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Longitudinal Associations between TV Viewing and BMI among White and Black girls

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Abstract

Purpose: Childhood overweight is one of the most important public health problems facing America today, and time spent watching television has been proposed as a causal factor. This study examines the effects of TV viewing on the trajectory of BMI over the course of adolescence.

Methods: We analyzed data on TV viewing and BMI from the NHLBI Growth and Health Study, a panel study of 2,379 White and Black girls followed for up to 10 annual visits, beginning at age 9 or 10. Latent growth curve models were used to estimate the effects of daily TV viewing on the slope of BMI, one using TV viewing at age 10 to predict the trajectory of BMI from ages 11 to 14, and one using TV viewing at age 14 to predict BMI trajectory from ages 15-19. Models controlled for baseline BMI, physical activity, maturation stage, and socio-economic status.

Results: For White girls, higher levels of baseline TV viewing were positively associated with a steeper trajectory of BMI for the four years following a baseline visit (ages 11 to 14, on average). TV viewing was not associated with the trajectory of BMI over the last five of the ten visits. For Black girls, TV viewing was not associated with either trajectory of BMI.

Conclusions: White girls who watched more TV at baseline showed a steeper increase in BMI over early adolescence compared to girls who watched less TV. TV viewing may be a factor contributing to overweight among young girls.

Overweight and obesity have increased substantially since the 1960s, and particularly since the late 1970s [1-3]. Of particular concern is the increase in overweight and obesity among children and adolescents. In the 2003-2004 NHANES, 17.1% of US children and adolescents were overweight, and the number of overweight children is growing, particularly among minorities [4]. Many cross-sectional studies [5-7], but not all [8-10] have identified a positive association between television viewing and children's weight status. However, cross-sectional studies cannot rule out the possibility that heavier children spend more time watching television. More compelling evidence for causal order comes from longitudinal studies which have generally shown a small but positive association between TV viewing and weight [11-15], and from a randomized controlled trial that reduced measures of adiposity by reducing TV viewing and video game use [19]. Nevertheless, most longitudinal studies of children have included limited follow-up sessions, often, just one or two follow-up waves after an initial visit. Further, they have typically not included large enough populations of ethnic or racial minorities in order to compare the effects of TV on weight status among subgroups, or have not reported effect sizes by subgroup.

The current study addresses these deficiencies by examining the relationship between TV viewing and BMI in a cohort of 2,379 White and Black girls interviewed annually for up to ten years, beginning at ages 9 or 10 in 1987-88, using data from the National Heart, Lung, and Blood Institute Growth and Health Study (NGHS). This dataset is valuable for a number of reasons. First, panel studies are useful for identifying individual-level changes and predictors of individual change. Further, the NGHS oversampled Black girls, and Black girls are a population of particular interest, given their high rates of overweight [4] and patterns of heavy television viewing [7,17]. In addition, anthropometric measures in the NGHS study were collected by trained health professionals, increasing their accuracy.

The present study uses latent growth models to investigate the long-run association between TV viewing and the trajectory of BMI, using data from NGHS. Latent growth models (LGMs) use structural equation modeling analytic frameworks to estimate the growth factors that are believed to underlie observed measures [18]. These models allow for the estimation of individual rates of changes (i.e., slopes), and predictors can be included in the model to estimate their effects on the slopes. In addition to providing information about the effects of TV on the trajectory of BMI among White and Black girls, this method allows for the modeling of error structures and relationships between error terms.

METHODS

Sample

The NGHS was initiated in 1987 as a multicenter cohort study of the development of obesity among Black and White pre-adolescent girls. Details of the study design and baseline characteristics of the cohort have been described elsewhere [19]. In brief, the study enrolled a total of 2,379 girls 9 and 10 years of age in three regions of the United States: Richmond, CA; Cincinnati, OH; and Washington, D.C. Girls were eligible if they declared themselves as being either Black or White; if they were age 9 or 10 at the first clinical visit; if they had parents or guardians who identified themselves as the same race as the child; and if parents or guardians completed a household information form and provided consent for participation. At baseline, slightly over half (n=1213, 51.0%) were Black and the remainder (n=1166, 49.0%) were White.

