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"Decrease in television viewing predicts lower BMI at one year follow up in adolescents but not adults"

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Abstract

Objective—To examine associations between television viewing, sugar-sweetened beverage consumption, eating out, physical activity and body weight change over 1 year.

Design—Secondary data analysis from randomized intervention trial.

Setting—Households in the community.

Participants—Adults (n=153) and adolescents (n=72) from the same households.

Intervention(s)—Households were randomized to a home-based obesity prevention intervention or to a no-intervention control group for a one-year period.

Main Outcome Measure(s)—Self-reported television viewing hours, diet and physical activity. Body mass index computed from measured weight and height (primary outcome measure).

Analysis—Mixed-model regression.

Results—Among adolescents, a significant prospective association was observed between decreases in television viewing hours and lower BMI z-score at one year follow-up (decreased TV hours: BMI z-score mean = 0.65; no change or increase TV hrs: BMI zscore = 0.92; $p < .02$). No significant prospective associations were observed among adults.

Conclusions and Implications—Reducing television viewing may be an effective strategy to prevent excess weight gain among adolescents.

INTRODUCTION

Specific environmental and behavioral variables have received research attention as possible important contributing factors to the obesity epidemic.[1] Behaviors related to energy balance include television (TV) viewing, eating out, sugar-sweetened beverage (SSB) intake and physical activity (PA). TV viewing is a highly prevalent activity among youth and adults.[2,3]

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Cross-sectional studies consistently show that TV viewing is related to overweight and obesity, among both youth[4-9] and adult populations.[10-13] Among youth, prospective studies have shown positive associations between TV viewing and excess weight gain.[14,15] However, other studies reported no association.[16] Among adults, fewer studies are available. A large cohort study found no association between changes in TV viewing and weight gain over six years.[17] Obesity treatment interventions that include a TV viewing reduction component have been successful in reducing body weight.[18-20]

Sugar-sweetened beverages have received a great deal of attention as potential contributors to excess weight gain and the development of obesity. Overall conclusions reported by seven recent reviews reveal mixed opinions within the scientific community about the interpretation of available empirical data.[21-27]

Eating out, particularly at fast food restaurants, has been identified as a potential obesigenic exposure.[28,29] Cross-sectional studies consistently show that frequency of eating out or fast food frequency is associated with overweight and obesity among adults.[10,30,31] Results of available studies are less consistent with youth populations.[32,33] Prospective[34-39] and experimental studies[40] consistently show a positive association between eating out, fast food and weight gain.

While the individual contribution of each of these behaviors to excess weight gain and obesity may be small, it is important to examine their possible role in promoting excess weight gain. Associations between these behaviors and risk for excess weight gain may differ among adults and adolescents due to their different physical and social developmental stages.[41,42] No previous studies that we are aware of have examined the prospective association of these obesigenic behaviors among adolescents and adults living in the same household (HH) environment.

The purpose of the present study is to examine the cross-sectional and prospective associations between energy balance behaviors and body weight change in adolescents and adults recruited from the same HHs. This paper is a secondary analysis of data from a community based obesity prevention intervention that targeted entire HHs.[42] Families were enrolled in a larger trial to test a household-level intervention for weight gain prevention. The intervention had no significant effects on change in body weight over a one-year period, but was successful in reducing TV and increasing PA.[42] It was hypothesized that decreases in TV viewing, SSB intake and eating out, and increases in PA, would be associated with less weight gain over a one-year period.

METHODS

Study Population and Recruitment

HHs were recruited from the community for a one-year obesity prevention intervention trial.[42] The intervention included both HH environment and individual-level behavioral components. Recruitment sources included community libraries, worksites, schools, daycare centers, health clinics, religious institutions, park and recreation centers, grocery stores and food co-ops. Overall, 732 inquiries were received, 289 families were eligible, and 90 HHs enrolled in the study. At twelve months, 86 HHs completed the follow-up visit (96% retention). The university IRB approved the study.

