

Television Exposure and Overweight Risk in Preschoolers

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Objective: To test the independent effect of television exposure in preschool-aged children on overweight risk.

Design: Cross-sectional and longitudinal analysis of the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development.

Setting: Ten US sites.

Participants: One thousand sixteen children selected via conditional random sampling.

Main Exposure: Being awake in the room with the television on for 2 hours or more per day, by maternal report at age 36 months.

Main Outcome Measures: Child overweight (body mass index [calculated as weight in kilograms divided by the square of height in meters] \geq 95th percentile) calculated from measured anthropometrics at ages 36 and 54 months. Covariates tested included child sex and race; maternal marital status, education, age, and depressive symptoms; income-needs ratio, child behavior problems; Home

Observation for Measurement of the Environment total score; hours per week in nonparental care; and proportion of television exposure that was educational.

Results: At age 36 months, 5.8% of children were overweight; at age 54 months, 10.0% were overweight. Exposure to 2 or more hours of television per day was associated with an increased risk of overweight at both age 36 months (odds ratio, 2.92; 95% confidence interval, 1.36-6.24) and age 54 months (odds ratio, 1.71; 95% confidence interval, 1.03-2.83) in unadjusted analyses. Only maternal age altered the concurrent relationship, and the effect of television remained significant (odds ratio, 2.61; 95% confidence interval, 1.21-5.62). Television exposure at age 36 months was no longer a significant predictor of overweight at age 54 months when controlling for covariates.

Conclusion: Excessive television exposure is a risk factor for overweight in preschoolers independent of a number of potential confounders associated with the quality of the home environment.

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EXCESSIVE TELEVISION (TV) viewing has been linked to a variety of adverse outcomes in children.^{1,2} The relationship between TV viewing and overweight risk has been more thoroughly described in school-aged³⁻¹⁰ than in preschool-aged¹¹⁻¹⁷ children, and only 2 studies in preschoolers control for important potential confounders.^{12,13} The American Academy of Pediatrics recommends that total media time be limited to less than 2 hours per day in children aged 2 years and older.² Helping families achieve this goal requires more information, including whether the relationship is confounded by family characteristics that have not been previously controlled, such as overall quality of the home environment or maternal depressive symptoms. In addition, the relationship in US children has been evaluated only in low-income

groups,¹³ who watch significantly more television.¹⁸ It is possible that the relationship may be stronger in low-income populations or that important confounders of the relationship are present to a greater degree in low-income families. Excessive television viewing in preschoolers may also simply be a marker for an understimulating home environment, which has been independently linked to overweight risk.¹⁹

The present study seeks to address these gaps in the current literature. We investigate the relationship between television exposure and overweight risk in an age range in which there are limited data and in socioeconomic strata of the United States in which it has not previously been studied in large samples. We control for a number of covariates that have not previously been available and examine both the cross-sectional and longitudinal relationships between television exposure and

overweight risk. We hypothesized that a relationship between excessive television exposure and overweight risk would be present both cross-sectionally and longitudinally, but that it would be confounded by markers of quality of the home environment.

METHODS

The sample was composed of children and their parents enrolled in the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development.²⁰ This is a longitudinal study of relations between child behavior and development, particularly in relation to child care experience. Families were recruited shortly after the birth of a child in 1991 from 10 areas of the United States, both urban and rural. Details of the recruitment methods and sampling plan are available elsewhere.²¹ The initial sample included 1364 children and was representative of the demographics of the catchment areas from which the sample was recruited.²⁰ We examined the cross-sectional relationship between television exposure and overweight risk with data collected at age 36 months and the longitudinal relationship with data collected at ages 36 and 54 months. This study was approved by the institutional review boards of all pertinent institutions.

