

Published in final edited form as:

*Am J Prev Med.* 2007 February ; 32(2): 124–130.

## Patterns and Correlates of Physical Activity and Nutrition Behaviors in Adolescents

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### Abstract

**Background**—Knowledge of the prevalence, clustering, and correlates of multiple adolescent health behaviors can inform the design of health promotion interventions.

**Methods**—A cross-sectional design was used to assess 878 adolescents aged 11 to 15 years (53.6% girls; 58% non-Hispanic white) recruited in primary care clinics in 2001–2002. Adolescent physical activity (assessed with accelerometers); television viewing time (reported); percent calories from fat; and servings of fruits and vegetables (assessed with multiple 24-hour recalls) were dichotomized into meeting or not meeting national guidelines. Parent health behaviors were assessed with self-reported measures. Analyses were conducted in 2006.

**Results**—Fifty-five percent of adolescents did not meet the physical activity guideline, and 30% exceeded 2 hours daily of television viewing time, with boys more active and less sedentary than girls ( $p < 0.01$ ). The majority of the adolescents did not meet dietary guidelines. Nearly 80% had multiple risk behaviors and only 2% met all four guidelines. The number of risk behaviors was associated with being older and being at risk for overweight or being overweight, for boys and girls ( $p < 0.05$ ). Having a parent with a history of smoking and who did not meet the fruit and vegetable guideline were significantly associated with a higher number of risk behaviors for girls ( $p < 0.05$ ).

**Conclusion**—Eight of ten adolescents in this sample failed to meet guidelines for two or more diet, physical activity, and sedentary risk behaviors. Some parent health behaviors, along with the adolescent's weight status and age, were associated with a higher number of adolescent health risk behaviors.

### INTRODUCTION

Modifiable physical activity, sedentary and diet behaviors are associated with morbidity and mortality, and it is a national priority to improve these behaviors in all populations, including among adolescents. Expert groups have recommended 60 minutes/day of moderate to vigorous

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No financial conflict of interest was reported by the authors of this paper.

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physical activity for youth,<sup>1, 2</sup> yet data based on objective measures suggest that only 30% of teenagers meet this guideline.<sup>3</sup> Television watching is the dominant sedentary behavior in adolescents,<sup>4</sup> and it is estimated that 57% adolescents view television for less than 2 hours a day.<sup>5</sup>

The Centers for Disease Control and Prevention (CDC) estimates that only 15% of adolescents aged 12–19 years meet the <30% of energy recommendation for total fat intake, and 7% of adolescents meet the <10% of energy recommendation for saturated fat intake.<sup>3, 5</sup> Data from CDC's 2003 Youth Risk Behavior Survey indicated that fewer than 22% of high school students consumed the recommended 5 or more servings/day of fruits and vegetables.<sup>6</sup> Meeting the public health recommendations for these four health risk behaviors is expected to improve quality of life and reduce considerably the incidence of obesity and several chronic diseases.<sup>2, 7, 9</sup>

Despite extensive evidence about the high prevalence of risk behaviors, little is known about the relationship among these behaviors, such as their clustering patterns, especially in adolescents.<sup>10</sup> There is some evidence that diet and physical activity behaviors tend to cluster among individuals.<sup>10–12</sup> Improved understanding of behavioral clustering could inform strategies for multiple risk factor interventions. Identifying characteristics of adolescents most likely to have multiple risk behaviors could lead to more targeted intervention strategies.

The aims of the present study were to: (1) describe the prevalence and clustering patterns of four adolescent health behaviors (physical activity, TV viewing time, fruit and vegetable consumption, dietary fat intake); (2) examine the sociodemographic, behavioral and parent health behavior correlates of the number of health risk behaviors. These aims were considered exploratory and primarily hypothesis generating, with the goal of identifying patterns and relationships that can inform further research and suggest possible intervention strategies.

