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Applied Research Brief: Fitness

Television Viewing: Moderator or Mediator of an Adolescent Physical Activity Intervention?

Dan J. Graham, MA; Margaret Schneider, PhD; Dan M. Cooper, MD

Abstract

Purpose. To determine whether the amount of television (TV) watched by participants enrolled in a physical activity intervention mediates or moderates program effectiveness.

Design. Nine-month, controlled, school-based physical activity intervention.

Setting. Public high school.

Participants. One hundred twenty-two sedentary adolescent females (mean \pm standard deviation age = 15.04 \pm 0.79 years).

Intervention. Supervised in-class exercise, health education, and internet-based self-monitoring.

Measures. Physical activity by 3-day physical activity recall; TV viewing by self-reports; cardiovascular fitness by cycle ergometer.

Analysis. T-tests were conducted to examine between-group differences. Linear regression equations tested the mediating or moderating role of TV watching relative to the intervention.

Results. TV viewing moderated the intervention's effect on vigorous activity; the intervention significantly predicted change in physical activity among high ($\beta = -.45$; $p < .001$), but not among low ($p > .05$), TV watchers. TV viewing did not mediate the intervention effect.

Conclusions. Consistent with displacement theory, adolescents who watched more TV prior to the intervention showed postintervention increases in vigorous physical activity and concomitant decreases in TV viewing, whereas those who watched less TV showed no change in physical activity or TV viewing. (*Am J Health Promot* 2008;23[2]:88–91.)

Key Words: Physical Activity, Television, Obesity, Adolescents, Intervention.

Manuscript format: research; Research purpose: relationship testing; Study design: quasiexperimental; Outcome measure: behavioral; Setting: school; Health focus: fitness/physical activity; Strategy: skill building/behavior change; Target population: youth; Target population circumstances: fitness, age, body mass index

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PURPOSE

Television (TV) has been implicated in the growing epidemic of childhood obesity in the United States.¹ Results of a nationally representative survey of 8- to 18-year-olds in the United States

revealed that, on average, members of this demographic group use some form of media between 6 and 7 hours daily, with TV accounting for approximately half of this total.² Since the mainstream introduction of TV, displacement theories have been proposed that suggest that time spent

watching TV displaces time spent engaging in other pursuits.^{3,4} Physical activity (PA) is one pursuit that may be displaced by TV viewing. Displacement of PA by TV viewing could harm public health by altering energy balance and promoting weight gain. The present study seeks to determine whether the amount of TV watched by participants in a PA intervention will mediate or moderate program effectiveness.

TV viewing could behave as a mediator if the intervention leads to decreased TV viewing and then to increased PA. Decreasing TV viewing was not an intervention goal; however, the displacement hypothesis implies that this mediation is a possibility worthy of investigation. Another possibility that will be investigated is that TV viewing might act as an intervention moderator. If TV viewing functions as a moderator, high-TV viewers would show a different PA outcome after the intervention than low-TV viewers. Based on the notions that TV viewing might displace some PA time and that adolescents who spend a lot of time watching TV have a relatively larger reservoir of potentially active time, we hypothesize that participants who are more prolific TV consumers at baseline (i.e., those who have more available minutes to potentially reallocate from TV viewing to PA) will show a greater increase in PA after the intervention than those who watch less TV.

METHODS

Design

A 9-month, controlled, school-based PA intervention was conducted at two Southern California high schools. Intervention details are presented elsewhere.⁵ The schools were similar in size, demographics, and academic achievement (i.e., the ethnic distributions, Academic Performance Indicator scores, and

