electronic games" (ICC = 0.72) and "My Mum and Dad think that sports clothes/equipment (e.g., shoes, basketballs, leotards) are too expensive to buy" (ICC = 0.69). The following response categories were provided: strongly agree, agree, neither, disagree, strongly agree, and don't know. For analyses, the categories of strongly agree and agree were combined. All other responses were collapsed into a second category.

Parents' Screen-Based Behaviors. Children reported their perceptions of how much each parent watches TV (e.g., "How much TV does your Mum watch?"), plays electronic games, and uses the computer. The following response categories were provided: none, a little bit, some, a lot, and I don't know. The test-retest reliability (ICC) ranged from 0.60 to 0.76. The item responses of some and a lot were combined. All other responses were collapsed into a second category.

Parental Enjoyment of Screen-Based Behaviors. Children also reported their perceptions of how much each parent enjoys watching TV (e.g., "How much does your Mum like watching TV?"), playing electronic games, and using the computer. The following response categories were provided: he/she doesn't like it at all, he/she likes it a little bit, he/she likes it, he/she likes it a lot, and I don't know. The categories were recoded into likes it and likes it a lot, with all other responses collapsed into a second category. The test-retest reliability of these items was not assessed; however, the internal consistency of these items (Cronbach's α) was 0.61.

Children were asked their perceptions of how much each parent likes watching TV, playing electronic games, and using the computer with them. For example, "How much does your Mum like doing each of the following things with you?" The following response categories were provided: doesn't do this/don't have this, likes it very much, likes it, doesn't like or dislike it, dislikes it, and dislikes it very much. Test-retest reliability (ICC) ranged from 0.69 to 0.78. The categories of likes it and likes it very much were combined into one category, and all other response options were collapsed into a second category.

Children's Objectively Assessed Physical Activity. Each child wore a Manufacturing and Technology, Inc. (formerly known as Computer Science and Applications, Inc., Fort Walton Beach, FL) accelerometer (model AM7164-2.2C) for an 8-day period. Accelerometers provide objective estimates of overall physical activity and physical activity-related energy expenditure and have been shown to have acceptable validity among adults (38) and children (39). Importantly, these devices are useful for ranking children from most to least active (40).

The first and last incomplete days of monitoring were discarded for each child, and only children who wore the accelerometer for a minimum of 4 days (including 1 weekend day) were included in analyses (41). Days in which total accelerometer counts were $<$10,000 or exceeded 20,000,000 were also excluded from the analyses as invalid data. Only 46 children were excluded by all of these criteria, leaving a total of 881 children with complete accelerometer data. Mean movement counts per day were calculated by summing total movement counts per day (between days 2 and 7) and then dividing the total by the number of days the accelerometer was worn (based on the above inclusion criteria). For the purpose of analysis, children in the lowest quartile of average movement counts per day were classified as the low-active children.

Children's Height and Weight. Children's height (assessed by portable stadiometer) and weight (assessed using digital scales) without shoes were measured by the same person in private at the child's school. BMI (kilograms per meter squared) was calculated, and internationally accepted age- and sex-specific cut-off points were used to define overweight and obesity (42). These child cut-off points approximate adult values for overweight (25 kg/m^2) and obesity (30 kg/m^2) (42).

Data Analysis

Data were analyzed in May 2004 using Stata 8.0 (Stata Corporation, College Station, TX). Descriptive statistics were used to characterize participating families, the time (minutes per day) children spent watching TV, playing electronic games, and in computer use, and the average daily movement counts of children in the sample. Because the screen-based behaviors and accelerometer data were skewed, the data were log transformed, and differences by sex were analyzed by independent Student's t tests. Pearson's χ^2 tests of significance were used to compare differences in the family environment between boys and girls.