## METHODS

### Participants

Adolescents between the ages of 11 and 15 years were recruited through their primary care providers as part of a health promotion intervention trial.<sup>13</sup> A total of 45 primary care providers from six clinic sites in San Diego County agreed to participate in the study. The goal was to recruit an ethnically representative sample of adolescents seeing primary care providers in San Diego County. All study procedures were approved by university and clinic institutional review boards. Recruitment occurred between May 2001 and June 2002. A total of 878 adolescents were enrolled into the study after signing consent forms and completing baseline measurements.

### Measures

**Physical Activity**—Physical activity was measured with the Computer Science and Applications (CSA) Accelerometer (WAM 7164; now called Actigraph, available through [www.theactigraph.com](http://www.theactigraph.com)). This uni-axial accelerometer is small (5.1 × 3.8 × 1.5 cm), lightweight (45 g), and worn on a belt around the waist. Accelerometers stored data as 1-minute averages. In laboratory and field settings, Actigraph accelerometers have been shown to be a valid measure for quantifying children's activity.<sup>14</sup> Minutes of moderate (3–5.9 METs) and vigorous (> 6 METs) physical activity was estimated using cut-points from Freedson et al.<sup>15</sup> and Trost.<sup>14</sup> Adequate accelerometer data (at least 3 days of monitoring) were available for 770 (88%) participants. Adolescents wore the accelerometer an average of 8.3 (sd = 2.2) days with 96% wearing it 5 or more days.

**Sedentary Behavior**—Time spent watching television was used as a proxy for sedentary behavior to measure compliance with Healthy 2010 television viewing time guideline<sup>5</sup> and because television viewing is consistently related to overweight status.<sup>7</sup> Time spent watching television on a recent nonschool day was measured with a modified version of a validated survey developed by Robinson.<sup>17</sup> In a study of 100 middle school students the test–retest reliability of the 7-item sedentary behavior scale, based on one-way model intra-class correlations was 0.70.<sup>18</sup> Participants responded with an 8-point scale ranging from “None” to “6 hours or more.” Nonschool day TV time was measured to estimate self-selected behavior during unstructured time (e.g., no school), but it was highly correlated with school day TV time ( $r=0.78$ ) in this sample.

**Dietary Intake**—Three 24-hour food recall interviews assessed dietary intake. Trained data collectors conducted dietary recalls for 2 weekdays and 1 weekend day using the University of Minnesota Nutrition Data System for Research (NDS-R) software version 4.04.<sup>19</sup>

Participants learned to measure food portions with 3-dimensional food models before the first interview. The first interview was conducted in person and the second and third by phone (participants were given two-dimensional food models to use for the 2nd and 3rd assessments). Percent daily calories from fat and daily servings of fruit and vegetables were calculated by averaging values from the 3 intake records.

**Body Mass Index (BMI)**—An Accu-Hite wall stadiometer model 216 (Seca Accu-Hite, Hanover, MD) measured standing height. Weight was measured with a calibrated digital scale. Each measure was taken twice and the average of the two readings calculated. BMI was calculated as kilograms per square meters. BMI-for-age percentile was determined from CDC national norms.<sup>20</sup> A two-level “BMI status” variable was created using the accepted cut-point of the 85th percentile.<sup>21</sup> This grouped adolescents considered “at risk for overweight” (a BMI  $\geq$  85th and  $<$  the 95th percentile) with those considered overweight ( $\geq$  95th percentile). Adolescents with a BMI-for-age  $<$  85th percentile were considered “normal weight.” The CDC considers children below the 5th percentile to be underweight. Ten adolescents in the sample met this definition for underweight and they were included in the “normal weight” group.

**Highest Household Education Level**—A parent of the adolescent participant completed a short demographic survey and indicated the highest level of education for any adult in the household. Household education was collapsed into three categories, “ $<$  high school through associates degree”, “Bachelors degree”, “graduate or professional school.”

**Parent health behaviors**—Parents’ health behaviors were assessed with self-report stage of change surveys developed for and validated in adults.<sup>22, 23</sup> Participants’ parents selected the statement that best described their actual current behavior and “readiness to change” in relation to quitting smoking (a statement for never-smoker was added), exercising three times a week for at least 20 minutes each time, consistently avoiding eating high fat foods, and consistently eating at least 5 servings of fruits and vegetables each day. Based on the responses regarding meeting guidelines, dichotomous variables were created. Smoking behavior was categorized as never smoker, former smoker or current smoker.

