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Does Television Viewing Increase Obesity and Reduce Physical Activity? Cross-sectional and Longitudinal Analyses Among Adolescent Girls

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ABSTRACT. To examine the relationships between hours of television viewing and adiposity and physical activity among female adolescents, a cohort study with follow-up assessments 7, 14, and 24 months after baseline was conducted. All sixth- and seventh-grade girls (N = 971) attending four northern California middle schools were eligible to participate. Six hundred seventy-one students had sufficient data for baseline cross-sectional analyses, and 279 students in a no-intervention cohort had sufficient data for longitudinal analyses. The baseline sample had a mean age of 12.4 years and was 43% white, 22% Asian, 21% Latino, 6% Pacific Islander, 4% black, 2% American Indian, and 2% other. Hours of after-school television viewing, level of physical activity, and stage of sexual maturation were assessed with self-report instruments. Height, weight, and triceps skinfold thickness were measured and body mass index (ratio of weight [in kilograms] to height [in meters] squared) and triceps skinfold thickness were adjusted by level of sexual maturity for the analyses. Baseline hours of after-school television viewing was not significantly associated with either baseline or longitudinal change in body mass index or triceps skinfold thickness. Baseline hours of after-school television viewing was weakly negatively associated with level of physical activity in cross-sectional analyses but not significantly associated with change in level of physical activity over time. All results were essentially unchanged when adjusted for age, race, parent education, and parent fatness. Among adolescent girls, television viewing time appears to have only weak, if any, meaningful associations with adiposity, physical activity, or change in either over time. ***Pediatrics*** **1993; 91:273–280;** ***television, obesity, adiposity, physical activity, adolescents, females.***

ABBREVIATIONS. BMI, body mass index; SMI, sexual maturity index.

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According to recent A.C. Nielsen Company estimates, 6- through 11-year-old children in the United States watch an average of more than 23 hours of television per week, and 12- through 17-year-olds watch an average of more than 21 hours per week.[1] Because television holds such a prominent place in American culture, researchers have long been interested in the effects of television on both children and adults. Investigators have studied effects on cognitive skills and development, aggression and violence, attitudes and perceptions, and recently, health-related behaviors and health status.[2] Time spent watching television was found to be directly associated with prevalence and incidence of obesity among children and adolescents in cycles II and III of the National Health Examination Survey.[3] Similar relationships have been reported from a national sample of third and fourth graders[4] and in large samples of adults.[5–7] However, these studies were limited by their cross-sectional designs and, in one case, the use of self-reported heights and weights.[6] No significant association between television viewing and body mass index (BMI) was detected in a cross-sectional study of adolescent boys.[8]

It has been suggested that a relationship between television viewing and obesity may be the result of increased energy consumption, either during viewing or as a result of food advertising, or a reduction in energy expenditure due to displacement of physical activity.[3] Television advertising and programming tend to emphasize high-calorie foods of poor nutritional quality,[9] and exposure to food advertisements may produce incorrect nutritional beliefs among children.[10] In addition, experimental studies with children have demonstrated direct effects of exposure to advertising for high-calorie foods on actual snack choices and consumption.[11,12]

Data on associations between television viewing and physical activity are mostly lacking. In a cross-sectional sample of male adolescents, hours of television viewing were negatively associated with assessments of physical fitness. Physical activity participation levels were not assessed.[8] Hours of television viewing were unrelated to measures of physical activity among 3- to 8-year-old children in another cross-sectional study,[13] though parent reports of television viewing were negatively correlated with parent (but not teacher) ratings of children's physical activity[14] and children's performance on a mile walk/run,[4] among third and fourth graders participating in the National Children and Youth Fitness Study II. In a natural experiment of the introduction of television into a Canadian town,[15] reported sports participation among children and adults was significantly greater in the no-television town (Notel) than in a single-channel control town (Unitel), and significantly greater in Unitel than in a multiple-channel (Multitel) control town, at baseline. Introduction of television was followed by a decrease in sports participation in Notel over the 2-year follow-up, compared with a concurrent rise in sports participation in the control towns. Similar observations have been reported from small samples of children in Australia[16] and Scotland.[17]

While associations between television viewing and obesity and physical activity have been reported from very few samples, they have received substantial attention in both the popular press and clinical literature. We attempted to confirm these findings by examining data on television viewing, BMI, and physical activity from a school-based cohort of female adolescents participating in a longitudinal study of weight regulation practices.