Table 1
TV Viewing, Physical Activity, and Participant Ethnicity*

	All Participants			Intervention Participants Only			Comparison Participants Only		
	Low TV	High TV	Low and High	Low TV	High TV	Low and High	Low TV	High TV	Low and High
Sample size	62	57	119	25	35	60	37	22	59
TV viewing, h/d (SD)†									
Baseline	0.98 ^a (0.49)	3.20 ^{a,k} (1.56)	2.04 (1.59)	1.11 ^b (0.40)	3.10 ^{b,l} (1.69)	2.27 (1.65)	0.89 ^c (0.53)	3.35 ^c (1.36)	1.81 (1.51)
9 months	1.19 ^d (0.86)	2.37 ^{d,k} (1.98)	1.76 (1.61)	1.31 ^e (0.98)	2.26 ^{e,l} (1.49)	1.86 (1.37)	1.10 ^f (0.77)	2.56 ^f (2.62)	1.65 (1.83)
Vigorous PA, METS/d (SD)‡									
Baseline	0.59 (0.73)	0.57 ^m (0.68)	0.58 (0.70)	0.63 (0.73)	0.71 ⁿ (0.70)	0.68 (0.71)	0.57 (0.73)	0.35 (0.61)	0.49 (0.69)
9 months	0.70 (0.60)	0.84 ^m (0.55)	0.77 (0.58)	0.79 (0.57)	1.03 ^{g,n} (0.39)	0.93 ^h (0.48)	0.64 (0.62)	0.55 ^g (0.63)	0.61 ^h (0.62)
Ethnicity, No. (%)									
Caucasian	35 (57)	32 (56)	67 (56)	18 (72) ⁱ	21 (60)	39 (65)	17 (46) ^j	11 (50)	28 (48)
Asian	10 (16)	11 (19)	21 (18)	3 (12)	7 (20)	10 (17)	7 (19)	4 (18)	11 (19)
Latina	13 (21)	10 (18)	23 (19)	3 (12)	4 (11)	7 (12) ^j	10 (27)	6 (27)	16 (27) ^j
Other	4 (6)	4 (7)	8 (7)	1 (4)	3 (9)	4 (7)	3 (8)	1 (5)	4 (7)

* TV viewing and physical activity reported at baseline and at 9 months.
† SD indicates standard deviation; PA, physical activity; METS, metabolic equivalents.
‡ METS were log-transformed because of skewness in the distribution.
a–n $p < 0.05$ for pairwise differences between corresponding lettered values.

percent of students qualified for meal subsidies were very similar at the two schools). Both schools offered physical education 5 days per week for one class period. All tests were performed at a university-based general clinical research center.

Sample

Participants were sedentary adolescent females (N = 122; mean ± standard deviation (SD) age = 15.04 ± .79 years) who were recruited *via* flyers at two public high schools. Sedentary was defined as not meeting Centers for Disease Control and Prevention PA criteria⁶ (i.e., three vigorous or five moderate exercise sessions per week). Sedentary status was confirmed by excluding volunteers who scored in the top 25th percentile for their age of the baseline cardiovascular fitness test. Parents/guardians provided informed consent, and adolescents assented to the procedures. The study was approved by the institutional review board at the University of California, Irvine. Adolescent females are of special concern because they engage in less PA compared with boys and are therefore at greater risk for the negative health consequences of inactivity⁷; 72% of high school girls do not meet current Centers for Disease Control and Prevention PA recommendations⁸; and, during high school, females move from active to sedentary status at a disproportionately high rate.⁹ Participants were assigned to the intervention (n = 63) or the comparison (n = 59) group based on the

school attended. The participants' average VO_{2max} was mean ± SD = 23.6 ± 4.4 ml/min/kg, and the average BMI was 23.0 ± 4.2. Table 1 includes the participants' ethnic distribution.

Measures

Cardiovascular Fitness. Cardiovascular fitness was measured *via* cycle ergometer. A ramp-type, progressive exercise test on the electronically braked ergometer was conducted to determine each participant's peak oxygen consumption (VO_{2peak}; L/min). Participants warmed up by cycling for 3 minutes with no resistance (i.e., 0 W), after which they pedaled at a rate of 70 revolutions per minute (rpm) while the power output increased progressively by 15 W per minute. The test ended after 8 to 12 minutes when the participant became too fatigued to pedal at 70 rpm. The SensorMedics Vmax 229 metabolic cart (SensorMedics, Yorba Linda, CA) measured VO_{2peak} by using a method designed for children and adolescents.¹⁰

Body Mass Index. Body mass index (BMI; weight/height²) was assessed by using standard, calibrated scales and stadiometers.

Activity Level. Activity level was assessed *via* 3-day PA recall (3DPAR). Activities were converted into metabolic equivalents (METs) with the compendium published by Ainsworth et al.¹¹ and were aggregated to

calculate average daily minutes spent engaging in moderate (3–6 METs) and vigorous (>6 METs) activity.

TV Viewing. TV viewing, assessed *via* self-report methods, included hours spent watching both TV programming and videos. A median split divided the participants into high- and low-TV groups.

Intervention

Participants attended supervised exercise sessions 4 days per week throughout the school year (approximately 40 minutes of PA per session). Health education was provided during class on the fifth day. The supervised PAs were determined in part by participant preferences and included both aerobic (three times per week, including aerobic dance, kickboxing, and brisk walking) and strength-building (one time per week, including weightlifting and yoga) activities. The intervention effectively increased average levels of PA and cardiovascular fitness among the participants.⁵ Participants at the comparison school were given no special instructions regarding physical activity; many participated in standard physical education.