## Statistical Analysis

All analyses were gender-specific. Adolescents’ physical activity, television viewing, and dietary intake data were categorized as meeting or not meeting national guidelines.<sup>5</sup> A total risk behavior score was created for each participant based on the total number of unmet guidelines (range: 0 to 4).

First, the proportion of adolescents meeting each guideline was computed. Differences on meeting guidelines by gender were tested using Chi-square tests of independence. Second, the proportion of adolescents in each multiple risk factor combination was determined to examine the clustering patterns of the behaviors. Finally, a multiple linear regression model was constructed to test the correlates of the number of risk behaviors score with demographic, anthropometric, adolescents' and parents' activity and diet behaviors as independent variables. The intra-class correlation coefficient for clinic site was nonsignificant and as a result, the random effect of clinic site was not included in statistical model. In the first model building step age (centered at eleven years), ethnicity (white vs Hispanic or other minority), highest household education level, and BMI status were retained as control variables. At the second step, automated backward selection determined which correlates remained in the model. All two-way interaction terms for variables remaining in steps 2 were forward entered in step 3. A significance criterion for removing variables was set at  $p < 0.05$ . The models were fit using maximum likelihood estimation using SAS version 8 (SAS Institute, Cary NC, 2000). All analyses were conducted in 2006.

## RESULTS

### Demographic Characteristics by Gender

Table 1 displays the demographic, behavioral and anthropometric characteristics of the participants. The mean age of the sample was 12.7 (SD=1.3) years, with 42% of the participants from racial/ethnic minority backgrounds. Although not fully representative of the San Diego community (San Diego Association of Governments, [www.sandag.org](http://www.sandag.org), March 7, 2003), in which those age 10–17 are 35% Hispanic (13% in the study sample), 7% African-American, 12% Asian or other (3% in the study sample), and 45% non-Hispanic white (58% in the study sample), the study sample was diverse. About 46% of the sample had a BMI for age  $\geq$  85th percentile and 28% were overweight (BMI for age  $\geq$  95<sup>th</sup> percentile; result not shown) with no significant gender differences.

The accelerometer data indicated that boys engaged in an average of 67.6 min/d (SD= 30.8) of moderate to vigorous physical activity (MVPA), while girls engaged in about 50 min/d (SD = 24.2) of MVPA. Boys and girls reported similar television viewing time on nonschool days. Adolescents consumed about 33% of total calories from fat and roughly 3 servings of fruit and vegetables a day, with boys reporting a slightly higher mean number of servings (3.2, SD = 2.1) than girls (2.9, SD = 1.6).

### Prevalence of Meeting Health Guidelines

The proportion of girls and boys meeting the health behavior guidelines for adolescents is displayed in Table 2. Overall, 55% of the adolescents did not meet the recommendation of 60 minutes/day of physical activity. Significantly more boys (59%) than girls (33.6%) met the physical activity guideline ( $\chi^2(1) = 49.9$   $p < 0.001$ ). More boys (70.5%) reported meeting the television-viewing time guideline than girls (64.3%) ( $\chi^2(1) = 3.9$   $p = 0.05$ ). There were no gender differences on the dietary guidelines, with only 32% and 11.9% of the sample meeting the recommendations for fat consumption and servings of fruits and vegetables, respectively.

Only 2% of the adolescent sample met all guidelines. Thirty-six percent had two risk factors, while nearly half (48.2%) had more than three risk factors. Girls had significantly more risk factors than boys ( $\chi^2(4) = 28.4$   $p < 0.001$ ), with 88.6% of girls having 2 or more risk behaviors compared to 78.9% of boys with 2 or more risk behaviors.