SUBJECTS AND METHODS

All sixth- and seventh-grade girls (N = 971) attending four northern California middle schools were eligible to participate in a longitudinal study examining the natural history of disordered eating practices.[18] The study included a randomly selected intervention group and a no-intervention control group. Only subjects in the no-intervention control group were included in longitudinal components of the present analyses. Trained staff conducted physical and paper-and-pencil assessments over a 5-day period in each middle school. The baseline assessment took place during March 1989. Follow-up assessments took place approximately 7, 14, and 24 months after baseline. Both tracking and confidentiality were maintained through use of unique identification numbers. A passive consent process was used. Parents were informed by mail and given the opportunity to withdraw their child from participation at any time, without prejudice. Students were given the opportunity to decline participation at the time of each assessment. The study was approved by the Stanford University School of Medicine Committee for the Protection of Human Subjects in Research.

Demographics

Students reported their age by circling the month and year of their birthday. Race was reported by circling one of the following seven descriptors: white, black, Asian, Hispanic/Latino, Pacific Islander, American Indian, or other. Due to smaller numbers, black, Pacific Islander, American Indian and other were collapsed into a single category for the analyses. Parent education level was assessed for both mother and father, separately. Students responded to the question, "How many years of education has your [father/mother] had?" by circling one of the following: less than high school, high school graduate, some college, college graduate, some grad school, or graduate degree. The higher of the two reports was used in the analyses as an integer from 1 to 6, as an indicator of socioeconomic status.

Level of Parent Fatness

Level of parent fatness was assessed using standard male and female drawings representing eight levels of increasing fatness.[19] No subjective descriptors labeled the individual drawings. Students were asked to identify the figures most resembling their "real (biological)" mother and father as the most they had ever seen them weigh. If they had never seen their biologic parent(s) they were instructed to check "don't know." The higher of mother's or father's fatness level was used in the analyses as an integer from 1 to 8. This single variable representing parent fatness was selected because (1) it was more highly correlated to subject sexual maturity-adjusted BMI (Spearman $r = .20$, $P < .0001$) than either the mother's or father's fatness levels, and (2) mother's and father's fatness levels accounted for no significant variance in subject's sexual maturity-adjusted BMI beyond that explained by the higher of the two levels, in this sample.

Television Viewing

Television viewing was measured as part of an assessment of after-school activities. Subjects were asked to respond to the following: "We would like to know how much time (if any) you spend doing each of the following after school is over." "Viewing television" was one of 13 activities listed (eg, eating with family, doing homework), and subjects responded by circling an answer from 0 to 5 hours, presented in one-half hour intervals. A small number of students (14 in the baseline sample) wrote in values greater than 5 but less than or equal to 7 hours. These responses were used in the analyses for these subjects. When subjects in the no-intervention control group were asked the same question 24 months later there was a correlation (Spearman) of .37 ($P < .0001$), suggesting that self-reported hours of after-school television viewing was a moderately stable variable in this sample.

Physical Activity

Level of physical activity was measured by three questions previously validated by Washburn et al.[20] The first two questions combine to assess the frequency of exercise-induced sweating by asking "At least once a week do you engage in regular activity like brisk walking, jogging, bicycling, etc, long enough to work up a sweat?" followed by "yes" and "no" answers, and "If yes, how many days per week?" to which subjects responded by circling listed numbers 1 through 7. The third question assessed perceived level of physical activity relative to peers by asking, "Compared with others your age and sex would you consider yourself to be (I) much more active, (II) somewhat more active, (III) about the same, or (IV) somewhat less active?" To produce a summary measure of level of physical activity (range 0 to 100), the frequency of activity-induced sweat episodes and the direction-corrected comparative activity measures were combined. Each was standardized on a scale from 0 to 100, assuming constant intervals between each response level for a particular question, and the sum was divided by two. The combination variable was chosen prior to any analyses involving television viewing or BMI for its face validity, to eliminate redundancy and for its superior 7-month (Spearman $r = .53$), 14-month (Spearman $r = .52$), and 24-month (Spearman $r = .44$) stabilities, compared to those of each variable treated individually.

