Published in final edited form as:

J Adolesc Health. 2009 May ; 44(5): 493–499. doi:10.1016/j.jadohealth.2008.10.142.

Patterns of Adolescent Physical Activity, Screen-Based Media Use and Positive and Negative Health Indicators in the U.S. and Canada

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Abstract

Purpose—To examine: 1) how adolescent physical activity (PA) and screen-based media use (SBM) relate to physical and social health indicators, and 2) cross-national differences in these relationships.

Methods—Essentially identical questions and methodologies were used in the Health Behavior in School-Aged Children cross-sectional surveys of nationally-representative samples of American (N = 14,818) and Canadian (N = 7,266) students in grades 6 to 10. Items included questions about frequency of PA, SBM, positive health indicators (health status, self-image, quality of life, and quality of family and peer relationships), and negative health indicators (health complaints, physical aggression, smoking, drinking, and marijuana use).

Results—In regression analyses controlling for age and gender, positive health indicators were uniformly positively related to PA while two negative health indicators were negatively related to PA. However, PA was positively related to physical aggression. The pattern for SBM was generally the opposite; SBM was negatively related to most positive health indices and positively related to several of the negative health indicators. The notable exception was that SBM was positively related to the quality of peer relationships. Although there were cross-national differences in the strength of some relationships, these patterns were essentially replicated in both countries.

Conclusions—Surveys of nationally representative samples of youth in two countries provide evidence of positive physical and social concomitants of PA and negative concomitants of SBM. These findings suggest potential positive consequences of increasing PA and decreasing SBM in adolescents and provide further justification for such efforts.

Keywords

physical activity; sedentary behavior; screen-based media use; quality of life; physical health status; quality of family relationships; quality of peer relationships; health complaints; substance use

A lifestyle that includes regular physical activity (PA) has been associated with numerous health benefits including reduced risk of coronary heart disease, type 2 diabetes, obesity and associated health risks, cancer, arthritis, sexual dysfunction, depression, anxiety, mood disorders, and cognitive impairment [1,2]. Time spent in sedentary activities such as television watching, computer game playing, and video/DVD viewing reduces daily energy expenditure and interventions suggest a causal relationship between sedentary behaviors and obesity [3].

In addition to the physical health effects of PA, there is evidence that PA is associated with positive physical and social health indicators such as perceived health status [4,5], self-image [5–9], quality of life [10], and quality of peer relationships [11]. However, independent of the direct influence of family on PA [12,13], the potential relationship of adolescent PA to quality of family relations has not been well investigated.

Other than the literature relating sports participation to specific health problems or risk behaviors [e.g., 14–17], there is relatively little research relating PA to negative health indicators such as health complaints, physical aggression, or getting drunk. There is some evidence that PA is unrelated to physical aggression [18,19], smoking [16,17,20–22], alcohol use [8,16,17,20], and marijuana use [8]. There is also evidence that adolescent PA may have a protective effect against subsequent adult alcohol use [23] and progression to other illicit drugs [15].

Interest in screen-based media use (SBM) as an independent risk factor for chronic health problems is growing but compared with PA there is less evidence on the relationship of SBM with positive or negative health indicators other than aggression and substance use [24]. However, youths classified as frequent television watchers are more likely to have a longitudinal association with lower self-esteem [8], lower perceived health status [4], poorer school grades [8], and a higher prevalence of smoking [4]. Higher daily SBM is associated with more frequent reports of somatic symptoms [25], alcohol use [8], and illicit drug use [8].

One limitation for these findings is that most studies are of small samples from a limited geographic area. Studies of larger, representative populations and that compare findings across countries are needed.

Hypotheses

The primary purpose of this study is to examine the independent relations of PA and SBM with positive and negative health indicators using a nationally-representative sample of U.S. adolescents. It was predicted that in the U.S. national sample, PA would have positive associations with positive health indicators and negative relations with negative health indicators. The opposite pattern was predicted for SBM. It was expected that these relationships would be replicated in analyses of a large nationally-representative sample of Canadian adolescents, suggesting that these patterns are robust and consistent in youth from different nations.