Our outcome measure in the cross-sectional analysis was overweight status at age 36 months. We evaluated 3 outcome measures in the longitudinal analysis: overweight status at age 54 months; incidence of new cases of overweight between the ages of 36 and 54 months; and change in body mass index (BMI), calculated as weight in kilograms divided by the square of height in meters, between the ages of 36 and 54 months.²² Height and weight were measured during the laboratory visits at ages 36 and 54 months by trained research assistants.²³ Body mass index was calculated and child overweight defined dichotomously as a BMI greater than or equal to the 95th percentile for age and sex based on National Center for Health Statistics norms.²⁴

Mothers reported hours of TV exposure by questionnaire when the child was aged 36 months, describing 2 weekdays (Tuesday and Wednesday) and 2 weekend days for each of the three 6-hour time blocks between 6 AM and midnight in 15-minute increments. Television exposure was defined as "being awake in the room when the television is on" and included both broadcast and cable television as well as videos.²⁵ The mean \pm SD television exposure on weekdays (3.61 \pm 2.53 hours) and on weekends (3.58 \pm 2.67 hours) were correlated ($r=0.75$, $P<.001$). We indexed average daily TV exposure by multiplying mean weekday exposure by 5, summing this with mean weekend exposure, and dividing by 7. Given that the American Academy of Pediatrics recommends less than 2 hours of media exposure per day,^{1,2} we dichotomized our predictor to "less than 2 hours of television per day" vs "greater than or equal to 2 hours of television per day" to simplify interpretation of the results.

Demographic data consisted of the child's sex, the child's race/ethnicity ("white" or "not white"), maternal marital status ("single" vs "not"), years of maternal education, and maternal age. Additional characteristics hypothesized to modify an association between TV exposure and overweight were often available only for a subset of subjects and were therefore tested as potential covariates separately from the main analysis. Parents reported average hours per day in nonparental care via telephone interview every 3 months, and we calculated average hours per day in nonparental care between the ages of 24 and 36 months ($n=1016$). Maternal depressive symptoms were indexed with the Center for Epidemiologic Studies Depression scale ($n=928$), one of the most widely used and validated measures of depressive symptomatology, which asks respondents to self-report the fre-

quency of 20 depressive symptoms. Potential scores range from 0 to 60, with higher scores reflecting more depressive symptoms and scores greater than 16 reflecting a high risk for a clinical diagnosis of depression.²⁶

The income-to-needs ratio ($n=912$) is the ratio of total family income relative to the poverty line for a family of a particular size. A family with an income-to-needs ratio less than 1 is considered "poor." Child behavioral problems were indexed with the Child Behavior Checklist ($n=1014$), a 99-item rating scale that is the most widely used assessment of behavioral problems in young children.²⁷ Scores are presented as T scores that have a mean of 50 with a standard deviation of 15. A cut-off of 70 is frequently used to denote clinically significant behavioral problems. The quality of the home environment was measured by the Home Observation for Measurement of the Environment (HOME) ($n=996$), one of the most widely used indices of the quality and quantity of stimulation and support available to a child in the home. Information is obtained during a home visit via observation and interview. It is composed of 55 items, each of which is scored in a binary fashion (yes/no), with scores therefore ranging from 0 to 55 and higher scores indicating higher-quality home environments. The HOME has consistently been correlated with cognitive, language, achievement, and social-emotional outcomes.²⁸

We included an index of educational TV exposure based on the hypothesis that educational programming is higher quality and would therefore potentially promote healthier eating habits and exercise or, at a minimum, limit exposure to unhealthy advertising messages. Parents reported, in the same format described earlier, exposure to 6 programs comprising a significant proportion of children's programming on the Public Broadcasting Service in the early 1990s.²⁵ Mean \pm SD daily educational TV exposure (1.70 \pm 1.68 hours) was correlated with average daily total TV exposure (3.59 \pm 2.50 hours) ($r=0.64$, $P<.001$). We calculated the proportion of total daily TV exposure that was educational ($n=917$).