Sexual Maturity

Self-assessment of pubertal stage used the method of Duke et al.[21,22] Subjects were presented with standardized drawings and descriptions, based on the Tanner stages of pubertal maturation,[23] to designate breast stage and pubic hair stage. When self-ratings were compared with physician ratings, Duke et al[21] found κ coefficients of 0.81 for breast stage and 0.91 for female pubic hair stage. Williams et al[24] demonstrated that the validity of adolescents' self-assessments of pubertal stage is independent of level of fatness. Among our subjects, self-staging of breast and pubic hair were correlated (Spearman $r = .64$, $P \leq .0001$). The average of breast and pubic hair stages, rounded up to a single integer, was defined as the sexual maturity index (SMI).[25]

Body Mass Index

Subjects were measured in light clothing, with shoes removed, by trained data collectors during school hours. The same data collectors performed the measurements at all sites. Weight was measured to the nearest 0.1 kg, using a portable electronic scale, and standing height was measured to the nearest millimeter with a portable direct-reading stadiometer. Each subject's weight and height were measured twice, and the means were used in the analyses. Test-retest reliabilities for these measurements were high (weight, Spearman $r = .99$; height, Spearman $r = .99$). Body mass index was calculated as the ratio of weight (in kilograms) to height (in meters) squared. Body mass index was chosen as the primary estimate of adiposity for its advantages over other anthropometrically derived measures.[26] Body mass index and skinfold thickness are comparably correlated with densitometrically estimated percent body fat and total body fat in children and adolescents,[27] and BMI has demonstrated clinical validity for blood pressure and hypertension,[28–31] and adverse lipoprotein profiles[32,33] among children and adolescents. To account for changes in adiposity associated with normal sexual development, BMI values were adjusted by SMI within the overall sample, at each point in time. Sexual maturity-adjusted BMI was used in preference to age-adjusted BMI because BMI correlates more strongly with pubertal stage than chronologic age in this age range (baseline sample: SMI-BMI Spearman $r = .41$, age-BMI Spearman $r = .17$). In addition, age contributed no significant variance in BMI beyond that explained by SMI, in this sample. Sexual maturity adjustment allows for more appropriate longitudinal comparisons, and it also eliminates the problem of collinearity from including both age and SMI in multivariate analyses.

Triceps Skinfold Thickness

Triceps skinfold thickness was measured at baseline and 14-month follow-up as a measure of subcutaneous fat. Skinfold thickness was measured with calipers to the nearest 0.2 mm, over the triceps muscle at the midpoint between the acromion and the olecranon, according to established guidelines.[34] Each subject's triceps skinfold thickness was measured three times, and the median value was used in the analyses. Test-retest reliabilities for these measurements were high (Spearman $r = .99$). As expected, triceps skinfold thickness was highly correlated with BMI (Spearman $r = .84$). For the analyses triceps skinfold thickness was adjusted by SMI within the overall sample, at each point in time. Sexual maturity adjustment was found to be preferable to age adjustment for triceps skinfold thickness, using the same methods described above for BIM. Triceps skinfold thickness was correlated more strongly with pubertal stage than chronologic age, and age contributed no significant variance in triceps skinfold thickness beyond that explained by SMI in this sample.

Analyses

For the cross-sectional analyses, the sample included all subjects with complete baseline data for all of the following: after-school television viewing, height, weight, self-ratings of Tanner stages of breast and pubic hair development, and the three physical activity questions. Analyses were performed similarly but separately for the three dependent variables, SMI-adjusted BMI, SMI-adjusted triceps skinfold thickness, and physical activity. Spearman correlation coefficients were calculated for the associations between baseline hours of reported television viewing and the three dependent variables. Then, to evaluate the associations between television viewing and the dependent variables, while adjusting for potential confounders, multivariate linear regressions were performed by simultaneously entering the television viewing variable along with the following potential confounders: age, race, parent education level, and baseline SMI-adjusted BMI for the dependent variable physical activity; and age, race, parent education level, parent fatness, and baseline physical activity for the dependent variables SMI-adjusted BMI and SMI-adjusted triceps skinfold thickness.

Subjects included in the longitudinal analyses were drawn only from the no-intervention control group of the overall study, to eliminate any possibility of confounding effects of the intervention. The longitudinal sample comprised those no-intervention group subjects from the defined baseline cross-sectional sample who also had the necessary information to calculate both SMI-adjusted BMI and physical activity, at one or more follow-up assessments (7, 14, and 24 months). All available follow-up data were utilized to fit subject-specific least-squares regression lines for changes in SMI-adjusted BMI, SMI-adjusted triceps skinfold thickness, and physical activity, as plotted against chronologic age, in months. The slopes of the fitted lines were used as the dependent variables for examining associations between television viewing at baseline and longitudinal changes in SMI-adjusted BMI, SMI-adjusted triceps skinfold thickness, and physical activity. This method allowed use of all available follow-up data (up to four serial measures over 2 years) to produce the best estimates of change over time. As with the baseline cross-sectional analyses described above, univariate relations were evaluated with Spearman correlation coefficients, and multivariate relations were explored by simultaneously including baseline measures of the same potential confounders along with baseline reported hours of television viewing in a multivariate linear regression.