Eligibility criteria included: 1) at least one adult and two HH members (including the adult) ages > 12 yrs; 2) residence in a private house or apartment within 20 miles of the university; 3) HH TV viewing weekly average of > 10 hrs per person; 4) no HH members with dietary, medical, psychological, or physical limitations that would prevent their participation in

intervention activities; and 5) willingness to be randomized to active intervention or control group. All HH members were required to consent or assent prior to HH enrollment. All HH members were required to attend the measurement evaluation sessions.

The intervention program was one year in duration and included six monthly face-to-face group meetings, monthly newsletters, and 12 home-based activities. All HH members ages 12 yrs and older were encouraged to attend the group sessions, which were held at the university on weeknight evenings. HHs randomized to the intervention were assigned in groups of 3-5 HHs to the same group meeting session day and time for all six face-to-face sessions. Home environment intervention included placement of television-limiting devices on all HH televisions for the one-year intervention duration, and the provision of a home digital scale for adult daily self-weighing. The TV-limiting devices were used to limit TV viewing time in the HH as part of the intervention and turned the television off after the HH's weekly TV viewing allowance had been used. The average length that the TV devices were kept on HH TVs was 10 months. Home environment intervention also included implementation of HH-level goals to reduce the home availability of SSBs and reduce the frequency of eating out. Additional details about the study have been published.[42]

Measures

Measures were collected by trained research staff on all HH members at in-person visits to the university data collection research center at baseline and 12 months. Weight and height were directly measured on all HH members. A behavioral survey was completed by HH members > 12 years to measure dietary, PA and TV behaviors. HH demographic variables were self-reported by adults only. Adults and adolescents completed surveys independently.

Weight and Height

Body weight was measured in street clothing without shoes using a calibrated electronic scale.[43] Height was measured using a wall-mounted stadiometer. Two separate measurements were conducted for both the weight and the height measures. The average of the two values were used in statistical analyses. Body mass index was calculated as weight (kg)/height^2(m). BMI z-score is the most widely accepted measure for body mass / body composition in children and was used in the present study for children aged 12-17 years.[43]

Dietary Intake and Eating Behaviors

Food choices were measured using a modified food frequency questionnaire.[44,45] Participants reported the frequency of consumption during the past month of SSBs (2 items) ["Over the last month, how many times did you drink fruit drinks (such as cranberry cocktail, Hi-C, lemonade or Kool-Aid)?" "Over the last month, how many times did you drink regular (non-diet) soft drinks, soda, or pop?"]. Frequency response options were "Never", "1-3 times last month," "1-2 times per week," "3-4 times per week," "5-6 times per week," and "7 or more times per week." For each question, serving size was measured using the question "Each time you drank regular (non-diet) fruit drinks [soft drinks], how much did you usually drink?" Serving size response options were "less than 12 ounces (less than one can)," "12-20 ounces," and "more than 20 ounces." Frequency of consumption was multiplied by average serving size to estimate average number of servings per day. Frequency of eating at a fast food restaurant was measured using the question: "Over the last month, how many times per week did you eat breakfast, lunch or dinner at places such as McDonalds, Burger King, Wendy's, Arby's, Pizza Hut or Kentucky Fried Chicken?"[34,35] Frequency of eating out was computed from the sum of responses to two additional questions about frequency of eating out at full-service and carry-out restaurants: "How many times per week do you eat something from a carry-out, delivery, or counter-service-only restaurant?" and "How many times per week do you eat something at a traditional sit-down

restaurant with wait service?" Participants wrote in the number of times per week for each question.

Physical Activity (PA)

PA was measured among adults with a modified International Physical Activity Questionnaire (IPAQ).[46,47] Minutes were summed across settings to provide a total minutes score for walking, and for moderate and vigorous activity. The Three Day Physical Activity Recall (3DPAR) was used to measure PA among the children aged > 12 yrs.[48-50] The 3DPAR queries children about their main PA during each 30-minute time block between 6 a.m. and midnight during the past three days. Scores are computed based on the number of blocks of time in which PAs of different intensities are engaged. The IPAQ and the 3DPAR have high test-retest reliability and validity.[47-49]

Television Viewing (TV)

TV hours per day was self-reported using a standard set of questions.[3] TV hours included video/DVD viewing on the television, but did not include time spent using small screens, computers or other video devices.