All data analysis was performed using SAS 8.2 (SAS Institute Inc, Cary, NC). We excluded children without data for television exposure ($n=267$) or BMI at age 36 months ($n=273$). We examined the sample included in our model ($n=1016$) vs those excluded because of missing data ($n=348$) and found significant differences. Neither average daily TV exposure nor overweight prevalence at age 36 months differed significantly in those with and without complete data ($P=.51$ and $P=.67$, respectively). Children included in the sample compared with those excluded were more likely to be white (82.8% vs 73.6%, $P<.001$) and had mothers who were more educated (14.4 vs 13.7 years, $P<.001$). We tested the location of data collection (each of the 10 sites) as a variable in the final model, as well as its interaction term, and found these to be nonsignificant.

Univariate statistics were first computed to provide a description of the sample of 1016 children. Then, bivariate analyses were performed to inform the development of the multiple logistic regression models. We analyzed all covariates by TV exposure (<2 hours per day vs ≥ 2 hours per day) using t tests for continuous variables and cross tabulations with χ^2 tests for categorical variables. We sought to confirm the utility of the American Academy of Pediatrics-defined cut point of fewer than 2 hours of television per day and therefore performed a logistic regression analysis evaluating the relationship between TV exposure and overweight risk at age 36 months by quartile of average daily TV exposure (with cut points at 1.75, 3.00, and 4.90 hours per day). All remaining analyses use TV exposure (<2 hours per day vs ≥ 2 hours per day) as the primary predictor.

To evaluate the cross-sectional relationship between TV exposure and overweight risk at age 36 months, we first created a logistic regression model adjusting for the demographic covariates sex; race/ethnicity; and maternal marital status, edu-

cation, and age simultaneously. Second, a base model was created using maximum likelihood ratios to derive the most parsimonious model with the best fit for the demographic covariates (sex; race/ethnicity; and maternal marital status, education, and age). Doing so allowed us to limit the number of covariates included simultaneously in the model, thereby maintaining the stability of the model when the additional covariates of interest were tested. After this base model was identified, we tested additional covariates, most of which were only available for a subset of the sample, each individually in the model as potential confounders. These were hours per day in nonparental care, Center for Epidemiologic Studies Depression scale score, income-needs ratio, Child Behavior Checklist total score, HOME score, and proportion of TV exposure that was educational.

To evaluate the longitudinal relationship between TV exposure at age 36 months and overweight risk at age 54 months, we repeated the analysis described earlier but with overweight status at age 54 months as the outcome (both with and without BMI z score at age 36 months as a covariate in the model). We also evaluated incidence (new cases of overweight emerging between the ages 36 and 54 months) as an outcome. We evaluated change in BMI between the ages 36 and 54 months using multiple linear regression and the Mallows Cp criterion²⁹ to identify the most parsimonious model for this continuous outcome.

We computed both unadjusted and adjusted odds ratios (ORs) and their corresponding 95% confidence intervals (CIs) from the logistic regression models. We used a *P* value of less than .05 (2-tailed) to determine statistical significance.

RESULTS

The sample included 1016 children. About half of the sample was male and 5.5% were overweight (BMI \geq 95th percentile).^{30,31} Fewer than one third (31.7%) of children were exposed to less than 2 hours of TV per day. In bivariate analyses, 2 or more hours of television exposure per day was associated with families who were less likely to be white; were more likely to be headed by single mothers; had lower income-needs ratios, lower HOME scores, and a lower proportion of television exposure that was educational; and had less educated, younger mothers with more depressive symptoms. Children exposed to 2 or more hours of TV per day had more reported behavior problems. Child sex and hours in nonparental care were not related to TV exposure (**Table 1**).