To confirm the results of the baseline cross-sectional analyses, longitudinal data on BMI and physical activity were used to create alternative point-estimates of these dependent variables. For each subject in the longitudinal cohort, estimates of SMI-adjusted BMI and level of physical activity, at age 13 years, were calculated from the slopes used in the longitudinal analyses. These values were used in univariate and multivariate analyses as described above.

Obesity is often defined by cutoffs of measures of adiposity. However, the clinical validity of these definitions is somewhat suspect.[26] Among adults, adiposity has been shown to be related to morbidity and mortality in a curvilinear manner, with no apparent threshold.[35,36] Recent correlational morbidity data from children and adolescents[37] appear to demonstrate similar curvilinear associations. Even more important, the proposed mechanisms for an association between television viewing hours and obesity[3] would be logically expected to be manifest as increased adiposity in a continuous manner. In addition, defining groups as obese and nonobese decreases statistical power to detect significant effects, increasing the possibility of a type II error. For these reasons, we believe it is most appropriate to use our measures of adiposity as continuous variables. However, to allow for more direct comparisons with previous work, we performed additional secondary analyses choosing the 85th percentiles of SMI-adjusted BMI and SMI-adjusted triceps skinfold thickness, in the overall sample, as cutoffs for "obesity." We used a nonparametric Wilcoxon rank sum test to evaluate univariate associations and multiple logistic regression for multivariate analyses, mimicking the primary cross-sectional analyses described above.

RESULTS

Sample Characteristics

Of 971 available students, 931 (95.9%) participated in the baseline assessment. Nineteen students refused to participate. The remaining missing subjects were absent from school during scheduled assessments. The sample used in the longitudinal analyses was drawn from a total of 536 students who were initially randomized to the no-intervention control group as part of the overall study. Numbers and baseline characteristics of all subjects included in the cross-sectional and longitudinal analyses are presented in the Table. The sample used in the baseline cross-sectional analyses did not differ significantly from the initial total baseline sample in age, level of parent education, parent fatness, BMI or triceps skinfold thickness (both adjusted and unadjusted for sexual maturity), level of physical activity, number of weekly activity-induced sweat episodes, or hours of daily after-school television viewing. Racial distribution did differ significantly, with a greater percentage of Asians and relatively fewer Hispanic/Latinos in the sample used for cross-sectional analyses. The longitudinal sample was comparable with the cross-sec-

TABLE. Baseline Characteristics of Subjects

	Sample Used in Baseline Cross-sectional Analyses	Sample Used in Longitudinal Analyses
No.	671	279
Mean age, y (SD)	12.41 (0.74)	12.37 (0.73)
Race, %		
White	42.9	42.7
Hispanic/Latino	21.2	23.3
Asian	22.2	21.1
Pacific Islander	6.3	7.9
Black	3.6	2.5
American Indian	2.2	1.8
Other	1.6	0.7
Parent education, %		
Less than high school	7.9	7.9
High school graduate	19.5	19.4
Some college	22.2	25.8
College graduate	24.6	24.0
At least some graduate school	18.2	17.2
Unknown	7.6	5.7
Parent fatness, mean (SD)	4.57 (0.98)	4.61 (0.94)
Body mass index, kg/m^2		
Mean (SD)	20.21 (3.74)	20.33 (3.89)
25th percentile	17.58	17.74
50th percentile	19.46	19.63
75th percentile	22.25	22.45
90th percentile	25.56	25.62
95th percentile	27.06	27.10
Triceps skinfold thickness, mm		
Mean (SD)	16.0 (6.6)	16.0 (7.0)
25th percentile	11.1	10.5
50th percentile	14.3	14.5
75th percentile	19.9	20.4
90th percentile	25.2	25.7
95th percentile	28.1	28.9
Level of physical activity, mean (SD)	41.8 (24.2)	42.4 (23.5)
No. of activity-induced sweat episodes per week, mean (SD)	2.6 (2.2)	2.7 (2.2)
After-school hours of television viewing, mean (SD)	2.48 (1.55)	2.51 (1.52)

tional sample, with no evidence of differential dropout for any of the above variables. For the longitudinal sample, physical activity data were available for 12.2% at a single follow-up, 42.7% at two follow-ups, and 45.2% at all three follow-ups, and SMI-adjusted BMI data were available for 10.8% at a single follow-up, 28.3% at two follow-ups, and 60.9% at all three follow-ups. Triceps skinfold thickness measurements were available for 670 subjects in the baseline sample. Of the 279 students in the longitudinal sample, 238 had triceps skinfold measurements at both baseline and the 14-month follow-up.