Methods

Health Behavior in School-Aged Children (HBSC) is a collaborative school-based survey with standardized methods and survey items across over 40 countries and regions [26]. The present

paper analyzed data from the nationally-representative HBSC surveys conducted in the U.S. and Canada. Surveys sampled students in grades 6 through 10 during the 2001–2002 school year. The U.S. [27] and Canadian [28] samples are described elsewhere. Investigators from each country obtained approval from their corresponding institutional human subjects review boards. The number of students participating in each country by grade and gender are presented in Table 1.

Measure

All of the questions used in the HBSC survey must have evidence of reliability and validity when used with children in multiple countries before they are considered for inclusion [26].

Physical Activity

Students were provided with a definition of PA and examples of moderate-to-vigorous PA. PA was then assessed with two questions asking about the number of days the respondent engaged in at least 60 minutes of PA over the last week and in a typical week. A mean of the responses to these two questions was used as the measure of PA [29].

Screen-Based Media Use

SBM was estimated using 2 two-part questions asking each youth how many hours per weekday and weekend day was spent: 1) using a computer during free time (excluding time spent doing homework), and 2) watching television (including videos) [30,31]. Mean hours per day of both screen time activities were calculated and summed to create a SBM score.

Positive Health Indicators

Five indices were developed to reflect positive psychological, social, and physical health. Psychological and physical health were reflected in self-image, quality of life, and physical health status. Social health was reflected in the quality of family and peer relationships.

Physical Self-Image

Perception of one's body size was converted to indicate satisfaction with self-image ('just right' scored as 3, some dissatisfaction ('a bit too thin' or 'a bit too fat') scored as 2, and extreme dissatisfaction ('much too thin' or 'much too fat') scored as 1).

Physical Health Status

Perceived physical health status was assessed with a 4-point self-rating ranging from 'poor' to 'excellent.'

Quality of Life

Participants indicated where they stood on a 10-point ladder with 0 being the 'worst possible life' and 10 being the 'best possible life' [32].

Quality of Family Relationships

Participants indicated on a 4-point scale how easy it was to talk to specific others about things that were bothering them. A mean score was derived from responses about six family members (excluding members they don't see or have): father, step-father, mother, step-mother, older brother, and older sister (Cronbach's $\alpha = .77$).

Quality of Peer Relationships

Three items asked whether it was easy to talk with a best friend, friends of the same sex, and friends of the opposite sex using the same scale as the items for quality of family relationships. Two items asked the number of close male and female friends: none, one, two, or three or more. Two items asked how many days/week they usually spent time with friends immediately after school (0 to 5) and how many evenings/week they usually spent time with friends (0 to 7). A weighted mean (each response divided by the maximum possible score for that item) of the seven items was used as the index for quality of peer relationships (Cronbach's $\alpha = .65$).

Negative Health Indicators

Negative health indices reflect two primary areas: perceived health problems and health risk behaviors: physical aggression, tobacco use, alcohol use, getting drunk, and marijuana use.

Health Complaints

Participants indicated on a 5-point scale ('rarely or never' to 'about every day') how frequently they had each of seven symptoms (headache, stomachache, backache, feeling low, irritability or bad temper, feeling nervous, difficulties getting to sleep, feeling dizzy). A mean of the responses represented subjective health complaints (Cronbach's $\alpha = .80$).

Physical Aggression

Four items contributed to an index of physically aggressive behavior: frequency of bullying other students in the past two months (5-point scale reflecting 'none' to 'several times a week'); number of times in the past two months that this bullying involved hitting, kicking, pushing, shoving, or constraining another student (5-point scale reflecting 'none' to 'several times a week'); number of times in a physical fight in the past 12 months (5-point scale, 0 to 4 or more); and number of days a weapon was carried in the past 30 days (5-point scale, 0 to 6 or more). A mean of these items provided the physical aggression index (Cronbach's $\alpha = .64$).

Tobacco Use

A single item asking "How often do you smoke tobacco at present?" on a 4-point scale ('I do not smoke', 'less than once a week', 'at least once a week but not every day', 'every day') indicated cigarette smoking.

Alcohol Use

Alcohol use indicated the highest frequency of use (5-point scale from 'never' to 'every day') of beer, wine, or liquor/spirits. Students also indicated the number of times they had ever been drunk (5-point scale from 'never' to '10 or more times').