Data collection took place annually, with girls participating in up to 10 waves of data collection. Retention rates were 96%, 94%, and 91% at waves 2 to 4, dropped to a low of 82% at wave 7, and increased again to 89% at wave 10 [20]. Overall, 58.2% of participants participated in each of the 10 waves of data collection, and an additional 15.6% missed only 1 wave. Only 2% participated in 3 or fewer waves of data collection.[1] The number of waves of data collection completed was not correlated with baseline TV viewing or baseline BMI; however, girls whose parents had less education, came from lower-income households, or were White completed fewer waves of data collection.

Measures

Television viewing—Participants were asked to indicate which television programs they had watched in the previous week, using lists of specific programs that had aired in their area as a prompt. Coders then tallied up the hours watched during that week. Mean baseline level of TV viewing was 3.59 hours per day for White girls (+/− 2.06) and 5.21 hours per day for Black girls (+/− 2.55).

[1]The analyses presented here were run with and without the data from the 2% of girls who participated in 3 or fewer waves of data collection. Since the results did not differ, the data from these girls were included in the final analyses.

BMI—Body mass index (BMI) was the outcome measure. In the NGHS, height was measured to the nearest 0.1 cm using stadiometers with participants' heels together and toes apart at a 45 degree angle. Two height measures were taken and a third was taken if the first two were more than 0.5 cm apart. Weight was measured to the nearest 0.1 kg with calibrated electronic scales and with the participant wearing a standard T-shirt. Two weight measurements were obtained and a third was taken if the first two differed by more than 0.2 kg.

Covariates—Baseline BMI was included as a covariate. Age was accounted for in the LGM models, and models were run separately for Black and White girls. Socioeconomic status has been shown to affect both BMI and TV viewing [21]; thus, parental education (high school or less vs. some college or more) and income (less than $40,000 vs. $40,000 or more) were used to control for socioeconomic status. . Decreased levels of physical activity have been associated with TV viewing and BMI [22]; therefore, baseline physical activity was included as a covariate. Physical activity was collected with a 3-day activity diary created for the study since, at the study's inception, there was vitually no published information on a tool to assess physical activity longitudinally among children [23]. The diary was self-administered on 2 consecutive weekdays and 1 weekend day. Participants completed the activity diary by checking off the time duration of various activities they performed during specific parts of the day[2]. A summary daily activity score for each participant was calculated by assigning a metabolic equivalent (MET) value to each activity and multiplying it by the duration of the activity. To further increase their validity, completed activity diaries were reviewed in a structured manner by centrally trained staff using a common protocol. Finally, pubertal stage was included as a covariate. Pubertal timing is linked with girls' adiposity [24], and it is feasible that girls who mature earlier than their peers may watch more TV than their later-maturing peers. This variable was assessed by trained registered nurses using criteria based on Tanner staging principles [25].

Analysis

Amos 5.0 (SPSS, 2003) was used to model latent growth curves using data from repeated measures of BMI collected at waves 2 through 10. Multiple-group analyses were performed in AMOS to ascertain whether the models should be run separately for Black and White girls. This was accomplished by testing a series of models in which different aspects were sequentially constrained to be the same across groups (i.e., no constraints, regression weights constrained, structural variances and covariances constrained, and error variances and covariances constrained), and then by comparing chi-square and AIC values for the different models [26]. Results of these analyses showed that the data fit best to unconstrained models in which all parameters were allowed to vary between groups; therefore, data for White and Black girls were modeled separately.

In the first step, LGMs for Black and White girls' BMI were modeled without predictors to establish optimal models for each. In the next step, TV viewing and the covariates of BMI, household income, parental education, pubertal stage, and physical activity were added to the model. To model the growth curves, each repeated measurement was represented as an indicator of 2 latent factors, intercept and slope, each with a mean and variance. The mean of the intercept represents average starting values and the mean of the slope represents the average rate of change, while the variances represent individual variability in intercepts and slopes. Like other types of structural equation models, fit measures are used to assess whether the specified model is a good fit for the data. RMSEA and CFI are reported here.