Television Viewing and BMI

The baseline relationship between hours of after-school television viewing and SMI-adjusted BMI is illustrated by the scatterplot in Fig 1. Reported hours of after-school television viewing and SMI-adjusted BMI were not significantly associated at baseline in univariate (Spearman $r = .053$, $P = .17$) or multivariate (regression coefficient estimate = −.067, $P = .86$) cross-sectional analyses. The cross-sectional analyses using the age 13 estimate of SMI-adjusted BMI derived from longitudinal data produced similar results (univariate Spearman $r = .055$, $P = .33$; multivariate regression coefficient estimate = −.072, $P = .90$). Longitudinal analyses also produced similar, nonsignificant results (univariate Spearman $r = .030$, $P = .62$; multivariate regression coefficient estimate = .054, $P = .82$). Similar results were produced when the SMI-adjusted BMI was dichotomized at the 85th percentile (Wilcoxon test: $z = -.075$, $P = .94$; multiple logistic regression coefficient estimate = −.033, $P = .67$). Obese subjects (>85th percentile) reported a daily average of 2.44 hours of after-school television viewing compared with 2.49 hours for nonobese subjects.

Television Viewing and Triceps Skinfold Thickness

Reported hours of after-school television viewing and SMI-adjusted triceps skinfold thickness were not significantly associated at baseline in univariate (Spearman $r = .005$, $P = .90$) or multivariate (regression coefficient estimate = −.403, $P = .29$) cross-sectional analyses. Longitudinal analyses produced similar, nonsignificant results (univariate Spearman $r = .028$, $P = .54$; multivariate regression coefficient estimate = −.190, $P = .67$). Similar results were produced when the SMI-adjusted triceps skinfold thickness measure was dichotomized at the 85th percentile (Wilcoxon test: $z = -.758$, $P = .45$; multiple logistic regression coefficient estimate = −.083, $P = .30$). Obese subjects (>85th percentile) reported a daily average of 2.32 hours of after-school television viewing compared with 2.51 for nonobese subjects.

