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Pediatrics 2006;117:1281-1290
DOI: 10.1542/peds.2005-1692

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Physical Activity and Sedentary Behavior Patterns Are Associated With Selected Adolescent Health Risk Behaviors

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The authors have indicated they have no financial relationships relevant to this article to disclose.

ABSTRACT

OBJECTIVE. Little is known about how physical activity (PA), sedentary behavior, and various adolescent health risk behaviors are associated. The objective of this study was to examine relationships between PA and sedentary behavior patterns and an array of risk behaviors, including leading causes of adolescent morbidity/mortality.

METHODS. Nationally representative self-reported data were collected (National Longitudinal Study of Adolescent Health: wave I: 1994–1995; II: 1996; \textit{N} = 11,957). Previously developed and validated cluster analyses identified 7 homogeneous groups of adolescents sharing PA and sedentary behaviors. Poisson regression predicted the relative risk of health risk behaviors, other weekly activities, and self-esteem across the 7 PA/sedentary behavior clusters controlling for demographics and socioeconomic status. Main outcome measures were adolescent risk behaviors (eg, truancy, cigarette smoking, sexual intercourse, delinquency), other weekly activities (eg, work, academic performance, sleep), self-esteem.

RESULTS. Relative to high television (TV) and video viewers, adolescents in clusters characterized by skating and video gaming, high overall sports participation with parents, using neighborhood recreation center, strict parental control of TV, reporting few activities overall, and being active in school were less likely to participate in a range of risky behaviors, ranging from an adjusted risk ratio (ARR) of 0.42 (outcome: illegal drug use, cluster: strict parental control of TV) to 0.88 (outcome: violence, cluster: sports with parents). Active teens were less likely to have low self-esteem (eg, adolescents engaging in sports with parents, ARR: 0.73) and more likely to have higher grades (eg, active in school, ARR: 1.20).

CONCLUSIONS. Participation in a range of PA-related behaviors, particularly those characterized by high parental sports/exercise involvement, was associated with favorable adolescent risk profiles. Adolescents with high TV/video viewership were less likely to have positive risk behavior outcomes. Enhancing opportunities for PA and sport may have a beneficial effect on leading adolescent risk behaviors.
Most American adolescents engage in suboptimal levels of physical activity (PA) and spend much of their time in sedentary pursuits, such as television (TV) viewing.\textsuperscript{1–3} Although much is known about the beneficial effects of PA in relation to health outcomes,\textsuperscript{4–8} little is known about the relationships among PA, sedentary behaviors, and an array of other adolescent risk behaviors. Many of these risk behaviors may be preventable (eg, accidents, particularly those involving alcohol,\textsuperscript{9–11} and sexually transmitted diseases\textsuperscript{12}) and yet are associated with the majority of adolescent deaths, injuries, and hospitalization. By better characterizing the associations between PA patterns and a broad range of these preventable risk behaviors, we may be better able to understand overall adolescent lifestyles, which include a variety of health-related risk behaviors, and ultimately enhance population-wide health promotion efforts targeting teenage populations.

Research has suggested that PA and sport participation is negatively associated with cigarette and marijuana intake,\textsuperscript{13–15} sexual intercourse,\textsuperscript{16,17} and positively associated with self-esteem\textsuperscript{18–21} and academic performance.\textsuperscript{22} However, although the multidimensional patterning of health behaviors has recently gained recognition (eg, \textsuperscript{23–27}), the previous literature in this area has focused on describing PA and/or sport participation as a discrete phenomenon rather than as a complex set of multidimensional behavioral characteristics that co-occur in important patterns.

Although PA and sedentary behavior may operate through different behavioral mechanisms,\textsuperscript{28} have different determinants,\textsuperscript{29} differentially track,\textsuperscript{3} and influence disease risk independently, these behaviors are likely correlated within individuals,\textsuperscript{30,31} and are thus best considered as co-occurring behaviors, rather than independent actions.\textsuperscript{28} Our previous research has used cluster analysis, a data-driven technique to identify mutually exclusive, homogeneous groups of individuals sharing numerous characteristics,\textsuperscript{32} to elucidate PA and sedentary behavior patterns in adolescence and better characterize these complex behavioral traits.\textsuperscript{21}

These PA-related behavior patterns may themselves be associated with important health outcomes. Understanding how these patterns are associated with other specific health behaviors can inform strategies aimed at promoting positive behavioral outcomes and reducing risky behaviors in adolescents. Using nationally representative data, this study investigates the association between PA and sedentary behavior patterns and (1) adolescent risk behaviors (truancy, cigarette smoking, sexual intercourse, delinquency, use of alcohol and other illegal drugs), (2) self-esteem, and (3) other weekly activities (work, academic performance, and sleep). In addition, these analyses of detailed activity patterns were contrasted with those using a dichotomous measure of achieving $\geq$5 weekly bouts of moderate-vigorous PA (MVPA).