TELEVISION EXPOSURE AT AGE 36 MONTHS AND CONCURRENT OVERWEIGHT STATUS

Bivariate analyses showed that children who were exposed to 2 or more hours of TV per day were significantly more likely to be overweight than children exposed to less than 2 hours of TV per day (*P* = .004) (Table 1). We first evaluated the unadjusted risk of overweight in each quartile of TV exposure in a cross-tabulation and found higher risk of overweight in quartiles 2 through 4 in comparison with children watching 1.75 or fewer hours of TV per day (TV exposure in quartile 1). We found that 2.0% of those in the first quartile (least TV exposure) were overweight, compared with 5.6% in the second quartile, 5.8% in the third quartile, and 8.8% in the fourth quartile (greatest amount of TV expo-

Table 1. Characteristics of Children by Amount of Television Exposure Per Day

Characteristic	<2 Hours TV per Day (n = 322)	\geq 2 Hours TV per Day (n = 694)	<i>P</i> Value
Child overweight at age 36 m, %			.004
Yes	2.5	6.9	
No	97.5	93.1	
Sex, %			.23
Male	53.7	49.7	
Female	46.3	50.3	
Race, %			<.001
White	89.4	79.7	
Not white	10.6	20.3	
Maternal marital status, %			.004
Single	8.4	14.8	
Not single	91.6	85.2	
Maternal education, mean (SD), y	15.4 (2.7)	14.0 (2.3)	<.001
Maternal age, mean (SD), y	29.8 (5.1)	27.8 (5.6)	<.001
Income-needs ratio, mean (SD)	4.5 (4.2)	3.2 (2.6)	<.001
Child Behavior Checklist total score, mean (SD)	31.7 (17.2)	38.6 (18.2)	<.001
Center for Epidemiologic Studies Depression scale score, mean (SD)	8.2 (7.2)	10.4 (8.6)	<.001
HOME total score, mean (SD)	43.5 (7.2)	41.0 (7.2)	<.001
Time in nonparental care, mean (SD), h/wk	22.0 (15.8)	22.6 (17.2)	.58
Proportion of TV exposure that was educational, mean (SD)	0.60 (0.30)	0.50 (0.30)	<.001

Abbreviations: HOME, Home Observation for Measurement of the Environment; TV, television.

sure). We estimated this relationship in logistic regression models. Using quartile 1 as a reference, each of the 3 other quartiles conferred additional obesity risk in the unadjusted analysis (*P* = .02): quartile 2, OR, 2.98, 95% CI, 1.06-8.40; quartile 3, OR, 3.06, 95% CI, 1.10-8.55; and quartile 4, OR, 4.87, 95% CI, 1.81-13.06. Overweight risk did not differ significantly between quartiles 2, 3, and 4. In summary, results of the quartile analysis supported dichotomizing TV exposure by the American Academy of Pediatrics guidelines, and we proceeded with additional analyses using this dichotomous variable as the predictor in our models.

A relationship between 2 or more hours of TV exposure per day and overweight at age 36 months was present in the unadjusted analysis (OR, 2.92; 95% CI, 1.36-6.24). In the unadjusted analyses, both maternal age and income-needs ratio were found to be associated with overweight while maternal education and marital status approached statistical significance (**Table 2**). In the adjusted analysis controlling for all demographic covariates (sex; race; and maternal education, marital status, and age) simultaneously, a relationship between TV exposure and overweight at age 36 months persisted (Table 2).

In the analysis resulting from using the maximum likelihood ratio to derive the most parsimonious model, both watching 2 or more hours of TV per day (OR, 2.61; 95% CI, 1.21-5.62) and maternal age (OR, 0.95; 95% CI, 0.90-0.995) predicted overweight at age 36 months. We tested for the presence of an interaction between TV exposure and maternal age and it was not statistically significant,

Table 2. Unadjusted and Adjusted Odds Ratios for Concurrent Overweight at Age 36 Months for 1016 Children