Marijuana Use

Students in grades 9 and 10 indicated on a 7-point scale ('never' to '40 or more') the number of times they had ever used marijuana.

Analysis Plan

Zero-order Pearson correlations were calculated to identify simple relations between indices and t-tests were used to compare mean differences across gender. Linear regression models within each country with each health index as the dependent variable and age, gender, PA, and SB as the independent variables indicated how PA and SB independently related to each of the positive and negative health indices. All analyses were repeated separately for males and females. Using SAS procedures for weighted data, weights were used for U.S. regression

analyses to correct for the over-sampling of minorities. Uniform weights were applied for Canada.

To examine country effects, regression models combining both samples were performed with country as a dummy variable. Country by predictor variable interaction terms were used to evaluate whether country had an effect on the relationship between the predictor and the outcome. Because of the number of statistical comparisons being examined, a significance level of $p < .01$ was set for all analyses.

Results

Results for the U.S. and Canadian data are presented in Table 2 and Table 3, respectively. There were minimal cross-country differences in the variables assessed. The Canadian sample (Table 3, column 2) was slightly older than the U.S. sample (Table 2, column 2). When age and gender were controlled in regression analyses, Canadian students reported slightly higher daily PA, physical self-image, physical health status, alcohol use, marijuana use, and getting drunk; U.S. students reported more health complaints.

PA was negatively related to age (Table 2 and Table 3, column 4) in both countries and boys reported more PA than girls in the U.S. (U.S. boys mean PA = 4.5, girls mean PA = 3.9; $t(14000) = 18.26$, $p < .0001$) and Canadian samples (Canadian boys mean PA = 4.6, girls mean PA = 4.1; $t(7085) = 11.10$, $p < .0001$). In contrast to PA, SBM was positively related to age (Table 2 and Table 3, column 6); however, in both the U.S. (U.S. boys mean SBM = 4.8, girls mean SBM = 4.4; $t(13000) = 8.14$, $p < .0001$) and Canada (Canadian boys mean SBM = 4.8, girls mean SBM = 4.1; $t(6439) = 11.12$, $p < .0001$) boys reported more SBM than girls.

Physical Activity and Positive Health Indicators

In both countries, the pattern of results for the correlations (Table 2 and Table 3, column 4) and regression coefficients (Table 2 and Table 3, column 5) of PA with positive and negative health indices was surprisingly similar. With both PA and SBM in the regression models, PA was positively related to all of the positive health indices including physical self-image, physical health status, quality of life, and quality of family and peer relationships. Although all of these associations were significant and in the same direction for both Canadian and U.S. youths, there was an effect of country for one of the relationships. The association between PA and physical health status was significantly greater in Canadian youths than in U.S. youths ($\beta = .07$, $p < .0001$). In addition, in separate regression analyses of boys and girls, the association between PA and self-image was not significant in Canadian girls.

Physical Activity and Negative Health Indicators

With regard to negative health indices, the pattern of associations with PA was not as uniform as the relationships with positive health indices. Frequency of PA was inversely related to cigarette smoking. However, PA was positively related to physical aggression; this effect was primarily due to a positive relation with aggression in boys. PA was negatively related to health complaints in U.S. boys and to marijuana use in U.S. boys and Canadian girls. PA was positively related to alcohol use in Canadian boys.

Screen-based media use and Positive Health Indicators

The findings for SBM were very similar across countries (Table 2 and Table 3, columns 5 and 6). As expected, SBM was negatively related to PA in both countries. However, the relationships were modest and do not suggest that these two behaviors are opposing ends of the same construct. Furthermore, the pattern of relationships of SBM with the positive and negative health indices is not uniformly opposite to that of PA.

In the U.S. sample (Table 2), with both PA and SBM in the regression models, SBM was negatively related to most of the positive health indices: physical health status, quality of life, and quality of family relationships. However, SBM was positively related to quality of peer relationships. The pattern was similar in the Canadian sample (Table 3); SBM was negatively related to physical health status, quality of life, and quality of family relationships, but positively related to quality of peer relationships. When males and females in both samples were analyzed separately, the effect for family relationships was seen in girls, not boys.