Demographic Variables

Demographic variables were self-reported. HH configuration was a four-category variable created based on crossing the number of adults and children living in the HH: one adult/one child; one adult/multiple children; two adults/one child; two adults/multiple children. HH income was defined as the combined self-reported annual income of the adults living in the HH and included income from all sources. HH education was defined as the highest level of education completed by anyone living in the HH. HH race was defined based on the self-reported racial identification of the main adult respondent for the HH (adult study contact person).

Statistical Analysis

Cohort retention was 96% (86 of 90 HHs completed the follow-up clinic and home visit). Ninety-two percent of adolescents and 90% of adults from these HHs completed follow-up measurements.

All analyses were conducted using SAS.[51] The original study was a cluster-randomized trial in which HHs were randomized to intervention or control condition. The intervention had no significant effect on household BMI-z score. However, because the intervention did significantly affect the behaviors examined in the present study, treatment group assignment was included as a covariate in the analyses. HH identification number was included as a random effect in all models. This allows for correlations within HHs and imposes a compound symmetry model for the intra-class correlation coefficient. Data are presented individually to the calculation of the maximum likelihood (PROC MIXED in SAS) but are modeled as correlated within HH. Cross-sectional and prospective associations were examined using mixed model regression. Type III sums of squares (Wald F-tests) were used to determine statistical significance for the independent variable. Personal correlation of measures over the year is addressed by the use of a baseline-adjusted model. Separate analyses were conducted for adolescents and adults.

Each of the independent variables was examined in separate models. Distributions were examined visually and means and medians were compared to assess normality. Categorical variables were dichotomized due to their non-normal distributions. For example, adult and adolescent reported mean frequency of fast food restaurant use was less than 1 time per week out of a possible 5-option response category. In cross-sectional models, the

independent variable was dichotomized using a median split. In prospective models, the independent variable was dichotomized into “decreased” and “no change or increased” categories. This was done because the focal study questions involved comparison of those who decreased the behavior (eg., TV viewing) with those who did not decrease or who increased, and associations between independent and dependent variable changes were complex and nonlinear in shape. The baseline value of the independent variable was included as a covariate. Change in BMI z-score (adolescents) or BMI (adults) was examined using the follow-up value as the dependent variable, and including the baseline value as a covariate. The outcome adjusted for baseline corresponds to a “correlationally reduced” change. Because the correlation for BMI over one year is high (about 0.8), this analytic approach is reasonable and allows for ease of interpretation for the reader. Model covariates were HH configuration, HH treatment group assignment, HH income (combined adults), HH education (highest adult), main respondent age and race, and individual smoking status. The main respondent was the adult in the HH who was the primary contact person for the study. If only one adult was present in the household, the main respondent’s answers to HH level-demographic questions were the sole source of the HH-level variables (such as income, education, smoking, age, race).

Power calculations were computed for the main outcomes of the intervention study using Excel. These power calculations do not address the question of the present study, which is detection of mediating behavior changes. For the present study, among 72 adolescents, a correlation of changes between behavior and BMI z-score of .60 of a standard deviation is detectable with 80% power. Among 153 adults, this detectable difference is estimated to be . 38.

RESULTS

Demographic and Behavioral Characteristics

Demographic and baseline behavioral characteristics of the adolescents and adults are shown in Table 1. Sixty-one percent of the 90 HHs recruited were comprised of two adults and two or more children; another 21% were comprised of two adults and one child. Eighteen percent of HHs were comprised of single parents with one or more children. Table 2 shows the baseline, follow-up and change means for BMI and the behavioral variables. Overall, adults and adolescents were very similar in reported levels of TV and eating out. Mean BMI z-score was 0.71 among adolescents. Mean BMI among adults was 28.9 kg/m^2.