Because many of the family sedentary environment items were developed to explain children's TV viewing, and 20% of girls in the sample did not have electronic games at home, the multivariate modeling of screen-based behaviors was performed using proxy-reported TV viewing only. To determine those aspects of the family environment that were associated with the likelihood of exceeding the recommendations for TV viewing (≥ 2 h/d) and the likelihood of being low-active, bivariate logistic regression analyses were performed with each of the family environment variables separately for boys and girls. Family environment variables that were significantly associated at the bivariate level were entered into multiple logistic regression models separately for boys and girls. All family environment explanatory variables were assessed for multicollinearity using correlation coefficients between each pair of variables and the variance inflation factor (<2.0) (43). Single- or dual-parent status was excluded from the girls' model due to collinearity. All other explanatory variables were found to be unrelated to each other. Because weight status was not related to TV viewing among boys or to low-level physical activity among boys or girls, correction for potential confounding by weight status was conducted only for multivariate analyses predicting TV viewing among girls. All multivariate models were also adjusted for SES (maternal education) and clustering by school.

Results

Sample Characteristics

A total of 927 families were recruited into the study. There were 881 children with complete accelerometer data and 878 children with complete TV viewing data (46% boys). The mean age of the children in the study was 11.5 ± 0.6 years. Most families (94%) reported usually speaking English in their household, most parents or guardians were married or de facto/living together (82%), and the majority of respondents to the survey were mothers of children in the current study (82%). Eighteen percent reported being single parent families. SES was evenly distributed across families (low SES, 30%; medium SES, 37%; high SES, 33%). Twelve percent of the children had no siblings (average number of siblings 1.5). Among boys, 22% were overweight, and 9% were obese; among girls, 22% were overweight, and 5% were obese.

Children's Screen-Based Behaviors and Accelerometer Movement Counts

The average time children spent watching TV was 130.7 (± 68.9) min/d. Independent Student's t tests on log transformed data revealed no significant differences in TV viewing by sex. More than one-half of the boys (61%) and girls (57%) in the sample watched 2 or more hours of TV per day. Among families who reported having a computer (92%), the average time spent using the computer or Internet was 26.3 (± 34.7) min/d, and among families with electronic games (84%), the average time spent playing electronic games was 33.1 (± 45.0) min/d. Although there were no differences in (log-transformed) computer use, there were differences in electronic games playing by sex ($p < 0.001$). Untransformed data revealed that boys spent 48.7 ± 49.3 min/d playing electronic games compared with girls who spent 19.7 ± 36.3 min/d. There were also significant differences in log-transformed movement counts by sex ($p < 0.001$), with untransformed data showing that boys recorded significantly higher mean movement counts (1093.5 ± 955.8 counts^{1000}/d) compared with girls (909.8 ± 830.2 counts^{1000}/d).

Family Environment

Table 1 shows the profile of the family environment reported by parents and how this differed between boys and girls. A higher proportion of parents with boys reported restricting their child's playing of electronic games and computer use. Significantly more boys than girls had a TV set in their bedroom and electronic games within their home. A higher proportion of girls' families reported access to pay TV in their homes. Almost twice as many boys as girls reported a preference for watching TV or playing electronic games rather than participating in physical activity. More girls than boys, however, reported that their parents watched some/a lot of TV, that their parents liked watching TV some/a lot, and that their mother liked watching TV some/a lot with them.

Table 1. Profile of the family environment of boys and girls

	Boys	Girls	p
Parental report (%)			
Preferences			
My child prefers TV or e-games to physical activity	17.7	16.5	0.336
Rules/restrictions			
Restrict TV	36.7	35.4	0.373
Restrict e-games*	72.1	59.6	<0.001
Restrict computer*	65.7	57.5	0.017
No TV until homework done	67.1	70.7	0.140
No TV during meals	42.2	44.6	0.261
TV must be supervised	40.5	39.7	0.423
Computer use must be supervised*	64.7	65.1	0.489
E-games must be supervised*	18.7	15.3	0.145
Parental sedentary behavior			
Mother's TV viewing ($\geq$2 h/d)	36.2	32.4	0.134
Father's TV viewing ($\geq$2 h/d)	37.2	38.4	0.398
Mother's e-games + computer use (=30 min/wk)*	53.9	59.5	0.085
Father's e-games + computer use (=30 min/wk)*	65.5	67.5	0.256
Family influences			
Watch TV as a family $\geq$several times/wk	63.9	63.8	0.526
Play e-games/computer as a family $\geq$several times/wk*	14.9	13.6	0.347
Sedentary opportunities at home			
$\geq$2 TV sets	88.0	86.1	0.224
$\geq$3 TV sets	49.5	46.7	0.212
TV in bedroom	32.1	24.6	0.007
Computer at home	92.1	92.4	0.477
E-games at home	90.2	78.1	<0.001
Internet access at home	69.8	70.0	0.501
Pay TV at home	32.3	38.7	0.030
Child's report (%)			
Preferences/enjoyment			
I prefer TV or e-games to physical activity	29.7	17.0	<0.001
I enjoy watching TV	84.2	81.5	0.281
I enjoy playing e-games and computer*	85.0	69.8	<0.001
I enjoy using the Internet*	68.6	65.6	0.223
Beliefs			
Parents think videos and e-games too expensive	37.5	25.3	<0.001
Parent uses TV as a reward	52.5	57.4	0.092
Parent uses e-games/computer as a reward*	45.5	39.2	0.062
Parental screen-based behaviors			
Mother watches TV some/a lot	48.7	58.3	0.002
Mother plays e-games some/a lot*	5.6	5.0	0.429
Mother uses computer some/a lot*	45.9	49.4	0.198
Father watches TV some/a lot	64.8	74.2	0.002
Father plays e-games some/a lot*	17.2	19.0	0.315
Father uses computer some/a lot*	59.5	60.7	0.405