The size of the associations with SBM was different across Canadian and U.S. samples. The negative relationships of SBM with self-image ($\beta = -.10$, $p < .0001$) and physical health status ($\beta = -.06$, $p < .0001$) were significantly greater in the Canadian sample than in the U.S. sample.

Screen-based media use and Negative Health Indicators

In the analyses of negative health indices, the pattern for SBM was not a mirror image of the results for PA. In both countries, SBM was positively correlated with health complaints, physical aggression, cigarette smoking, alcohol use, and having been drunk. However, when age, gender, and PA were controlled, the relationship with having been drunk was no longer significant in either country. The relationship between SBM and cigarette smoking in the U.S. sample was primarily due to a significant relationship in boys; this was the only significant difference between the U.S. and Canada for these relationships ($\beta = -.06$, $p < .01$).

Discussion

The current study indicated a consistent positive association between PA and positive health indicators. Although the magnitude of some of these relationships was small, the consistency of results across several different types of behaviors and different countries suggests positive consequences of PA for varied indices of psychological and social health. In contrast, SBM was modestly but consistently associated with individual perceptions of poorer physical health, quality of life, and quality of family relationships. In Canadian youths, SBM was also associated with poorer self-image.

These patterns provide a strong argument for the promotion of PA and the reduction of SBM in adolescents. One explanation for the potential broad positive effect of engaging in PA is its association with a general sense of well-being that may reflect improved psychological and social functioning [7,11]. The positive effect of PA on mood [6] and cognitive performance [33] may generalize to other personal and social areas. The negative findings for SBM and positive health indicators may be due to the passive nature of many SBM. Time spent watching television is time not spent engaging in social interactions, solving personal and social problems, or testing the limits of one's cognitive and physical capabilities. It is more likely that youth will develop a sense of competency from physically interacting with the environment than in passive observation [34].

Quality of peer relationships is the clear exception to the pattern for PA, SBM and positive health indicators. Both PA and SBM were positively related to quality of peer relationships and these relationships were among the strongest across behaviors in both countries. There is ample evidence that peer interactions are contexts for PA and that peer influences motivate PA [e.g., 35]. Peer interactions and use of the media are ubiquitous elements of adolescence and it is possible that engagement with peers is a reflection of engagement in the adolescent culture [36].

With regard to negative health indicators, the findings for SBM are compelling; time watching television and using computers was independently related to three of the six negative health

indicators in the Canadian sample and a fourth (cigarette use) in the U.S. sample. The findings for aggression and substance use are consistent with previous studies [28].

The pattern for PA and negative health indicators was more complex. In both the U.S. and Canada, PA was negatively associated with health complaints. This finding appears to be opposite to the association of PA and sports activities with physical injuries [28]. However, health indicators examined in the current study are not directly related to physical injury; it is possible that the improvements in physical fitness and duration of sleep associated with higher levels of PA reduces the frequency of non-injury health complaints [8].

Contrary to some studies [18,19], PA was positively related to physical aggression even when age, gender, and SBM were taken into account. Increased risk for violence and problem behaviors has been associated with frequent bouts of PA [8], particularly vigorous PA [7]. Aggressive physical contact is expected in some types of sports and these behaviors may generalize to other situations; but the relationship between sports participation and problem behaviors may be sport- and gender-specific [14]. Because time spent in sports was not assessed separately in this study and was included in the definition of PA provided when PA was assessed, some reports of higher levels of daily PA may reflect time spent participating in contact sports.

In regression analyses controlling for age, gender, and SBM, PA was negatively related to cigarette use in both countries; in separate regression analyses for males and females, PA was negatively related to marijuana use in U.S. males and Canadian females. These findings are consistent with previous research [22] and longitudinal studies suggest that maintaining PA during the adolescent years is associated with lower rates of smoking during adolescence and adulthood [4,23].

Neither the U.S. nor Canada has a uniform policy regarding physical education requirements; instead, requirements vary across states and provinces respectively. However, there were country differences in the mean PA and SBM as well as positive health and negative health indicators. Canadian youth reported slightly higher PA, physical self-image, physical health status, quality of family relationships, alcohol use, getting drunk, and marijuana use. U.S. youth reported slightly more SBM and health complaints. Country differences in the relations of PA and SBM with positive and negative health indicators did not affect the overall pattern. The relationship of PA with physical health status was positive in both countries but significantly greater in Canadian students. It may be that there is a threshold effect; the relationship between PA and physical health status may require a minimum level of PA [8] or may be limited to vigorous PA [9]. Canadian students were more active than American students and so may have more students with PA levels above the required threshold for this effect.