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[2]In the first and second years of the study, the AD was formatted as a pictorial menu because of possible limited literacy among participants.

Missing data—To account for missing data, maximum likelihood methods were used since they do not require that the data be missing completely at random and they tend to be less biased than other methods if the missing data is nonignorable [26].

RESULTS

Unconditional LGMs for BMI were estimated to examine overall group growth trajectories and to test for individual variability in change over time. First, a linear model, in which the model-implied rate of change was consistent across all periods of time was tested; however, that model proved to be a poor fit to the data, as the rate of change is not constant across time: BMI increases more sharply earlier in pre-adolescence/early adolescence than it does in the latter years of adolescence. Quadratic and cubic models provided similarly poor fits. Because it is critical to incorporate different growth profiles from different developmental stages in model specification [27] two separate models were tested, one for BMI assessed during the second through the fifth waves (when participants were aged 11 through 14, on average), and a second for BMI collected from waves 6 through 10 (when participants were aged 15 through 19, on average). This allowed the intercept and slope of BMI for waves 2 to 5 to differ from the intercept and slope of the last 5 waves. These models fit the data well (Model 1: RMSEA=0.04 [CI: 0.03, 0.05], CFI=0.99; Model 2: RMSEA=0.05 [0.04, 0.06], CFI=0.99). Means and variances of the intercepts and slopes for BMI were estimated for White and Black girls. For Model 1, the mean value of BMI at the intercept, or starting point, was 17.84 (+/− 0.10) for White girls and 19.44 (+/− 0.12) for Black girls. For Model 2, the mean value of BMI at the intercept was 21.30 (+/− 0.13) for White girls and 23.48 (+/−0.18) for Black girls. For White girls, the average between-wave change in BMI was 0.94 kg/m^2 from waves 2 to 5 and 0.45 kg/m^2 from waves 6 to 10. The average between-wave change for Black girls was 1.12 kg/m^2 from waves 2 to 5 and 0.64 kg/m^2 from waves 6 to 10. The variances of the intercept and slope factors were significant for both groups and both time periods, suggesting heterogeneity in BMI.

The intercept and slope were allowed to covary in each model. This covariance represented the association between individual differences in BMI at the intercept and the slope. For White girls, the correlation between the intercept and slope in model 1 did not reach significance,, while the correlation between the intercept and slope in model 2 was significant (r=0.54, p<0.001). This suggests that, in this sample of White girls, BMI in pre-adolescence is not related to rate of change in BMI in early adolescence, but BMI in mid-adolescence is related to the rate of change in BMI in the latter half of adolescence. In contrast, the association between the intercept and the slope of waves 2 to 5 was significant for Black girls (r=0.18, p<0.001), as was the association between the intercept and the slope of the last 5 waves (r=0.39, p<0.001).

In the next step, the predictor of baseline TV viewing was added to BMI model 1, as well as five covariates measured at wave 1: BMI, physical activity, parental education, household income and pubertal stage. Similarly, TV viewing at wave 5 was added as a predictor to BMI model 2, along with the same five covariates, each measured at wave 5. All exogenous predictors were allowed to covary. The two models will be discussed in turn. First, the full model predicting BMI trajectory from waves 2 to 5 provided a reasonable fit to the data: RMSEA=0.06 (CI: 0.05, 0.06); CFI=0.98. For White girls, baseline level of TV viewing was positively associated with the slope of BMI (i.e., the slope of BMI from ages 11 to 14): every additional hour of TV viewed per day at baseline was associated with an increase in the slope of BMI of 0.03 (p<0.01). For Black girls, baseline TV viewing was not associated with the trajectory of BMI (Table 1). Model 2, which predicted BMI for the second half of adolescence, also fit the data well: RMSEA=0.03 (CI: 0.03, 0.04); CFI=0.99. However, for neither White nor Black girls did TV viewing at wave 5 (when girls were 14, on average) predict BMI trajectory for the remainder of adolescence, from the ages of 15 to 19 (Table 2).