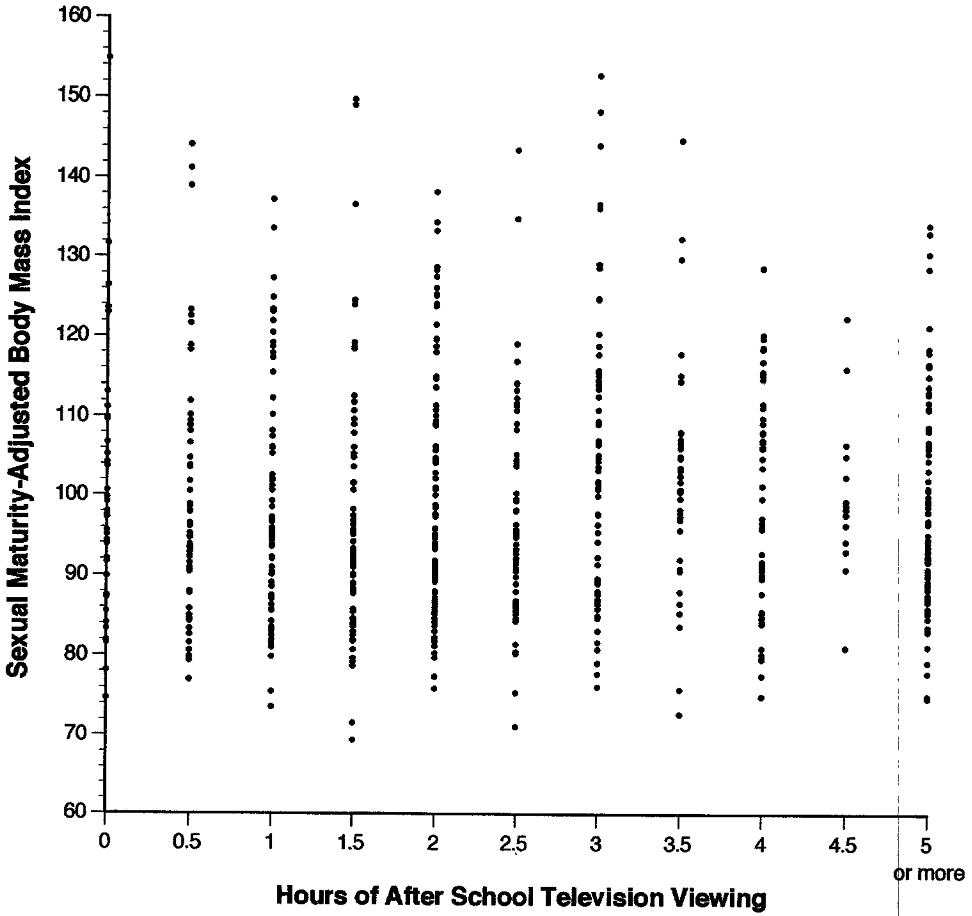

Fig 1. Relationship between hours of after-school television viewing and sexual maturity-adjusted body mass index in the baseline cross-sectional sample (N = 671). Some points represent more than one subject. Spearman r = .053, P = .17.

Television Viewing and Physical Activity

The baseline relationship between hours of after-school television viewing and physical activity is illustrated by the scatterplot in Fig 2. Reported hours of after-school television viewing was statistically significantly negatively associated with level of physical activity (Spearman r = −.086, P = .026), though the association accounted for less than 1% of the variance. After simultaneous adjustment for age, race, sexual maturity-adjusted BMI, and level of parent education, the association between television viewing and physical activity remained statistically significant (regression coefficient estimate = −1.281, P = .043) but of similar weakness. Additional cross-sectional analyses, using the age 13 estimate of physical activity derived from longitudinal data, produced weaker, nonsignificant results in the same direction (univariate Spearman r = −.022, P = .70; multivariate regression coefficient estimate = −.097, P = .92). Longitudinal analyses demonstrated no statistically significant association between baseline hours of television viewing and change in level of physical activity over time in either univariate (Spearman r = .042, P = .48) or multivariate (regression coefficient estimate = .763, P = .33) analyses.

DISCUSSION

In this large sample of female adolescents, hours of after-school television viewing was not appreciably associated with BMI, triceps skinfold thickness, level of physical activity, or change in any of these over time. Although a statistically significant association (P < .05) was detected between baseline physical activity and hours of television viewing, it was of such weak magnitude (accounting for less than 1% of variance) that we would not consider it clinically meaningful. The scatterplot of the univariate relationship between hours of television viewing and physical activity (Fig 2) graphically demonstrates the weakness of the association, despite meeting criteria for statistical significance. These findings are important because previously published reports on the potential health effects of television viewing have received widespread acceptance and attention.

There are two potential interpretations of our findings: (1) important associations between hours of after-school television viewing and BMI, triceps skinfold thickness, and/or physical activity were not present in this sample; or (2) important associations between hours of after-school television viewing and BMI, triceps skinfold thickness, and/or physical activity truly did exist but were not detected by our methods. The first interpretation is self-explanatory and consistent with our findings. The second interpretation requires additional discussion. Failure to detect significant associations may have occurred for two reasons: (1) our study lacked a large enough sample to detect meaningful differences, or (2) our measures of television viewing, BMI, triceps skinfold thickness, and/or physical activity were either in-