Analysis

Three participants were removed from data analyses because of outlying (>3 standard deviations from the mean) data values on time spent watching TV or engaging in vigorous PA. Student's independent-sample *t* tests were used to test for participant differ-

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ences (i.e., age, ethnicity, VO_{2max} , BMI, TV viewing time, and amount of vigorous activity) between groups (i.e., high- and low-TV groups overall, intervention and comparison groups overall, and high- and low-TV groups within the intervention and comparison groups) at baseline. Regression analyses were conducted using SPSS software version 13.0 (SPSS, Chicago, Illinois). In a hierarchical equation that predicted postintervention vigorous activity, baseline vigorous PA and ethnicity were entered on the first step. Group (intervention vs. comparison) and TV viewing (high vs. low) were added on the second step; the group by TV viewing interaction was entered on the third step to determine whether the effect of the intervention was moderated by the level of TV viewing. The three-step regression test for mediation described by Baron and Kenny¹² was also employed.

McClelland and Judd¹³ suggest adopting an alpha greater than .05 as one way researchers can “improve their chances of detecting interactions.” Accordingly, the possibility of moderation was examined for any interaction that trended towards conventional levels of significance at the $p < .10$ level.

Following the hierarchical regression test of moderation, separate regression models of postintervention PA were fit for high- and low-TV groups. Baseline vigorous activity and ethnicity were again entered as control variables.

Post hoc analyses were conducted to examine change over time in PA and TV viewing. Paired t -tests examined the changes in vigorous activity and TV viewing over time within each of the four subgroups: high-TV intervention, low-TV intervention, high-TV comparison, and low-TV comparison.

RESULTS

Group Comparisons

Table 1 presents the between-group comparisons for ethnicity, TV viewing, and vigorous PA. Comparisons were also made for age, VO_{2max} , and BMI, but this data is not included in Table 1, as there were no significant differences between any of the groups for these variables. The only significant difference between intervention and comparison groups at baseline was in ethnic distribution. The intervention group had a smaller proportion of Latina participants ($t[117] = -2.16$; $p < .05$) than the comparison group.

There were no significant differences between high-TV viewers at the intervention and the comparison schools. The low-TV group at the intervention school included a higher percentage of Caucasian students than the low-TV group at the comparison school ($t[60] = 2.07$; $p < .05$); this was likely because of the greater proportion of Caucasian students enrolled in the intervention school compared with the comparison school.

As expected, t -tests that compared the high- and low-TV groups within each school revealed significant differences in TV viewing time. At the intervention school, high-TV group members watched an average of mean \pm SD = 3.1 ± 1.7 hours of TV per day at baseline, and the low-TV group watched 1.1 ± 0.4 hours per day ($t[58] = -5.8$; $p < .001$). At the comparison school, the high-TV group watched 3.4 ± 1.4 hours of TV per day at baseline versus $.9 \pm .5$ hours for the low-TV group ($t[57] = -9.9$; $p < .001$). There were no other differences between the high- and low-TV groups within either school.

Test for Moderation

Based on the hierarchical multiple regression analysis, the interaction between intervention condition and TV viewing approached conventional levels of significance ($p < .08$), which suggests that the intervention’s impact on vigorous PA depended upon baseline TV viewing (Table 2). Therefore, the association of the intervention with exercise behavior was examined separately in the high- and low-TV groups.

The regression model for the high-TV group revealed that the intervention was a significant predictor of PA among high-TV watchers ($\beta = -.45$; $p < .001$). The regression model for the low-TV group did not reveal a significant effect of the intervention on PA for low-TV watchers ($p > .05$).

Test for Mediation

The first step of Baron and Kenny’s¹² test of mediation (which regresses the independent variable on the dependent variable) revealed that intervention status was a significant predictor of postintervention vigorous PA ($\beta = -.28$; $p < .01$). The second step of the mediation test revealed that the potential mediator (change in TV viewing) did not significantly predict PA ($p > .05$), which

suggests that TV viewing was not a mediator of the relationship between intervention status and vigorous PA.

Post Hoc Analyses

The average hours spent watching TV decreased significantly (from 3.1 ± 1.7 h/d to 2.3 ± 1.5 h/d) for the intervention/high-TV group ($t[34] = 2.1$; $p < .05$). For low-TV participants in the intervention group, TV viewing time did not change over the course of the intervention ($p > .05$). TV viewing time did not change for participants in either the high- or low-TV group at the comparison school ($p > .05$).