Table 1. (continued)

	Boys	Girls	*p*
Parental enjoyment of screen-based behaviors			
Mother likes watching TV some/a lot	48.7	58.3	0.002
Mother likes playing e-games some/a lot*	7.1	7.1	0.551
Mother likes using computer some/a lot*	39.1	44.0	0.108
Father likes watching TV some/a lot	64.8	74.2	0.002
Father likes playing e-games some/a lot*	24.6	26.9	0.286
Father likes using computer some/a lot*	50.9	50.5	0.485
Parental enjoyment of screen-based behaviors with the child			
Mother likes watching TV with me	75.8	81.0	0.034
Mother likes playing e-games with me*	14.2	18.8	0.066
Mother likes using computer with me*	41.7	48.2	0.054
Father likes watching TV with me	78.1	74.6	0.130
Father likes playing e-games with me*	43.2	44.1	0.445
Father likes using computer with me*	53.7	54.2	0.480

* For those families who reported having electronic games (e-games), a computer, and TV.

Relationship between the Family Environment and TV Viewing

Those aspects of the family environment that were associated with TV viewing are presented in Table 2. Multivariate analyses revealed that boys from high SES families and boys and girls whose parents reported rules prohibiting TV during mealtimes were less likely to watch 2 or more hours of TV per day. In contrast, boys and girls whose mother and father reported watching TV for ≥2 h/d and boys whose families watched TV together at least several times per week were more likely to exceed TV viewing recommendations. There were no significant bivariate associations between families with access to pay TV (e.g., FoxTel), mothers' and fathers' enjoyment of watching TV with their child, and parents who used TV as a reward and children's likelihood of exceeding TV viewing recommendations (data not shown). Therefore, these variables were not included in the multivariate model.

Given that a significantly higher proportion of girls, but not boys, who watched TV ≥2 h/d were overweight or obese (34%) compared with those who watched TV <2 h/d (17%, $p < 0.001$), multivariate analyses were repeated for girls adjusting for weight status (confounder). It was found that rules about meals in front of the TV were no longer significantly related [odds ratio (OR) = 0.63, 95% confidence interval (CI), 0.38 to 1.03, $p = 0.067$] to TV viewing; however, mothers' TV viewing (OR = 2.56, 95% CI, 1.41 to 4.64, $p = 0.002$) and fathers' TV viewing (OR = 2.89, 95% CI, 1.66 to 5.03, $p < 0.001$) remained significant.

Relationship between the Family Environment and Being Low Active

Multiple logistic regression analyses in Table 3 show that boys who reported high enjoyment of Internet use, who had rules about their TV viewing being supervised, whose mothers reported ≥30 min/d in computer and electronic games use, and who had electronic games at home were significantly more likely to be in the low-active group. In contrast, boys who had pay TV at home were 40% less likely to be low-active compared with those who did not have pay TV at home.