Covariate	Unadjusted		Adjusted*	
	OR (95% CI)	P Value	OR (95% CI)	P Value
≥2 h TV exposure per day	2.92 (1.36-6.24)	.006	2.64 (1.21-5.76)	.01
Sex				.68
Male	1.12 (0.65-1.92)	.69	1.12 (0.65-1.94)	
Female	1.00		1.00	
Race				.25
White	0.96 (0.47-1.93)	.90	1.58 (0.72-3.47)	
Not white	1.00		1.00	
Maternal education	0.89 (0.80-1.00)	.05	0.99 (0.86-1.14)	.93
Maternal age	0.94 (0.89-0.98)	.009	0.95 (0.89-1.01)	.11
Mother single	1.94 (1.00-3.79)	.05	1.64 (0.75-3.55)	.21
Income-needs ratio	0.84 (0.74-0.96)	.01	NA	NA
Child Behavior Checklist total score	1.01 (1.00-1.03)	.09	NA	NA
Center for Epidemiologic Studies Depression scale score	1.01 (0.98-1.05)	.42	NA	NA
HOME total score	0.97 (0.94-1.00)	.08	NA	NA
Time in nonparental care	1.00 (0.98-1.01)	.72	NA	NA
Proportion of TV exposure that was educational	0.92 (0.33-2.49)	.86	NA	NA

Abbreviations: CI, confidence interval; HOME, Home Observation for Measurement of the Environment; NA, not applicable; OR, odds ratio; TV, television.
*Adjusted for demographic covariates.

indicating that the relationship between TV exposure and overweight did not differ based on maternal age. Per our analytic plan, we next tested each additional covariate (hours per day in nonparental care, maternal depressive symptoms, income-needs ratio, child behavior problems, quality of the home environment, and proportion of TV exposure that was educational) individually in the model with TV exposure and maternal age. None of these covariates were statistically significant in these models, nor did they significantly alter the relationship between TV exposure and overweight risk at age 36 months.

TELEVISION EXPOSURE AT AGE 36 MONTHS AND FUTURE OVERWEIGHT STATUS AT AGE 54 MONTHS

Data regarding TV exposure at age 36 months and anthropometric data at age 54 months were available for 946 of 1016 subjects. Of these 946, 10% were overweight at age 54 months. In the unadjusted analysis, 2 or more hours of TV exposure per day predicted overweight status at age 54 months (OR, 1.71; 95% CI, 1.03-2.83). After adjusting for demographic covariates (sex; race; and maternal education, marital status, and age), however, the main effect of TV exposure became non-significant. The most parsimonious model predicting overweight at age 54 months created using maximum likelihood ratios included only maternal education. Television exposure was not statistically significant in the model.

Anthropometric data were available at both ages 36 and 54 months for 893 children. Of the 852 children who were not overweight at age 36 months, 62 became overweight by age 54 months. Watching 2 or more hours of TV per day did not predict the new onset of overweight at age 54 months in the unadjusted analysis (OR, 0.74; 95% CI, 0.42-1.32), nor did it predict the change in BMI from ages 36 to 54 months in the unadjusted analysis ($P = .39$).

COMMENT

Results indicated that being awake in a room with a television on for 2 or more hours per day at age 36 months was independently associated with an increased concurrent risk of overweight. To our knowledge, this study is the first to investigate the relationship between excessive TV exposure and childhood overweight in a preschool-aged sample with geographic, ethnic, and socioeconomic diversity while analytically controlling for a large number of potentially confounding factors. Children who watched 2 or more hours of TV per day had more behavior problems and mothers with more depressive symptoms as well as significantly less stimulating home environments. Excessive TV exposure was not simply a marker for these factors but was a significant independent risk factor for childhood overweight during the preschool age range. Neither spending time outside of parental care nor watching educational TV muted the effect of excessive TV exposure on overweight.