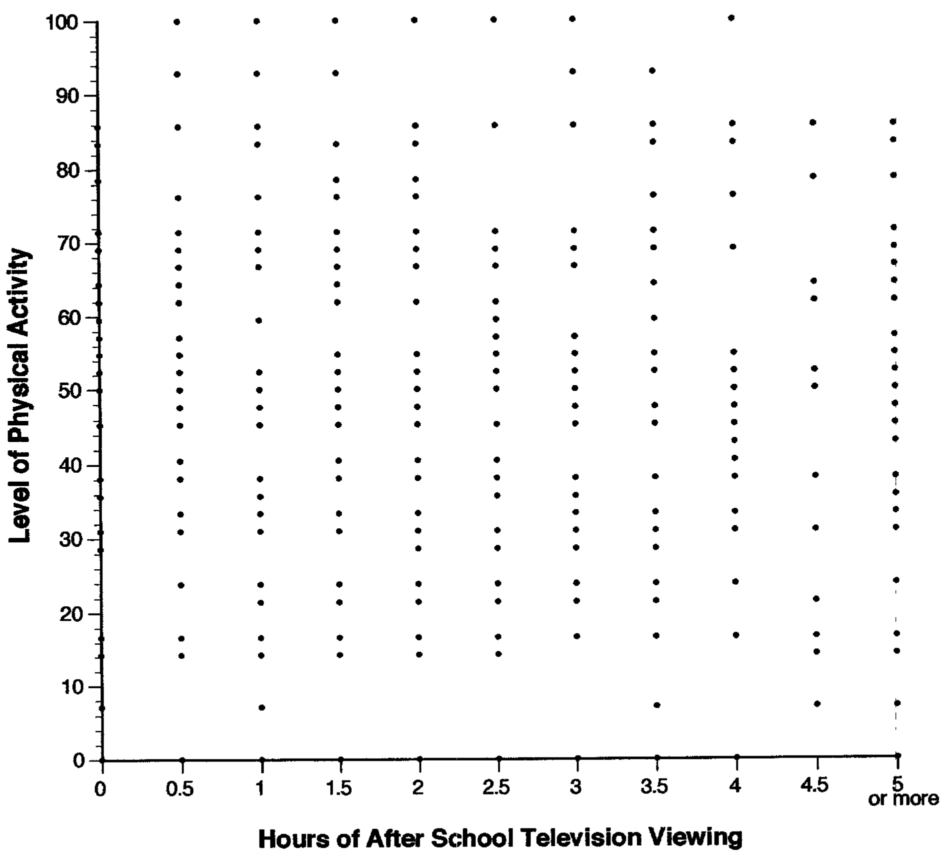

Fig 2. Relationship between hours of after-school television viewing and level of physical activity in the baseline cross-sectional sample ($N = 671$). Most points represent more than one subject. This figure graphically illustrates the difference between statistical significance (Spearman $r = -.086$, $P = .026$) and clinical or practical significance.

valid or unreliable, introducing either bias or excessive random error.

It is unlikely that our cross-sectional sample size of 671 and our longitudinal sample size of 279 were inadequate. Our cross-sectional and longitudinal samples were large enough to detect statistically significant correlations of .14 and .22, respectively, at a 5% two-tailed α level with 95% power.[38]

We are also confident in our measures. Height, weight, and skinfold thickness were measured reliably and the distributions of BMI and triceps skinfold thickness in our sample were similar to those of nationally representative samples of the same age and gender.[39,40] Self-ratings of sexual maturity have previously been validated in adolescent girls.[21, 22, 24] Because BMI and triceps skinfold thickness vary strongly with stage of pubertal maturation in this age group, the use of sexual maturity-adjustment has clear advantages over nonadjusted or age-adjusted estimates for both cross-sectional and longitudinal analyses. The high correlation between BMI and triceps skinfold thickness, and the similar findings that resulted when using each of these dependent variables, is additional evidence for the validity of these results.

It is difficult to measure physical activity and television viewing through self-reports, so we cannot rule out the possibility that error associated with these measures influenced our ability to detect stronger effects. However, our confidence in these measures is enhanced by the demonstrated relative stability of self-reports over long periods of time. The physical activity questions have been previously validated in college students.[20] Previous studies have also used similar questions to assess average daily hours of television viewing.[3] Compared with total daily hours of television viewing, we considered after-school viewing to be a potentially more sensitive discriminator for health-related outcomes. Limiting reports to after-school hours selects those periods of time over which adolescents generally have the most control. In addition, adolescents watch more television during the afternoon and evening than during any other time of day.[1] Our sample mean of 2½ hours of daily after-school television viewing is similar to A.C. Nielsen's national estimate of 2.1 daily average hours of viewing for 12- through 17-year-old girls between 3 PM and 11 PM, Monday through Friday, during the same month and year as our assessment (personal correspondence: Nielsen Media Research, New York, NY). The slightly greater estimate is consistent with the younger age distribution of our sample.[1] The use of A.C. Nielsen data and longitudinal stability estimates does not ensure the validity and reliability of our measures but should be considered a strength of this study. Similar validations have not been reported in the existing studies.

Of five published reports of significant associations between television viewing and obesity, only one includes detailed results for children and adolescents. Dietz and Gortmaker[3] examined data collected during cycles II and III of the National Health Examination Survey. Data on 6965 children, aged 6 through 11 years, were collected in cycle II (1963 through 1965), and data on 6671 adolescents, aged 12 through 17, were collected in cycle III (1966 through 1970). They reported statistically significant associations between parent reports (cycle II) or self-reports (cycle III) of "hours per day watching television" and prevalence of "obesity" (defined as triceps skinfold thickness greater than or equal to the 85th percentile for age and sex) and "superobesity" (triceps skinfold thickness greater than or equal to the 95th percentile for age and sex). In addition, they reported evidence for a dose-response relationship and for a statistically significant association between hours of television viewing at age 6 through 11 years and prevalence of obesity and superobesity at age 12 through 17, for the 2153 subjects assessed in both cycles II and III. However, after controlling for cycle II obesity and "socioeconomic characteristics," the longitudinal association between television viewing and obesity became statistically nonsignificant ($P < .07$) and the association with superobesity was weakened.