Girls who reported a preference for watching TV rather than being active and whose fathers reported ≥30 min/d in computer and electronic games use were more likely to be low-active. However, girls whose TV viewing was supervised, who perceived that their mother liked using the computer, and whose family used the computer together $\geq$several times per week were less likely to be in the low-active group. A high number of variables were not significantly related to the likelihood of boys or girls being low-active, including: proxy-reported preference for TV viewing and self-reported enjoyment of playing electronic games and computer use; restriction of TV viewing during mealtimes, restriction of screen-based behaviors, and supervision of electronic games use; parents' TV viewing, watching TV together as a family, and children's perceptions of their parents' screen-based behaviors; having a TV set in the bedroom, a personal computer, and Internet access at home; children's perceptions of their parents' enjoyment of watching TV and playing electronic games and their fathers'

Table 2. Family environment and likelihood of watching TV ≥ 2 h/d

	Boys ($n = 407$)		Girls ($n = 471$)	
	Unadjusted OR (95% CI)*	Adjusted OR (95% CI)†	Unadjusted OR (95% CI)*	Adjusted OR (95% CI)†
Socioeconomic status§				
Low	1.0		1.0	
Medium	1.0 (0.6 to 1.8)	1.3 (0.7 to 2.3)	0.8 (0.4 to 1.4)	1.0 (0.5 to 2.2)
High	0.4 (0.2 to 0.7)††	0.4 (0.2 to 0.8)**	0.4 (0.3 to 0.7)‡‡	0.7 (0.4 to 1.3)
Parental status§				
Single parent	1.0		1.0	
Dual parents	0.7 (0.4 to 1.2)		0.7 (0.4 to 0.9)**	‡
Siblings§				
No	1.0		1.0	
Yes	0.5 (0.3 to 0.9)**	0.8 (0.3 to 2.1)	0.6 (0.4 to 0.9)**	0.5 (0.2 to 1.2)
Preferences/enjoyment				
Does not prefer to watch TV§	1.0		1.0	
Prefers to watch TV	1.1 (0.6 to 1.8)		2.1 (1.2 to 3.6)††	1.7 (0.8 to 3.6)
I do not prefer to watch TV¶	1.0		1.0	
I prefer to watch TV	1.8 (1.3 to 2.5)††	1.4 (0.7 to 2.7)	1.6 (0.9 to 2.6)	
I do not enjoy watching TV¶	1.0		1.0	
I enjoy watching TV	1.8 (1.1 to 3.1)‡‡	1.3 (0.6 to 2.9)	1.2 (0.7 to 1.9)	
Rules/restrictions§				
Do not restrict TV	1.0		1.0	
Restricts TV	0.6 (0.4 to 0.9)††	0.7 (0.3 to 1.4)	0.7 (0.5 to 1.0)	
TV allowed before homework	1.0		1.0	
No TV before homework	0.6 (0.4 to 0.9)**	0.6 (0.3 to 1.1)	1.0 (0.7 to 1.5)	
TV during meals	1.0		1.0	
No TV during meals	0.4 (0.3 to 0.7)‡‡	0.6 (0.3 to 0.9)**	0.5 (0.3 to 0.8)††	0.6 (0.4 to 0.9)**
TV not supervised	1.0		1.0	
TV must be supervised	0.9 (0.6 to 1.3)		0.6 (0.5 to 0.9)††	0.8 (0.5 to 1.4)
Parental screen-based behavior§				
Mother watches TV <2 h/d	1.0		1.0	
Mother watches TV ≥2 h/d	4.1 (2.6 to 6.4)‡‡	1.8 (1.1 to 2.9)**	3.7 (2.1 to 6.6)‡‡	2.5 (1.3 to 4.8)††
Father watches TV <2 h/d	1.0		1.0	
Father watches TV ≥2 h/d	4.3 (2.6 to 7.2)‡‡	2.6 (1.7 to 4.2)‡‡	4.3 (2.7 to 6.8)‡‡	2.8 (1.8 to 4.3)‡‡
Parental screen-based behavior¶				
Mother watches no/a little TV	1.0		1.0	
Mother watches TV some/a lot	1.5 (1.0 to 2.3)**	1.5 (0.9 to 2.5)	1.4 (1.0 to 1.9)**	1.4 (0.9 to 2.2)
Mother likes watching TV no/a little	1.0		1.0	
Mother likes watching TV some/a lot	1.4 (0.9 to 2.1)		1.5 (1.0 to 2.1)**	1.2 (0.7 to 1.9)
Family influences§				
Don't/rarely watch TV as family	1.0		1.0	
Watch TV as family ≥ several times/wk	2.1 (1.7 to 2.6)‡‡	2.0 (1.3 to 3.4)††	1.3 (0.9 to 2.0)	
Sedentary opportunities at home§				
<2 TV sets	1.0		1.0	
≥2 TV sets	2.4 (1.4 to 4.1)††	1.0 (0.5 to 2.2)	2.4 (1.3 to 4.4)††	1.9 (0.9 to 4.0)
TV in bedroom§				
No	1.0		1.0	
Yes	1.4 (0.9 to 2.2)		1.7 (1.7 to 2.7)**	1.1 (0.7 to 1.7)