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These findings suggest that young White girls who watch more television at baseline may increase in BMI more rapidly in their pre-teen and early teenage years, although the effect of TV on BMI is not apparent for the latter years of adolescence. Television does not appear to have the same effect on the BMI of Black girls. The significant effects of baseline TV viewing on BMI slope among young White girls presented here can be used to estimate the trajectories of BMI for girls differing in initial levels of TV viewing, in a method described by Curran, Bauer, and Willoughby [28]. This is accomplished by plotting model-estimated trajectories for girls who were low, average, and high television viewers at baseline (low and high values were defined as the mean +/− 1 standard deviation; Figure 1). These results suggest that by wave 5, at age 14 on average, White girls who were high TV viewers at study inception would be expected to have a BMI 0.45 points higher than low baseline viewers, after controlling for confounders. This provides evidence that TV viewing may be an independent contributor to weight gain among pre-adolescent, White girls.

DISCUSSION

This study presented LGM analyses of the effects of television viewing on the trajectory of BMI in a sample of White and Black girls from preadolescence through adolescence. The dataset used, the NGHS, is unique in its ability to make compelling inferences about these relationships given the longitudinal nature of its design, the number of years of data available (with 89% of girls participating in the tenth wave), and the oversampling of Black girls which enabled the comparison of racial groups. For White girls, multivariate latent growth curve analyses found that higher levels of TV viewing at baseline (when girls were aged 10, on average) were associated with a steeper slope of BMI over the next four years, although level of TV viewing at wave 5 (when girls were aged 14) did not impact the slope of BMI for the latter half of adolescence. This findings are in line with a recent meta-analysis which found a progressively weaker effect of TV on adiposity measures as children moved from childhood through adolescence [29].

However, the same meta-analysis of primarily cross-sectional studies reported that the association between TV viewing and fatness is weak and of little clinical relevance. The analyses presented here showed that a girl who watched more television than average at baseline would go on to have a BMI 0.45 kg/m^2 higher than a similar, but below-average TV viewer. That the effect of TV on the trajectory of BMI is small is not to say that it is unimportant. The effect of TV on BMI held even when controlling for a range of possible confounders, including baseline BMI. Further, from a methodological standpoint, TV viewing was likely measured with significantly less precision than BMI, since TV viewing was assessed via self-report while BMI was measured by a trained health professional. Unreliable measures will tend to attenuate an independent variable's effects [30]. In addition, among the range of influences on weight, TV viewing habits are under individual control—unlike, for example, genetics or the built environment—and thus motivated individuals may be able to reduce adiposity by reducing their TV viewing. Indeed, reducing screen time in elementary school and middle-school children has been shown to produce clinically significant relative reductions in a range of adiposity measures [16,31].

In contrast, these analyses did not show an association between TV and BMI trajectory for Black girls. It is not clear why White and Black girls show different patterns of results. If television advertising plays a role in encouraging obesity, then evidence from content analyses suggests that Black girls might be more exposed to obesigenic content than White girls and thus would exhibit a stronger, not weaker, association between TV and BMI. For example, programs aired at African American viewers air more ads for unhealthy foods, particularly fast foods and candy, compared to programs aired at a general audience [32,33]. However, the finding of a lack of association between TV and BMI among Black girls is not unique, as other researchers have reported similar findings [34,35]. Further, studies in areas such as tobacco and sexual activity have also shown an effect of mass media use on health outcomes for White, but not Black, youth [36,37].