Television exposure at age 36 months did not predict overweight risk at age 54 months. Given prior data that TV exposure increases throughout childhood,¹⁸ it is unlikely that TV exposure in our sample decreased over time, although we do not have these data and cannot confirm this supposition. Given that maternal education was the most powerful predictor of overweight risk at age 54 months, we hypothesize that other risk factors connected to socioeconomic status or maternal cognitive functioning may overwhelm the contributing effect of TV exposure. Some of these factors presumably have a cumulative effect over childhood and may only begin to overwhelm the robust effect of TV exposure as children age. These may include maternal feeding behaviors,³² maternal weight status,³³ family dietary choices,³⁴ and exercise patterns.³⁵ Studies that have detected a longitudinal relationship between TV exposure and overweight

risk have also had larger sample sizes with longer follow-up than our study had.¹²

Our findings on correlates of excessive TV exposure mirror prior work^{12,13,18} in that children from disadvantaged environments watch more television. Despite the previously documented associations between behavior problems, TV exposure, and overweight risk,³⁶⁻³⁸ the relationship between TV exposure and overweight risk was not accounted for by child behavior problems. Although depression is associated with increased TV exposure³⁹ and obesity⁴⁰ in adults, and maternal depression is associated with increased TV exposure in preschool-aged children,⁴¹ the relationship between excessive TV exposure and overweight risk was not accounted for by maternal depressive symptoms. Overweight risk has been associated with understimulating home environments in older children,¹⁹ but TV exposure is an independent risk factor for overweight in preschool children, regardless of the overall quality of the home environment.

The mechanism of effect of TV exposure on overweight risk is undoubtedly multifactorial. Prior studies indicate that it appears to operate independently from reduced physical activity.¹⁵ Excessive TV exposure may instead operate through the extensive advertising messages for unhealthy foods targeted at very young children⁴² or from a tendency of children to snack while watching TV. Although educational TV exposure did not mute the effect of excessive total TV exposure on overweight risk, this may be because educational television in the United States does not equate with the absence of advertising for unhealthy foods.⁴³ Therefore, it remains possible that even the limited advertising on public educational television for children may be 1 mechanism of effect. Finally, our measure of TV exposure deserves comment. Being awake in the room with the television on is a broadly defined measure as compared with "watching television." Such an index is developmentally appropriate for children in this age range, given that children this age rarely actually sit watching the television with no other activity for prolonged periods of time. Our findings suggest that exposing children to TV even as "background noise" while they engage in other activities may increase overweight risk. It may be equally relevant in clinical practice to ask parents how often the child is in the presence of a TV that is "on" as it is to ask how much time the child spends "watching TV."

Our study has several limitations. Our sample size of overweight children was relatively small; therefore, the power to detect some effects may have been limited. Data regarding physical activity, diet, or maternal obesity were not available, which limits our ability to evaluate potential mechanisms of association. In addition, the cross-sectional nature of our analysis at age 36 months limits the ability to infer causation. Finally, as with many studies of this nature, the sample with complete data included in our analysis differed from the sample without complete data and therefore our findings may not be valid to generalize to the reference population of the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development. Although we tested covariates that are predictors of missingness

in the model and they did not alter the results, it remains possible that our results would have differed had complete data for the entire sample been available.

These data show a significant relationship between exposure to 2 or more hours of television per day at age 36 months and concurrent overweight, independent of a variety of demographic factors, child behavior problems, maternal depressive symptoms, amount of time spent in nonparental care, and proportion of TV exposure that is educational. These results provide further support for the utility of discussing television exposure during the well-child examination in the preschool years and before. The longitudinal results support the need to evaluate how low maternal educational level may shape the preschooler's environment to increase overweight risk. Although reduced TV exposure is a message that should be provided to all families, broadly based prevention and intervention efforts may best be placed in disadvantaged populations. School-based intervention programs have effectively reduced TV exposure and BMI in older children,^{44,45} but to our knowledge, there are no randomized controlled trials assessing such interventions in preschoolers. The most effective method of reaching these parents is a public health challenge where additional work is needed.

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The Walt Disney Internet Group announced in early July that it is teaming up with Sprint to develop a line of mobile phones, due out next year, aimed squarely at preteen children.
—From *Time*, "Young and Wireless" by Michele Oreckli, August 1, 2005