* ORs and 95% CIs adjusted for clustering by school only.

† Adjusted for clustering by school and all independent variables significantly related at the bivariate level.

‡ Parental status dropped from the multivariate model due to collinearity.

§ Parental report.

¶ Child report.

** $p < 0.05$.

†† $p < 0.01$.

‡‡ $p < 0.001$.

Table 3. Family environment and likelihood of being low-active*

	Boys (*n* = 403)		Girls (*n* = 478)	
	Unadjusted OR (95% CI)†	**Adjusted OR (95% CI)‡**	**Unadjusted OR (95% CI)†**	**Adjusted OR (95% CI)‡**
Enjoyment§				
I do not enjoy watching TV	1.0		1.0	
I enjoy watching TV	1.5 (0.7 to 2.9)		1.5 (1.0 to 2.2)**	1.3 (0.9 to 1.8)
I do not enjoy using internet	1.0		1.0	
I enjoy using internet	1.8 (1.1 to 2.8)**	1.7 (1.0 to 2.8)**	1.3 (0.8 to 2.0)	
Preferences/beliefs§				
I do not prefer to watch TV	1.0		1.0	
I prefer to watch TV	1.2 (0.7 to 2.1)		2.0 (1.2 to 3.4)**	2.3 (1.2 to 4.5)**
Parents think videos and e-games too expensive	1.0		1.0	
Parents think videos and e-games not too expensive	0.7 (0.4 to 1.0)**	0.8 (0.5 to 1.2)	1.2 (0.7 to 2.0)	
Rules¶				
TV not supervised	1.0		1.0	
TV must be supervised	1.8 (1.2 to 2.5)††	1.9 (1.0 to 3.3)**	0.6 (0.4 to 0.9)**	0.6 (0.4 to 0.9)**
TV allowed with homework	1.0		1.0	
No TV until homework done	1.6 (1.0 to 2.8)		1.4 (1.0 to 2.0)**	1.4 (0.9 to 2.3)
Computer use not supervised	1.0		1.0	
Computer use must be supervised	1.6 (1.1 to 2.4)**	1.2 (0.7 to 2.3)	0.8 (0.5 to 1.3)	
Parental screen-based behavior¶				
Mother uses e-games/computer <30 min/wk	1.0		1.0	
Mother uses e-games/computer ≥30 min/wk	1.9 (1.2 to 3.0)††	1.9 (1.2 to 3.2)††	1.3 (0.8 to 2.0)	
Father uses e-games/computer <30 min/wk	1.0		1.0	
Father uses e-games/computer ≥30 min/wk	1.3 (0.8 to 2.3)		1.7 (1.1 to 2.7)**	1.7 (1.1 to 2.8)**
Parental screen-based behavior§				
Mother likes using computers no/a little	1.0		1.0	
Mother likes using computers some/a lot	1.2 (0.7 to 1.9)		0.7 (0.5 to 1.0)	0.6 (0.4 to 0.9)**
Family influences¶				
Don't/rarely play e-games/computer as a family	1.0		1.0	
Play e-games/computer as a family ≥ several times/wk	1.3 (0.7 to 2.5)		0.5 (0.2 to 0.9)**	0.4 (0.2 to 0.8)††
Sedentary opportunities at home				
No pay TV	1.0		1.0	
Have pay TV	0.6 (0.4 to 0.8)††	0.6 (0.4 to 0.9)**	0.9 (0.6 to 1.5)	
No e-games	1.0		1.0	
Have e-games	2.3 (1.0 to 5.3)**	2.6 (1.1 to 6.2)**	0.8 (0.5 to 1.4)	

e-games, electronic games.