METHODS

The National Longitudinal Study of Adolescent Health (Add Health) is a survey of youths, grades 7 to 12, that provides national representation of the U.S. middle and high school population in 1994–1995. Survey procedures described elsewhere\textsuperscript{33} were approved by the University of North Carolina Institutional Review Board. In wave I (1994–1995), $>$90 000 students completed in-school surveys, and 20 745 adolescents (and parents) then completed in-home surveys. Wave II (1996) included 14 738 wave I adolescents who had not graduated from high school, including dropouts. Participants who were severely disabled ($n = 132$), pregnant at $\geq$1 wave ($n = 160$), and/or Native American (as a result of small sample size, $n = 74$, after other exclusion criteria) were excluded. In addition, only those with nonmissing in-school and in-home wave I or II activity data were included (final sample: $n = 11 957$, 81% of the total Add Health wave I sample).

Measurement of PA and Sedentary Behavior

Daily PA (in categories of housework, hobbies, active play, sports, exercise) was assessed using standard 7-day recall questionnaire methodology relevant for epidemiologic studies.\textsuperscript{34} Described in detail elsewhere,\textsuperscript{29,35} Add Health surveys used various questions similar to those used and validated in other large-scale studies.\textsuperscript{34,36,37} Questions worded, “During the past week, how many times did you…,” allowed calculation of activity frequency (bouts per week) by metabolic equivalent (MET) value. MVPA was 5 to 8 METs (1 MET = resting metabolic rate).\textsuperscript{38} Overall MVPA frequency was summed to determine if individuals achieved $\geq$5 weekly bouts MVPA as an operational definition of meeting the Centers for Disease Control and Prevention/American College of Sports Medicine national recommendation.\textsuperscript{39}

Adolescents reported participation in school physical education (PE) (days/week) and school-based sports and academic clubs (number per year). For participants interviewed while school was not in session, PE frequency was imputed from mean values of students in the same grade and school ($n = 2814$). In addition, adolescents reported using neighborhood recreation centers and watching/playing TV/videos, video or computer games (hours/week). Adolescents reported playing a sport with parent(s) in the previous month and parent-regulated TV viewing.

PA and Sedentary Behavior Clusters

Cluster analysis (SAS FASTCLUS; Research Triangle Institute, Research Triangle Park, NC) has been used in previous research to identify a total of 7 behavior patterns using 16 PA and sedentary behavior-related vari-
ables collected in waves I and II of Add Health. The full process for development and validation of these clusters can be found in Nelson et al.23 The final cluster solution identified 7 robust patterns observed across numerous iterations of analyses representing nonoverlapping groups of adolescents sharing PA and sedentary behaviors and primarily characterized as follows:

Cluster 1: Adolescents have high frequency of TV/video viewing and video gaming; adolescents make decisions regarding TV viewing;

Cluster 2: Adolescents have high frequency of skating, skateboarding, bicycling, and video gaming;

Cluster 3: Adolescents play sports with parent(s); have high frequency of overall sports participation;

Cluster 4: Adolescents use neighborhood recreation centers; have high frequency of overall sport participation;

Cluster 5: Adolescents’ TV viewing is limited by parents; participate in moderate amount of school PE;

Cluster 6: Adolescents have control over TV viewing but choose to watch very little; report few activities overall; and

Cluster 7: Adolescents have high participation in school activities, including team and individual sports, academic clubs, and PE.

Adolescent Risk Behaviors
Other adolescent risk behaviors were measured by a variety of self-reported survey questions. Sexual intercourse was reported as a dichotomous measure indicating that the respondent has had sexual intercourse in the last year. Use of birth control was reported as a dichotomous measure of use any type of birth control by self or partner when respondent last had sexual intercourse. Delinquency was assessed by scales developed by Felson and Haynie40 for violence and property damage in the past year. Sequentially, 8 survey items were used to assess property offenses, including having painted graffiti, damaged other’s property, shoplifted from a store, stole something worth less than $50, stole something worth more than $50, burglarized a building, borrowed/stole a car without the owner’s permission, and sold drugs in the past year.

Cigarette use was measured by whether the respondent smoked ≥5 cigarettes during the last 30 days. Alcohol consumption was reported as a dichotomous measure of being drunk at least once and as being drunk more than 1 time per month in the past year. Drunk driving was a dichotomous response to the question “Have you driven while drunk” in the past year. Illegal drug use was measured by whether the respondent used marijuana more than 1 time per year and/or used other illegal drugs in the past year. Truancy was defined as having ≥5 unexcused absences from school in the past school year. Use of seatbelt (always, most of the time, sometimes, rarely, never) when driving or riding in a car was also reported.

All risk behaviors are self-reported at wave II, relative to the time period between waves I (1994–1995) and II (1996), eg, approximately within 1 year (unless otherwise noted). For reporting of intimate risk behaviors such as contraception, sexual intercourse, illicit behaviors, alcohol, drugs, tobacco, and delinquency, the Audio Computer Administered Self-Interview (CASI) was used to enhance privacy.