Cross-Sectional Associations Between Obesity-Related Behaviors and Body Mass Index

Table 3 shows the adjusted cross-sectional associations at baseline between TV, eating out, PA and BMI. Among adolescents, higher TV hours was significantly associated with higher BMI z-score ($p < .01$). SSB intake, fast food and eating out frequency and PA were not significantly associated with BMI z- score among adolescents. Among adults, frequency of fast food and eating out were each significantly associated with higher BMI ($p < .05$ and $p < .04$, respectively), and SSB intake was marginally significantly associated ($p < .07$). TV and PA were not significantly associated with BMI among adults.

Prospective Associations Between Change in Obesity-Related Behaviors and Body Mass Index

Table 4 shows the adjusted prospective associations between TV, SSB intake, eating out, fast food, PA and BMI. The only significant prospective association observed was among adolescents. Adolescents who decreased their TV during the one-year observation period had a lower BMI z-score at follow up compared to those who did not change their TV hours or increased TV hours, adjusted for baseline BMI. Among adults, no changes in the

behavioral variables were associated with changes in BMI over one year. Change in SSB intake was marginally significant ($p < .09$), with decreased SSB intake associated with lower BMI at one year.

DISCUSSION

The present study provided unique prospective data to examine longitudinal associations between energy balance behaviors and weight change among a community sample of adults and adolescents recruited from the same HH. No previous studies have prospectively examined behavior changes related to weight gain among related adults and adolescents living in the same HH. Despite low power for these secondary analyses, a clear association was observed among adolescents between reduction in TV hours and decreased weight gain over one year. These findings are important, as they have direct implications for clinical recommendations to parents. Reducing TV hours is a clear strategy parents can use to help prevent excess weight gain among their children.

The present study was also unique in its ability to directly compare adults (parents) and adolescents (their children) living in the same HHs. It is clear that the effects of TV hours are different for parents and children. TV was not predictive of excess weight gain over the one-year observation period among the adults.

Although the reasons for this observed difference are not clear, the finding highlights the potential differences by age in strategies that might be effective in preventing excess weight gain and obesity, even among people in the same HH. An advantage of reducing TV hours among adolescents as an obesity-prevention strategy is that parents in the HH control the household policy around TV viewing hours and other HH TV-related practices such as whether the children are allowed to have TVs in their bedroom. The presence of a TV in a child's bedroom is associated with as much as three times the amount of TV viewing compared to children without TVs in the bedroom.[2,3]

Several mechanisms could promote weight gain as a consequence of TV viewing. TV viewing is positively associated with energy intake and high fat food consumption among adults and adolescents.[9,13,32,52,53] The association is thought to be due in part to the fact that TV exposes people to a high volume of food advertising and many people eat while watching TV, which may result in eating more frequently, eating larger quantities of food or food of lower nutritional quality.[54] Energy intake and eating locations were not measured in the present study.

PA is a second mechanism through which TV could affect body weight change. Significant inverse associations between TV viewing and PA among youth have been reported in several studies.[4,5,9,14,15] By contrast, the results of two school-based TV reduction intervention studies found no significant effects on youth PA levels.[16,20] It is hypothesized by some that leisure time PA and time spent in sedentary entertainment may be independent.[11,13,16,20,] In the present study, PA was not associated with BMI z-score in adolescents, cross-sectionally or prospectively.