Vigorous PA increased significantly in the intervention/high-TV group (from 12.0 ± 14.7 to 13.1 ± 7.3 METs; $t[33] = -2.1$; $p < .05$). The intervention/low-TV group did not show any significant change in vigorous PA. Vigorous activity did not change significantly for participants in the high- or low-TV group at the comparison school ($p > .05$).

DISCUSSION

Summary

The regression results and the comparisons of pre- and post- activity levels and TV viewing provide evidence that TV viewing may be displacing some PA among these adolescents. Analyses supported a moderating, but not a mediating, role of TV viewing in the relationship between the intervention and PA. Specifically, moderation was evidenced, in that adolescents who were above the median in TV viewing at baseline showed postintervention increases in vigorous PA and simultaneous decreases in TV viewing, whereas those who were below the median for TV viewing showed no change in vigorous PA or in TV viewing. These results suggest the possible displacement of PA with TV viewing. The displacement is not one-to-one (i.e., PA did not increase as much as TV viewing decreased), yet the increase in PA is meaningful and, if sustained, would be likely to translate into health benefits.

These results and a recent review article¹⁴ that addressed the influence of the media environment on PA and that reported that the evidence for displacement is mixed, suggest that further investigation of the displacement hypothesis is warranted. Indeed, although displacement has been demonstrated in individual studies of child and adult

Table 2
Results of Hierarchical Regression Analyses for Variables Predicting Postintervention Vigorous PA† (N = 119)

Variable	Model 1			Model 2			Model 3		
	B	SE B	β	B	SE B	β	B	SE B	β
Baseline vigorous PA	0.047	0.076	0.057	0.027	0.074	0.033	0.012	0.074	0.015
Ethnicity	0.196	0.107	0.168*	0.157	0.105	0.135	0.177	0.105	0.153
Intervention condition				-0.281	0.107	-0.243**	-0.103	0.146	-0.089
Television viewing				0.097	0.105	0.084	0.280	0.146	0.242*
TV × intervention							-0.375	0.210	-0.252*
F(df,df)	2.078 (2,116)			3.435 (4,114)**			3.439 (5,113)***		
DR ²				0.073			0.025		
R ² _{adjusted}	0.018			0.076			0.094		

† PA indicates physical activity.

* $p < 0.08$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed tests).

populations as well as in a recent meta-analysis examining children's media use and PA, some of the most methodologically rigorous research in the area has turned up only limited support for the displacement hypothesis.¹⁴

Limitations

Participants in this study were not randomly assigned to watch high or low amounts of television. Although the high- and low-TV groups were comparable in key characteristics, it is possible that another factor that differed between these groups could have accounted for the differential response to the intervention. Further, although key comparisons were made between the high- and low-TV groups within the intervention school, it is important to note that participants were not randomly assigned to control and intervention conditions, and the control school had a significantly larger proportion of ethnic minority students. The presence of a nonidentical comparison sample may be a source of bias in the findings. Future studies would benefit from more nearly matching the intervention and comparison groups, ideally by randomly assigning participants to conditions. There may also have been floor effects for indicators of fitness and PA (because of the study selection criteria) that resulted in the high- and low-TV groups showing no differences on these indicators. One might otherwise expect to see lower fitness and PA among high-TV viewers. Whether these results generalize to populations other than sedentary teenage girls has not yet been tested. The present analyses relied heavily upon self-reported data, which is

subject to many sources of potential error. Consistent results from studies that employ objective measures of PA (e.g., an accelerometer) and TV viewing (e.g., an automatic viewing log) would strengthen our assertion of moderation.

Significance

These results suggest that sedentary adolescent girls who spend a lot of time watching TV may derive a greater benefit from a school-based PA intervention than peers who watch less TV. An implication is that specific types of PA interventions could be more effective among girls who watch more TV, and other interventions would be more effective among girls who watch less TV. Matching individuals with appropriate interventions would improve both program effectiveness and cost effectiveness (i.e., money would not be spent unsuccessfully attempting to influence behavior of a group *via* means inappropriate for that population).

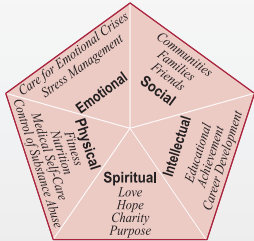
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