This threshold effect might also account for gender differences in these relationships. In six of the 19 significant U.S. and Canadian relationships involving PA, the effect was significant for males but not females. In only one of these regression analyses, PA and marijuana use in Canadian students, was the relationship for PA significant for females but not males. The only consistent pattern of gender differences across countries was that PA was associated with aggression in males only and SBM was associated with poorer quality of family relationships in females only. Further exploration of the meaning of PA and SBM across genders is needed.

The relationship of SBM with physical self-image, physical health status, and quality of life were negative in both countries but all were greater in the Canadian sample than in the U.S. sample. With relatively little available research on relations between SBM and these health indicators and no cross-country research, we can only speculate on potential explanations. One possibility is that normative expectations for SBM are different in the two countries. SBM may

be more accepted in the U.S. sample, thereby attenuating the negative relationship of SBM with physical self-image, physical health status, and quality of life.

Because the essential pattern remains the same, country differences in these relationships do not affect the primary conclusions of these analyses. However, these country differences may account for potential differences in findings across studies. Canada and the U.S. share many cultural similarities. Replication of these findings in countries with substantially different cultures is warranted.

Limitations

There are a number of limitations to interpretation of these findings. Because these data are cross-sectional, they do not necessarily indicate a causal relationship between engaging in PA or SBM and these health indices. Some of the relationships are quite weak but still statistically significant because they are being assessed in large, nationally-representative samples; as a result, the relative impact of these relationships may be quite modest. The clinical significance of these relationships may be more relevant to public health efforts than to individually tailored interventions. Another weakness of this study is that all of the indices reported are based on self-report. However, any errors introduced due to self-report of PA, SBM, and the health indices would tend to attenuate the statistical relationships suggesting that the actual relationships might be stronger. Furthermore, the large sample size and the relatively consistent pattern of results across countries suggest that these effects are robust and deserve further investigation.

Implications

There has been surprisingly little research on the health correlates of SBM other than aggression and substance use and a similar pattern exists for research on PA. These findings provide support for the argument that adolescent PA has beneficial effects on a variety of health, psychological, and social outcomes and on general well-being. In regression analyses including both PA and SBM, adolescent SBM adversely predicted these positive and negative health outcomes independent of PA behaviors. Interventions targeting PA or SBM with the expectation that changing one will have a positive effect on the other may be misguided. Instead, benefits may be gained from interventions independently targeting both PA and SBM. Further research identifying the psychological and behavioral health benefits of PA and health risks of SBM could foster identification of potential mechanisms for these relationships, provide further justification for public health and educational efforts to promote PA and reduce SBM, assist in efforts to tailor intervention efforts to groups with high levels of the negative health indices, and suggest new motivations for individual behavior change. Future studies should explore country-specific differences in these relationships and potential causes for these differences.

Acknowledgements

The 2001–2002 U.S. HBSC survey was supported by the Maternal and Child Health Bureau of the Health Resources and Services Administration and by the Intramural Research Program of the Eunice Kennedy Shriver National Institute of Child Health and Human Development. The 2001–2002 Canadian HBSC survey was supported by Health Canada and Queen's University. The WHO-HBSC is a WHO/Euro collaborative study. International Coordinator of the 2001/02 study: Candace Currie, University of Edinburgh, Scotland; Data Bank Manager: Oddrun Samdal, University of Bergen, Norway.