The present study was unique in its inclusion of a community-based sample of 90 HHs with a range of education and income, and in its inclusion of both adolescents and adults. The prospective study design was a strength, and the retention rate (96%) at one year was high. Behavioral measures used were reliable and valid, and BMI z-scores and BMI were computed from directly measured weight and height. In the main intervention, HH TV viewing weekly hours were reduced by about 50% using an objective TV viewing limiting device among the intervention HHs.[42]

Limitations of the present study included the self-selected sample and the limited power to detect associations between changes in energy balance behaviors and BMI. Families self-selected to participate because they initially were motivated to make changes in the HH related to TV viewing time, eating habits and PA. A minimum amount of TV viewing hours had to be met to enroll in the study. However, the enrolled HHs may have had more healthful eating habits than the general population, and no minimum inclusion criteria for fast food or SSB intake were stipulated. For example, the baseline consumption of SSBs and frequency of eating out was lower than national estimates.[29,30,55,56] This may have limited the ability of the intervention to further change these HH behaviors and as a result, limited the ability to detect associations between changes in these behaviors and changes in BMI. The relatively brief duration of follow-up is another limitation. A longer follow-up period may have enabled the small, cumulative behavioral effects on body weight to be detected. Although reliable and valid PA measures were used, the adolescent measure was self-administered instead of administered by an interviewer, which is the usual method of administration. This may have resulted in higher than usual measurement error. Finally, the dietary questionnaire was limited to a short list of targeted foods and beverages. The limitations of food frequency questionnaires are well-understood.[57]

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IMPLICATIONS FOR RESEARCH AND PRACTICE

The results of the present study suggest that TV viewing reduction may be an effective strategy to prevent excess weight gain among adolescents. Further research is needed to better understand the mechanisms by which TV viewing reduction achieves its protective effect on BMI among youth. Clear advice to parents to limit TV viewing among their children may be one powerful weight gain prevention strategy that parents can understand and implement in the home environment.

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Table 1

Unadjusted Means and Percents for Demographic Variables in a Community Sample of Adolescents and Adults Living in 90 Households

	Adolescents n=72			Adults n=153		
Household	**N**	**%**	**$\bar{X}$ (sd)**	**N**	**%**	**$\bar{X}$ (sd)**
Configuration						
Single parent: 1 child	10	(13.9)		10	(6.5)	
Single parent: 2+ child	26	(36.1)		18	(11.8)	
Multiple adult: 1 child	6	(8.3)		32	(20.9)	
Multiple adult: 2+ child	30	(41.7)		93	(60.8)	
Sex Male	44	(61.1)		59	(38.6)	
Female	28	(38.9)		94	(61.4)	
Age (yrs)			14.7 (1.7)			41.0 (8.7)
Race[A] (White)	53	(73.6)		122	(79.7)	
Household Income[B]						
≤a$45,000	31	(43.1)		41	(26.8)	
>$45,000-<$100,000	22	(30.6)		47	(30.7)	
≥$100,000	19	(26.4)		65	(42.5)	
Household Education [C]						
High School/GED	2	(2.8)		6	(3.9)	
Vocational	5	(6.9)		3	(2.0)	
Some college	22	(30.6)		34	(22.2)	
College degree	22	(30.6)		49	(32.0)	
Grad/Prof degree	21	(29.2)		61	(39.9)	
Smoker (yes)	1	(1.4)		16	(10.5)	

A = Household main respondent's race.

B= Combined adult income before taxes.

C= Highest education of any adults in household.

Table 2

Unadjusted Medians, 25th and 75th Percentiles for Body Mass Index, Television Viewing, Eating Out, Sugar-Sweetened Beverage Intake and Physical Activity Variables Among Adolescents and Adults in a Sample of 90 Community Households

	Adolescents n=72		Adults n=153	
	Baseline	**Follow-Up**	**Baseline**	**Follow-Up**
Body Mass Index[A]				
25th percentile	0.11	0.04	23.9	24.4
Median	0.71	0.79	27.2	27.5
75th percentile	1.37	1.43	32.0	32.8
Television (hrs/wk)				
25th percentile	10.5	5.3	10.5	5.3
Median	17.5	10.5	17.5	10.5
75th percentile	24.5	17.5	24.5	17.5
Fast Food Restaurant (per wk)				
25th percentile	0.50	0.50	0.50	0.00
Median	0.50	0.50	0.50	0.50
75th percentile	1.5	1.5	1.5	1.50
Eating Out (per wk)				
25th percentile	1.5	1.0	2.0	1.0
Median	2.0	2.0	3.0	2.0
75th percentile	4.0	4.0	4.0	4.0
Sugar Sweetened Beverages (portions per/wk)				
25th percentile	0.19	0.21	0.04	0.00
Median	0.28	0.43	0.14	0.07
75th percentile	0.75	0.71	0.58	0.29
Moderate/Vigorous Phlysical Activity (score)				
25th percentile	30.0	20.0	45.0	55.0
Median	105.00	100.0	85.0	90.0
75th percentile	200.0	170.0	142.5	155.0