The clustering patterns of the four risk behaviors are described in Table 3. For adolescents with three risk factors, the most prevalent cluster was formed by insufficient physical activity and

not meeting the dietary recommendations for fat and fruits and vegetables. The proportion of girls within this cluster (25.3%) was higher than the proportion of boys (14.2%). Consuming a high percentage of fat and less than 5 servings of fruit and vegetables, was the most common grouping of two risk factors, with a higher proportion of boys (25.4%) than girls (12.4%) comprising this cluster. Not meeting the fruits and vegetables recommendation was the most prevalent of the single risk factor clusters, with a higher proportion among boys (11.3%) than girls (6.3%).

### Correlates of the Number of Multiple Risk Behaviors

The linear regression models for the number of risk behaviors are presented in Table 4. For girls, a higher number of risk behaviors was related to being older, being at risk for overweight, having a parent who was a former or current smoker, and a parent who consumed less than the recommended servings of fruits and vegetables ( $p < .05$ ). For boys, age was positively related with the number of risk behaviors, while being normal weight was negatively associated ( $p < .05$ ). Parents' number of risk behaviors (physical activity, dietary fat, fruit and vegetables consumption, and smoking), was positively associated with a higher number of risk behaviors in boys, approaching statistical significance ( $p = 0.06$ ).

## DISCUSSION

Nearly 80% of sampled adolescents had multiple physical activity and dietary risk behaviors and almost half had at least three risk behaviors. Only 2% met all four of the health guidelines. These findings clearly demonstrate the need for effective interventions to help adolescents improve multiple risk behaviors.

Of the individual risk behaviors, adolescents were least likely to meet the fruit and vegetable guidelines; only 12% met this guideline, which is 10 percentage points lower than what has been reported nationally.<sup>6</sup> The second most common risk behavior was dietary fat, with only about one third meeting the guideline. Although 45% met the physical activity guideline, based on an objective measure, there was a large gender difference, with 59% of boys and only 34% of girls meeting the guideline. Present findings are similar to previous published reports,<sup>10</sup> including another study using accelerometers.<sup>24</sup> About two thirds of the girls and boys in the sample met the 2 hour per day television viewing guideline. This is a higher proportion than the baseline estimate in Healthy People 2010.<sup>5</sup> Regarding the risk factor combinations, the most prevalent three and two risk factor clusters among the sample included the two dietary behaviors. This finding provides additional evidence to support for concerted efforts to develop interventions to improve diet habits in adolescents.

The regression models for the number of risk behaviors identified several correlates for both girls and boys. However, the total variance explained by these models was small (4 to 8%) suggesting that other factors not assessed in this study are important for understanding variation in number of risk factors for girls and boys. Older girls and boys were more likely to have a greater number of risk behaviors as were girls and boys with BMIs over the 85<sup>th</sup> percentile. While all of these behaviors are commonly targeted in youth weight control programs, the present study highlights the need for developing better approaches to helping overweight adolescents improve all these behaviors, which should contribute to weight loss and have additional health benefits.

There was some evidence that parents' health behaviors were associated with adolescents' health behaviors. For the girls, two parent health behaviors—never smoking and meeting fruit and vegetable guidelines—were associated with fewer adolescent risk behaviors. This is consistent with what has been observed in other studies. Family dietary practices have been associated with adolescents' dietary behaviors.<sup>25–28</sup> Specifically, perception of parents'

consumption of fat and fruit has been identified as a predictor of adolescent fat and fruit and vegetables consumption practices.<sup>28</sup> In addition, parent low-fat eating practices have been related to children low-fat practices.<sup>33</sup> It is likely that home food availability and food preparation practices are the common link between parent and adolescent dietary patterns.<sup>25, 29</sup>

For boys, the marginal association of number of parent risk behaviors with number of adolescents' risk behaviors should not be ignored. These findings suggest that parents' and their children's health behaviors are interconnected, even as children move through adolescence. However, family-based health promotion interventions often are ineffective,<sup>30</sup> so improved intervention approaches that include parents are needed.