* Low-active, lowest quartile of accelerometer counts.

† ORs and 95% CIs adjusted for clustering by school only.

‡ Adjusted for clustering by school and all independent variables significantly related at the bivariate level.

§ Child report.

¶ Parental report.

** $p < 0.05$.

†† $p < 0.01$.

enjoyment of using the computer; and children's perceptions of their parents' enjoyment of engaging in screen-based behaviors with their child (data not shown).

Discussion

The aim of this study was to examine associations between the family environment and children's TV viewing and the likelihood of children being low-active. Several factors in the family environment were significantly related to children's TV viewing and to being in the low-active group. These included individual factors (e.g., enjoyment and preference for screen-based behaviors), family or social factors (e.g., rules and restrictions regarding TV viewing, parents' screen-based behaviors, frequency that the family watched TV or used the computer together), and environmental factors in the home (e.g., access to pay TV and electronic games). These relationships were not always in the expected direction and sometimes differed between boys and girls. In addition, associations between the family environment and TV viewing were only slightly attenuated by weight status among girls. The findings from this study suggest that the relationships between the family environment and TV viewing and low-level activity are complex and that these behaviors are quite distinct. Further studies are required to identify family environment influences on other sedentary behaviors.

Individual-level factors have been found to explain much of the variance in physical activity among adults and children (44). Enjoyment of physical activity has been shown to be a consistent predictor of children's physical activity. For example, a longitudinal study found positive relationships between self-rated enjoyment of and participation in physical activity among children (45). Furthermore, a preference for or enjoyment of sedentary behaviors may explain low levels of physical activity. A study of adults' choices to be active or sedentary found that adults who self-reported a preference for sedentary behavior were also more likely to report being inactive (37). Few studies, however, have examined the relationship between children's reported enjoyment of sedentary pursuits and objectively assessed physical activity. In the present study, girls who preferred TV viewing and boys who reported enjoyment from using the Internet were more likely to be low-active. Although boys' enjoyment of and girls' preference for watching TV were bivariately related to proxy-reported viewing time, these relationships were no longer significant after adjusting for all other bivariately significant variables in the model. A challenge for those interested in promoting physical activity is to develop family-based intervention strategies to increase children's preference for physical activity and reduce preference for sedentary behavior. Although the ecological validity may be limited, the application of some of the theoretical principles from the laboratory-based techniques employed by Epstein and colleagues (46) could be tried in

interventions. For example, a recent randomized controlled trial to reduce children's sedentary behavior and increase physical activity found that it was feasible to apply the principles of positive reinforcement of physical activity and to restrict TV viewing using behavioral contracts as important components of a suite of behavioral modification strategies (47).

Consistent with a recent prospective study predicting longitudinal increases in TV viewing time among children (30), the present study found that rules about eating meals in front of the TV were associated with a decreased likelihood of watching TV ≥ 2 h/d. Having rules about not watching TV at mealtimes may be a reflection of how the family functions and the value placed on interaction of family members. It is also possible that if parents enforce rules about eating in front of the TV, resulting in lower levels of viewing, children may subsequently engage in an alternative sedentary pursuit rather than an active one. As presented in Table 3, rules about watching TV during mealtimes were not related to physical activity. Alternatively, children who are allowed to eat meals or even snack while watching TV might find that this reinforces their viewing habits and creates an ideal TV environment. The development of strategies restricting TV viewing during mealtimes may be an effective approach for reducing TV viewing time among children; however, a focus on increasing physical activity would also be important.

Interestingly, in the present study, boys whose TV viewing was supervised were more likely to be low-active, whereas girls whose TV viewing was supervised were less likely to be low-active. Parents who report needing to supervise their boy's TV viewing may do so because they feel their child watches too much TV and is not active enough. The inconsistent finding for girls, however, is difficult to interpret due to the cross-sectional nature of the data. Although longitudinal research may help to clarify these relationships, the association between the family environment and TV viewing is a complex one, particularly when many other sedentary behaviors coexist and possibly cluster together (48). Further research that includes these other behaviors may provide further insights into how the family environment relates to these behavioral patterns.