A=(adults: kg/m^2) (adolescents: BMI z-score)

Table 3

Adjusted* Cross-Sectional Associations Between Television-Viewing, Eating Out, Physical Activity and Body Mass Index Z-Score Among Adolescents and BMI Among Adults in 90 Community Households

		BMI-Z Score Adolescents n = 72				BMI Adults n=153			
Variable		**n**	**LS Mean**	**Se**	**p**	**n**	**LS Mean**	**Se**	**p**
TV viewing (hrs/wk)	Low ≤ 17.5	45	0.55	0.11	.01	99	29.20	0.64	.63
	High > 17.5	30	1.00	0.13		53	28.66	0.90	
Sugar-sweetened beverages (portions/wk)	Low adolescent: ≤ 0.28 adult: ≤ 0.14	38	0.64	0.13	.31	82	28.08	0.71	.07
	High adolescent: > 0.28 adult: > 0.14	34	0.83	0.14		70	30.12	0.77	
Eating out (times/wk)	Low adolescent: ≤ 2.0 adults: ≤ 3.0	39	0.73	0.13	.94	73	27.90	0.72	.03
	High adolescent: > 2.0 adult: > 3.0	33	0.74	0.14		79	30.07	0.70	
Fast food restaurants (times/wk)	Low ≤ 0.5	42	0.83	0.12	.24	95	28.15	0.65	.04
	High > 0.5	30	0.60	0.14		57	30.44	0.84	
Moderate/Vigorous physical activity score	Low adolescent: ≤ 127.2 adult: ≤ 119.0	35	0.73	0.13	.98	77	30.30	0.98	.13
	High adolescent: > 127.2 adult: > 119.0	35	0.73	0.13		75	28.57	0.58	

*Adjusted for household configuration, income, education, race, age, smoking status, and treatment group. Wald F-tests used to evaluate significance of the independent variable.

Table 4

Change in Television Viewing, Eating Out, Physical Activity and Body Mass Index ZScore Among Adolescents and BMI Among Adults Over One Year

Variable		BMI-Z Score Adolescents				BMI Adults			
		n	LS Mean	Se	p	n	LS Mean	Se	p
TV viewing (hrs/wk)	Decrease	40	0.65	0.05	.02	94	29.32	0.15	.77
	No change/ Increase	26	0.92	0.07		50	29.24	0.21	
Sugar-sweetened beverages (portions/wk)	Decrease	28	0.75	0.08	.99	78	29.06	0.18	.09
	No change/ Increase	38	0.75	0.07		68	29.54	0.19	
Eating out (times/wk)	Decrease	29	0.73	0.08	.73	65	29.33	0.19	.80
	No change/ Increase	36	0.77	0.07		81	29.25	0.18	
Fast food restaurants (times/wk)	Decrease	15	0.81	0.12	.65	46	29.25	0.25	.84
	No change/ Increase	51	0.74	0.05		100	29.31	0.15	
Moderate/Vigorous physical activity score	Increase	24	0.70	0.06	.22	74	29.51	0.21	.20
	No change/ Decrease	39	0.85	0.08		72	29.12	0.18	

Note: Means are follow-up values adjusted for household configuration, income, education, race, age, smoking status, treatment group, and baseline value of BMI z-score (or BMI) and baseline value of the independent variable. Wald F-tests used to evaluate significance of the independent variable.