The National Children and Youth Fitness Study II, of a nationally representative cross-sectional sample of 2372 third and fourth graders, found a statistically significant association between parents' reports of their children's television viewing time and the sum of triceps, subscapular, and medial calf skinfold thicknesses in their children. However, the report specifies only that after controlling for sex and age, ". . . these correlations were relatively low in absolute magnitude. . . ."[4] One additional study of 379 male adolescents found no significant association between hours of television viewing and BMI.[8]

Although we found no statistically significant association between hours of after-school television viewing and BMI or triceps skinfold thickness, our results do not necessarily contradict those reported by Dietz and Gortmaker[3] for a much larger sample, from more than 20 years earlier. Dietz and Gortmaker did not report effect sizes but, with their reported P values and sample sizes (N), it is possible to calculate rough estimates of the size of the correlations (r) with the following equation based on bivariate normal distribution theory:

$$r = z/[z^2 + N - 2]^{1/2}$$

where z is the P value critical level of the standard normal distribution. When these calculations are performed, we find that Dietz and Gortmaker's reported significant associations may represent correlations of only about $r = .03$ to $.05$. These correlations are similar to those identified in our analyses and suggest that these two apparently contradictory reports actually demonstrate surprisingly consistent results. These findings support the validity of our results, and the use of the after-school television-viewing measure in particular. Despite different samples and variations in methodology, we have arrived at similar results. The consistent demonstration of such a weak association in several studies refutes previous suggestions that hours of television viewing is causally related to obesity among children and adolescents. These findings also highlight the general fact that statistically significant results may not have clinical, practical, or policy significance and may primarily reflect a large sample size.

Observations in natural experiments of the initial introduction of television into small communities in Canada[15] and Scotland[17] have provided the best available evidence for a significant negative association between television viewing and physical activity. However, it is difficult to extrapolate these findings directly to the present situation in the United States, where an estimated 92.1 million households, containing an estimated 235.23 million people, have at least one television and can receive an average of 30.5 channels.[1] Tucker[8] has reported a significant negative association between hours of television viewing and several measures of physical fitness among 379 male adolescents, though no direct assessment of participation in physical activity was included. In the National Children and Youth Fitness Study II, parents' estimates of their third and fourth graders' television viewing time were negatively associated with parents' (but not teachers') ratings of physical activity level, participation in organized sports and community athletic activities,[14] and performance on a 1-mile walk/run.[4] Himmelweit et al,[41] in a large study of 10- to 14-year-old British children, in the mid-1950s, found exposure to television produced small reductions in unorganized outdoor activities but almost no effects on participation in competitive sports. Taras et al[13] found hours of television viewing to be unrelated to measures of physical activity among 3- to 8-year-old children in a cross-sectional study in a southern California community. The availability of longitudinal data in our study is an advantage over much of the existing literature. The present results suggest that among adolescent girls, any effect of television viewing time on physical activity is likely to be very small and of questionable clinical or practical importance.

Our findings should not be misinterpreted as a defense of television viewing. These results do not demonstrate that television viewing has no effect at all. As noted above, experimental studies have provided evidence for a causal relationship between specific televised messages and children's eating behaviors[11,12] and between television viewing and reduced participation in sports.[15,17] It is possible that assessing television exposure with a global assessment of hours viewed may lack the sensitivity to identify important effects. How a child watches television and what he or she sees may be more important than the number of viewing hours. These suggestions are consistent with findings related to the effects of television violence on children. For example, in a controlled study of first and third graders, a treatment designed to reduce imitation of televised aggression resulted in a reduction in children's aggressive behavior, without a concurrent reduction in violent-television viewing.[42] As a result of our findings, we suggest that future investigations focus on the specific content to which children and adolescents are exposed and their behavioral and cognitive responses. The presence or lack of critical viewing skills, strength of prior attitudes, intentions or self-efficacy, or characteristics of the family or peer environments may prove to be more important variables than total viewing hours. However, our present findings suggest that total hours of after-school television viewing appears to have only weak, if any, associations with adiposity and physical activity among adolescent girls.

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