Limitations of the present study included the cross-sectional design, restriction to one geographic region of the U.S., use of self-reported sedentary behaviors, and a relatively narrow age range. These results need to be replicated, ideally with improved measures of parent health behaviors. Longitudinal studies are needed to explore how these risk behaviors covary over time and predict morbidity as adolescents grow into adults. Strengths of the study included a large, diverse sample, objective assessment of physical activity, and the use of multiple 24-hour dietary recalls to estimate diet behaviors.

These findings contribute to the body of evidence that most adolescents fail to meet multiple diet and physical activity guidelines and continue to be in need of interventions that target multiple behaviors. Although health promotion programs frequently target multiple behaviors, little is known about the best approaches to stimulating multiple behavior change. Initial research suggests that overall health effects may be less when two behaviors are targeted rather than one.<sup>31</sup> Further research is needed to investigate the feasibility and effectiveness of different strategies for promoting multiple behavior change in adolescence.

#### Acknowledgements

This project was supported by the National Institutes of Health, National Cancer Institute (R01 CA081495)

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**Table 1**  
Demographic and anthropometric sample characteristics

	Girls (n =471)	Boys (n =407)	Total (N =878)
Age (mean, SD)	12.8 (1.3)	12.7 (1.4)	12.7 (1.3)
Ethnicity			
Asian/Pacific Islander	12 (2.5%)	18 (4.4%)	30 (3.4%)
African American	27 (5.7%)	31 (7.6%)	58 (6.6%)
Native American Indian	4 (0.8%)	2 (0.5%)	6 (0.7%)
Hispanic	65 (13.8%)	50 (12.3%)	115 (13.1%)
Non-Hispanic white	274 (58.2%)	234 (57.5%)	508 (57.9%)
Multi-ethnic/other	89 (18.9%)	72 (17.7%)	161 (18.3%)
Highest household education level			
< High school to Associate degree	176 (37.4%)	113 (27.8%)	289 (32.9%)
Bachelors degree	123 (26.1%)	128 (31.4%)	251 (28.6%)
≥ Graduate or professional school	164 (34.8%)	154 (37.8%)	318 (36.2%)
Did not report	8 (1.7%)	12 (2.9%)	20 (2.3%)
Height (centimeters) *	156.3 (8.0)	158.6 (11.6)	157.4 (9.9)
Weight (kilograms) *	59.1 (17.8)	58.7 (19.4)	59.0 (18.5)
BMI	24.0 (6.5)	23.5 (6.4)	23.6 (6.3)
BMI category			
< 85 <sup>th</sup> percentile	248 (52.7%)	228 (56.2%)	476 (54.3%)
≥ 85 <sup>th</sup> percentile	223 (47.3%)	178 (43.8%)	401 (45.7%)
MVPA min/day <sup>a</sup>	50.0 (24.2)	67.6 (30.8)	58.2 (28.8)
Servings of fruit or vegetables/day *	2.9 (1.6)	3.2 (2.1)	3.1 (1.8)
Kcals from fat per day, %	32.8 (6.0)	32.5 (6.0)	32.7 (6.0)
Television time on non-school days, min/d	127.8 (92.8)	123.4 (92.7)	125.7 (92.7)

<sup>a</sup> MVPA, moderate to vigorous physical activity, sample size  $n = 770$  (414 girls, 356 boys).

\* Mean and standard deviation.

BMI, body mass index

**Table 2**

## Gender distribution of meeting recommendations

Health behavior	Total (n =877)	Girls (n =470)	Boys (n =407)	p value
Meet > 60 min PA n (%)				<0.001
No	421 (54.7)	275 (66.4)	146 (41)	
Yes	349 (45.3)	139 (33.6)	210 (59)	
Meet < 120 min TV n (%)				0.05
No	288 (32.8)	168 (35.7)	120 (29.5)	
Yes	589 (67.2)	302 (64.3)	287 (70.5)	
Meet < 30% Fat n (%)				0.49
No	597 (68)	325 (69)	272 (66.8)	
Yes	281 (32)	146 (31)	135 (33.2)	
Meet > 5 servings fruits/vegetables n (%)				0.70
No	771 (88.1)	416 (88.5)	355 (87.7)	
Yes	104 (11.9)	54 (11.5)	50 (12.3)	
Number of risk behaviors n (%)				<0.001
4	96 (12.5)	61 (14.8)	35 (9.8)	
3	275 (35.8)	173 (41.9)	102 (28.6)	
2	276 (35.9)	132 (31.9)	144 (40.5)	
1	107 (13.9)	42 (10.2)	65 (18.3)	
0	15 (1.9)	5 (1.2)	10 (2.8)	