We must turn to other hypotheses, then, to explain the lack of an overall association between TV and BMI for Black girls. One possibility is that television plays a different role for White girls than it does for Black girls; for example, there is evidence that television is more likely to be a constant presence in Black families and may be on even if no one is watching. If Black girls' report of TV viewing is actually a measure of the time that television is on rather than time spent watching, then an association between TV and BMI may be suppressed. In addition, Black girls may be less likely to be exposed to and/or affected by the ‘thin ideal’ that is typically presented on popular television programming, and thus may feel less pressure to manage their weight to achieve the slim social norm. Primetime programs featuring Black characters are more likely to show overweight characters than are programs featuring White characters [33] and TV viewing is associated with eating disorder symptomatology among White but not Black adolescents and college students [38]. Also, overweight and obesity among Black girls may be caused by other factors prevalent in the African-American community which dwarf any effects of TV viewing. For example, Black girls in the NGHS were more likely to come from single-parent homes, had lower household levels of education and income, and were less likely to report that they ate meals with their families. Economic hardship and lack of adult supervision may lead African-American girls to make less healthful food choices when eating alone, and/or their mothers may be more likely to serve high-calorie pre-prepared or fast foods because of time constraints, and/or their neighborhoods may be dangerous, leading them to engage in indoor, sedentary activities rather than outdoor play.

Some limitations of this study should be noted. First, as with any observational study, there may have been variables not included in the model that were a cause of both TV viewing and BMI, thus producing a spurious association between the two variables. For example, children who are socially isolated may be more likely to turn to television for company and food for comfort, leading to a higher BMI. In addition, the TV viewing measure, which asked girls to note which programs they viewed in the previous week, may have provided imprecise measures of time spent viewing if only a portion of the program was actually viewed. Also, girls in the NGHS were recruited from three sites; they are not representative of the population, and inferences drawn from this study should not be extrapolated to the broader population of adolescent girls, nor should they be applied directly to boys.

This research examined the TV-BMI relationship; it did not attempt to explore the mediators of the relationship. A number of explanations for the association have been proposed: that time spent with TV displaces more active leisure activities; that food ads influence children to make unhealthy food choices; and that TV viewing provides snacking opportunities [39]. However, no study has pinpointed a causal chain linking any of these from TV viewing to BMI. Future research should continue to examine why TV viewing may be associated with higher BMI in order to identify areas of intervention (e.g., policy initiatives to limit unhealthy food advertising to children). Other research should consider the effects of TV on BMI among children younger than those included in this study, given the prevalence of media use among children as young as two [40]. In addition, researchers should consider the effects of time spent with new media —including video/computer games, computers, music players, and mobile phones—on weight status, particularly in light of a trend among advertisers, including fast food and soda companies, to promote their products in these new media. In addition, more research is needed to elucidate the role that television viewing plays for youths of different social and cultural backgrounds, and to develop appropriate interventions to target overweight in these groups.

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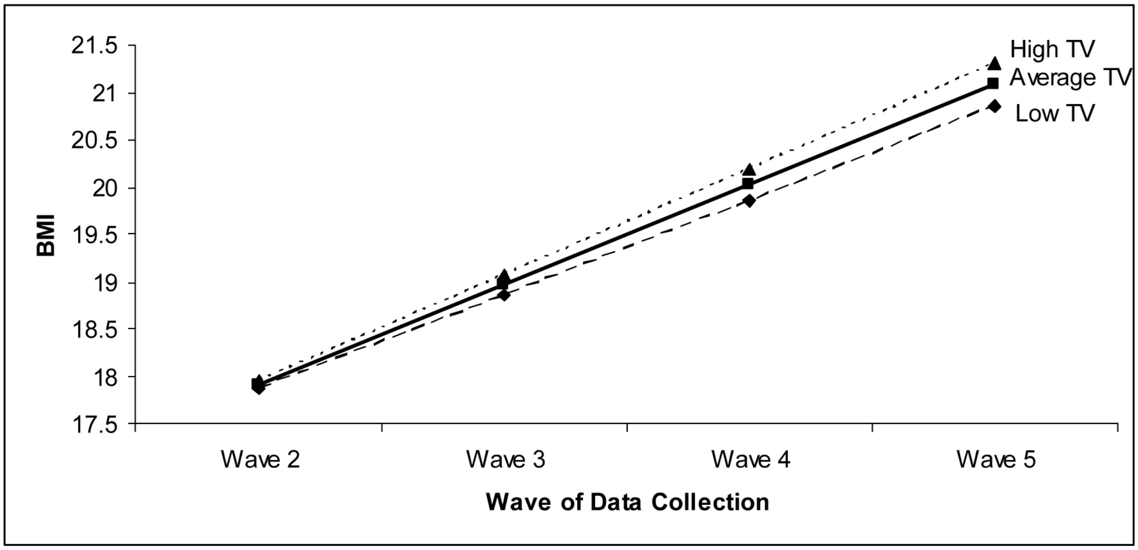