In this study, we found that mothers' and fathers' TV viewing was positively associated with their child's TV viewing. In addition, mothers who reported ≥ 30 min/d in computer and electronic games use were more likely to have a son in the low-active group, and fathers spending ≥ 30 min/d in those behaviors were more likely to have a daughter in the low-active group. Familial aggregation of TV viewing habits (19) and of physical activity (49) has been previously reported in the literature; however, to our knowledge, relationships between parents' sedentary behaviors and their child's physical activity levels have not been. An unexpected finding in this study was that social support of

sedentary behaviors and children's physical activity were positively associated, with girls who came from families that played computer and electronic games together several times per week less likely to be in the low-active group. Previous studies have shown that parents who provide support for their child's physical activity are more likely to have an active child (49). Perhaps parents who spend time with their child, whether that time is spent being active or sedentary, are more involved and supportive of their child's activities generally.

It was anticipated that having sedentary opportunities at home would be an important correlate of children's TV viewing and being low-active. Unlike some previous studies (27,28), however, we did not find a relationship between having a TV set in the bedroom and children's TV viewing, although other studies have also failed to find a positive association (30). It is also of interest that boys' access to pay TV in the home was associated with a reduced likelihood of being in the low-active group. Even though the multivariate analyses were adjusted for maternal education levels (our nominated indicator of family SES), having pay TV in the home may be another indicator of SES and a possible reason for the positive relationship with physical activity. Furthermore, it may be that TV viewing and other sedentary behaviors cluster with physical activity (48). There is certainly inconsistent evidence in the literature that TV viewing and physical activity are inversely related (31).

There were a number of limitations in this study. A potential source of Type I error was in the number of statistical tests that were performed, increasing the possibility of significant relationships through chance. In many cases, however, the resultant highly significant coefficients suggest real differences rather than chance occurrences. Dichotomization of children's TV viewing based on parental proxy report may also have resulted in differential or non-differential misclassification of the outcome. We assessed the agreement between children's self-reported and parents' proxy-reported TV viewing after stratifying by parents' self-reported viewing habits (data not shown). There was no evidence of differential misclassification. However, it was not possible to test for non-differential misclassification in this study; therefore, real differences between groups may have been obscured or underestimated.

The use of a proxy report measure of children's TV viewing is also a limitation because parents may not have been fully aware of how much TV their child watched. The modest response rate achieved in this study, which may be attributed to the requirement to obtain active parental consent, is a further limitation. Although our sample is not representative and may include selection bias whereby more physically active children and parents who are more interested in health and physical activity issues for their child were recruited to the study, the sample does include families from a range of socioeconomic and family environment

backgrounds, and levels of overweight and obesity were consistent with population estimates (3). In addition, if there was a higher proportion of active children in the sample, the strength of the relationships between the family environment and children's physical activity may be underestimated. These data provide an opportunity to examine relationships between the family environment and TV viewing and low-level activity in a large heterogeneous sample. Furthermore, the use of an objective measure of physical activity is an additional strength of the present study.

With more than one-half the children in this study exceeding the recommended daily limit of TV viewing (17,18), the development of effective strategies to reduce the time spent in this and other sedentary behaviors should be a key focus of public health interventions. Although the findings from a recent meta-analysis of the relationships among TV viewing, computer use, and body fat among children and youth found only small effect sizes (15), school-based initiatives to reduce sedentary behavior have been shown to be effective in preventing unhealthy weight gain among children and youth (50,51). Findings from the current study suggest that aspects of the family environment may be important to consider in the development of strategies to reduce children's TV viewing and low-level physical activity. It indicates that parents may be important mediators of their child's sedentary behavior, particularly focusing on rules and restrictions of TV viewing and minimizing their modeling of screen-based behaviors. Parents, health educators, teachers, and other professionals should promote enjoyable alternatives to sedentary behavior to increase children's participation in physical activity and prevent unhealthy weight gain. It is also apparent that the relationships between the family environment and TV viewing and low-level activity are complex and that these behaviors are quite distinct. Future studies should identify family environmental influences on other sedentary behaviors.

Acknowledgments

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