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Table 1
Unweighted Frequencies (and Percent of Country Sample) of Respondents by Country, Gender and Grade

	Grade					Total
	6	7	8	9	10	
United States	3741 (25%)	2907 (20%)	2764 (19%)	2751 (19%)	2665 (18%)	14818
Males Mean Age by Grade and Total Frequency	12.1	13.1	14.1	15.1	16.1	7088 (48%)
Females Mean Age by Grade and Total Frequency	12.1	13.1	14.1	15.1	16.1	7730 (52%)
Canada	2063 (29%)	1403 (19%)	1385 (19%)	1228 (17%)	1156 (16%)	7235
Males Mean Age by Grade and Total Frequency	12.0	13.0	14.0	15.0	16.0	3357 (46%)
Females Mean Age by Grade and Total Frequency	11.9	12.9	13.8	14.9	15.8	3878 (54%)

Table 2

U.S. Sample Weighted Mean, Standard Deviation, Range, Unweighted Correlation with Physical Activity (PA), Weighted Standardized Regression Coefficient on PA, Unweighted Correlation with Sedentary Behavior (SBM), and Weighted Standardized Regression Coefficient on SBM

Variable	Mean (SD)	Range	Correlation with PA	Regression Coefficient for PA ^b	Correlation with SBM	Regression Coefficient for SBM ^b
Age	13.7 (1.51)	10 – 17	-.04***	-	.04***	-
Physical Activity	4.3 (2.12)	0 – 7	-	-	-.03**	-.07***
Sedentary Behavior	4.5 (2.64)	0 – 14	-.03**	-.07***	-	-
Self-Image	.77 (.16)	0.33 – 1.0	.11***	.07***	.02	.01
Physical Health Status	3.0 (.74)	1 – 4	.18***	.12***	-.04***	-.03***
Quality of Life	7.5 (2.06)	0 – 10	.12***	.08***	-.07***	-.05***
Family Relationships	2.8 (.79)	1 – 4	.09***	.05***	-.05***	-.04***
Peer Relationships	.67 (.18)	0.0 – 1.0	.19***	.14***	.09***	.06***
Health Complaints	1.1 (.88)	0 – 4	-.06***	-.04*	.10***	.12***
Physical Aggression	.50 (.72)	0 – 4	.07***	.06***	.16***	.17***
Cigarette Smoking	1.3 (.72)	1 – 4	-.04*	-.04*	.06***	.05**
Alcohol Use	.65 (1.00)	0 – 4	.01	.02	.09***	.08***
Drunk	1.5 (.97)	1 – 5	.00	.01	.04***	.02
Marijuana Use ^a	.93 (1.78)	0 – 6	-.01	-.14*	.00	.00

*
p < .01

**
p < .001

p < .0001

^a Marijuana use was assessed in 9th and 10th grades only (n = 4,669).

^b Regression analyses controlled for age and gender.

Table 3

Canadian Sample Mean, Standard Deviation, Range, Correlation with Physical Activity (PA), Standardized Regression Coefficient on PA, Correlation with Sedentary Behavior (SBM), and Standardized Regression Coefficient on SBM

Variable	Mean (SD)	Range	Correlation with PA	Regression Coefficient for PA ^b	Correlation with SBM	Regression Coefficient for SBM ^b
Age	13.8 (1.49)	10 – 17	-.06***	-	.05***	-
Physical Activity	4.4 (1.89)	0 – 7	-	-	-.07***	-.09***
Sedentary Behavior	4.5 (2.52)	0 – 14	-.07***	-.09***	-	-
Self-Image	.84 (.20)	0.33 – 1.0	.07***	.06***	-.08***	-.07***
Physical Health Status	3.1 (.67)	1 – 4	.25***	.23***	-.12***	-.11***
Quality of Life	7.5 (1.86)	0 – 10	.16***	.13***	-.12***	-.11***
Family Relationships	2.8 (.76)	1 – 4	.11***	.08***	-.05**	-.05***
Peer Relationships	.67 (.18)	0.0 – 1.0	.19***	.21***	.04***	.06***
Health Complaints	1.0 (.80)	0 – 4	-.07***	-.03***	.13***	.15***
Physical Aggression	.52 (.71)	0 – 4	.07***	.05***	.15***	.12***
Cigarette Smoking	1.2 (.72)	1 – 4	-.05***	-.04*	.03*	.02
Alcohol Use	.88 (1.05)	0 – 4	.02	.04*	.10***	.08***
Drunk	1.6 (1.14)	1 – 5	0	.02	.05**	.02
Marijuana Use ^a	1.1 (1.91)	0 – 6	-.04	-.06	-.01	-.03

*
p < .01

**
p < .001

p < .0001

^a Marijuana use was assessed in 9th and 10th grades only (n = 2221).

^b Regression analyses controlled for age and gender.