Figure 1. Model-Implied Trajectory of BMI as a Function of TV Viewing, White Girls, Waves 2-5
Trajectories shown at the mean of Wave 1 TV viewing (medium) and at the mean +/−1 standard deviation of TV viewing (high and low).

Table 1

Regression Weights of Wave 1 TV Viewing on Trajectory of BMI, Waves 2-5

			White girls			Black girls		
			b	S.E.M.	p-value	b	S.E.M.	p-value
Wave 1 daily TV hours	→	BMI intercept	0.02	0.02	0.318	−0.02	0.02	0.334
Wave 1 daily TV hours	→	BMI slope	0.03	0.01	0.005	0.00	0.01	0.842
Wave 1 BMI	→	BMI intercept	1.03	0.01	<0.001	1.06	0.01	<0.001
Wave 1 BMI	→	BMI slope	0.03	0.01	<0.001	0.06	0.01	<0.001
Wave 1 maturation stage	→	BMI intercept	0.23	0.08	0.002	0.06	0.08	0.449
Wave 1 maturation stage	→	BMI slope	0.01	0.05	0.811	−0.05	0.05	0.382
Parental education	→	BMI intercept	−0.22	0.09	0.010	−0.19	0.08	0.019
Parental education	→	BMI slope	−0.01	0.06	0.857	0.06	0.05	0.255
Parental income	→	BMI intercept	−0.36	0.09	<0.001	−0.27	0.08	0.001
Parental income	→	BMI slope	0.13	0.06	0.025	−0.12	0.05	0.022
Wave 1 physical activity	→	BMI intercept	0.00	0.00	0.984	0.00	0.00	0.943
Wave 1 physical activity	→	BMI slope	0.00	0.00	0.046	0.00	0.00	0.082

Table 2

Regression Weights of Wave 5 TV Viewing on Trajectory of BMI, Waves 6-10

			White girls			Black girls		
			b	S.E.M.	p-value	b	S.E.M.	p-value
Wave 5 daily TV hours	→	BMI intercept	0.03	0.02	0.178	0.00	0.02	0.771
Wave 5 daily TV hours	→	BMI slope	−0.15	0.01	0.143	0.00	0.01	0.600
Wave 5 BMI	→	BMI intercept	1.00	0.01	<0.001	1.03	0.01	<0.001
Wave 5 BMI	→	BMI slope	0.03	0.04	<0.001	0.04	0.00	<0.001
Wave 5 maturation stage	→	BMI intercept	−0.30	0.07	<0.001	−0.19	0.07	0.007
Wave 5 maturation stage	→	BMI slope	−0.05	0.04	0.172	0.06	0.04	0.084
Wave 5 physical activity	→	BMI intercept	−0.00	0.00	0.766	0.00	0.00	0.200
Wave 5 physical activity	→	BMI slope	−0.00	0.00	0.634	0.00	0.00	0.765
Parental education	→	BMI intercept	0.22	0.11	0.051	−0.07	0.10	0.470
Parental education	→	BMI slope	0.02	0.06	0.690	−0.12	0.05	0.021
Parental income	→	BMI intercept	−0.09	0.11	0.431	−0.17	0.10	0.080
Parental income	→	BMI slope	−0.00	0.06	0.99	−0.08	0.05	0.115