Sample sizes: Meet PA: Girls n =414, Boys n =356; Meet TV: Girls n =470, Boys n =407; Meet fat: Girls n =471, Boys n =407; Meet fruit/veg: Girls n =470, Boys n =405; Number of risk behaviors: Girls n =413, Boys n =356.

PA, physical activity

**Table 3**

Descriptive cluster pattern of multiple risk behaviors (not meeting national recommendations)

Number of risk behaviors	TV > 120 min TV	PA < 60 min PA	Fat >30% Fat	Fruit/veg <5 servings	Percent of sample
Girls (n =413)					
4	Yes	Yes	Yes	Yes	14.8
3	Yes	Yes	Yes	No	1.0
3	Yes	Yes	No	Yes	7.8
3	Yes	No	Yes	Yes	8.0
3	No	Yes	Yes	Yes	25.3
2	Yes	Yes	No	No	0.5
2	Yes	No	Yes	No	0.7
2	Yes	No	No	Yes	3.2
2	No	Yes	Yes	No	3.6
2	No	Yes	No	Yes	11.4
2	No	No	Yes	Yes	12.4
1	Yes	No	No	No	0.0
1	No	Yes	No	No	1.9
1	No	No	Yes	No	1.9
1	No	No	No	Yes	6.3
0	No	No	No	No	1.2
Totals by risk behavior	35.7	66.4	69.0	88.5	100.0
Boys (n =356)					
4	Yes	Yes	Yes	Yes	9.8
3	Yes	Yes	Yes	No	1.1
3	Yes	Yes	No	Yes	3.4
3	Yes	No	Yes	Yes	10.2
3	No	Yes	Yes	Yes	14.2
2	Yes	Yes	No	No	0.6
2	Yes	No	Yes	No	0.3
2	Yes	No	No	Yes	4.5
2	No	Yes	Yes	No	2.0
2	No	Yes	No	Yes	7.9
2	No	No	Yes	Yes	25.4
1	Yes	No	No	No	0.6
1	No	Yes	No	No	1.7
1	No	No	Yes	No	4.2
1	No	No	No	Yes	11.3
0	No	No	No	No	2.8
Totals by risk behavior	29.5	41.0	66.8	87.7	100.0

**Table 4**  
Number of Risk Behaviors: Multivariate Model for Girls and Boys

	Girls		Boys	
	Standardized beta	<i>p</i> value	Standardized beta	<i>p</i> value
Age <sup>a</sup>	0.178	<0.001	0.132	0.01
Low education	0.020	0.68	-0.086	0.11
Hispanic or other minority	0.047	0.35	0.033	0.54
BMI ≥ 85 <sup>th</sup>	0.132	0.007	0.111	0.04
Parent fruit <sup>b</sup>	-0.132	0.007		
Parent never smoker, <sup>bc</sup>	-0.120	0.01	NA	
Parent number risk behaviors <sup>b</sup>	NA		0.102	0.06

<sup>a</sup> Age centered to 11 years

<sup>b</sup> Derived from stage of change measures on Parents

<sup>c</sup> Compared to non-smoking parent;

Both models were statistically significant: for Girls ( $n = 396$ ),  $F = 6.46$ ,  $p < 0.001$ ,  $\text{Adj } R^2 = 0.08$ ; for Boys ( $n = 336$ ),  $F = 3.56$ ,  $p = 0.003$ ,  $\text{Adj } R^2 = 0.04$ .

NA, not applicable.