Self-Esteem
Self-esteem was measured using responses to 6 items modified from or similar to the Rosenberg Self-Esteem inventory, a measure of global self-esteem;41 and examined for scale reliability in Add Health.42 Self-esteem was dichotomized into a measure of “low” (below median) self-esteem as done by Shrier et al.42

Other Adolescent Behaviors
“Work” was assessed as working for pay outside of the home during the school year or summer for ≥15 hours/week. Academic grades were self-reported and dichotomized into a grade of “A” for math and English during the most recent grading period. Sleep was self-reported and dichotomized into ≥8 usual hours of sleep per night.

Measurement of Covariates
A combination of parent and adolescent in-home surveys provided data on household composition, nationality, and race/ethnicity. Race/ethnicity categorized Hispanics, non-Hispanic whites (referred to as “whites” hereafter), non-Hispanic blacks (“blacks”), and Asians. As indicators of socioeconomic status (SES), family income and parental education were used. Parental education described the highest education achieved for either parent. Income was reported in $1000 increments and imputed where missing (n = 1673) using parental occupation, family structure, and school community (similar to imputation methods of other national surveys).43,44

Statistical Analysis
Using regression analyses, the 7 activity-related clusters predicted the likelihood of engaging in other risk and nonrisk behaviors and self-esteem at wave II. A majority
of the binomial health behavior outcomes included here were not rare (ie, prevalence >10%). Although logistic regression is commonly used in health research, the odds ratios yielded by these analyses overestimate risk ratios (RRs) that are >1.0 (and underestimate those that are <1.0) when the outcome is not rare. Several alternative analytical methods are available; in these analyses, Poisson regression was used with robust variance generate estimates of the adjusted RR (ARR). All models are relative to the cluster representing high TV and video viewers (referent) and control for covariates (gender, age, parental education, race/ethnicity, household income). Analyses of self-esteem were conducted separately by gender as a result of gender differences in psychosocial determinants of PA.22,46–48 Analyses using clusters were contrasted with a dichotomous measure of achieving ≥5 MVPA bouts per week (per Gordon-Larsen et al)1 to comparatively assess the detailed cluster measures with a simple measure of MVPA. Analyses were conducted in Stata (Stata Corp, College Station, TX) controlling for survey design effects of multiple-stage cluster sampling.

RESULTS
The final analysis sample (male: n = 5979; female: n = 5978) was comprised of 70% white, 14% black, 11% Hispanic, and 4% Asian adolescents. Approximately 13% of participants’ parents had less than high school education, 32% graduated from high school, 28% had some college, and 27% had a college degree or higher. Mean household income was $45 000/year. Mean age at wave II was 15.8 (±11.6) years.

Adolescent PA Patterns and Adolescent Risk Behaviors
Independent of age, gender, race/ethnicity, and SES, clusters predicted a range of risk behaviors (Table 1). Relative to high TV/video viewers, the cluster of skaters/gamers was less likely to engage in the risk outcomes related to sex, cigarette smoking, alcohol, truancy, and failure to use a seatbelt. The cluster of adolescents engaging in sports with their parents was less likely to engage in risk outcomes related to sex, delinquency, smoking, alcohol (drunk at least once, only), drug use, truancy, and seatbelt use. Adolescents who use a community recreation center were less likely to smoke, use drugs, or be truancies. The cluster characterized by strict parental control of TV decisions was also less likely to engage in every category of risk behavior. Adolescents reporting few overall activities were less likely to engage in delinquency and to fail to wear seatbelts; they were, however, more likely to drive while drunk. The cluster of adolescents who were active in school was less likely to smoke cigarettes, be truant, and to fail to wear a seatbelt.

Adolescent PA Patterns and Self-Esteem
Independent of demographics and SES, activity clusters predicted the relative risk of low self-esteem (Table 2). Risk of low self-esteem for the total sample was lowest in the cluster of adolescents engaging in sports with their parents (ARR: 0.74; CI: 0.70–0.79) and was similar for the clusters of skaters/gamers (ARR: 0.83; CI: 0.78–0.89), those using a community recreation center (ARR: 0.80; CI: 0.80–0.90), and those active in school (ARR: 0.84; CI: 0.78–0.89). There was little variation in the relationship between PA patterns and self-esteem by gender.

Adolescent PA Patterns and Other Weekly Activities
Independent of demographics and SES, skater/gamers were more likely to work outside of the home, do housework, and sleep ≥8 hours per night (Table 3). The cluster of adolescents who engaged in sports with their parents were more likely to work outside of the home (particularly during the summer), do housework, achieve an “A” in math and English, and sleep ≥8 hours per night. The cluster of adolescents who used a community recreation center and those reporting few overall activities were more likely to work outside of the home. Adolescents characterized by strict parental control of TV decisions were more likely to do housework and sleep ≥8 hours per night, whereas the cluster of adolescents who were active in school were more likely to work for pay (particularly during the summer), to do housework, and to earn high grades.

Likelihood of Achieving ≥5 Weekly Bouts of MVPA and Other Adolescent Behaviors
Results using a dichotomous indicator of achieving ≥5 weekly bouts of MVPA, and adjusting for key sociodemographic indicators, were in a similar direction as those seen using the behavioral clusters, although lacking in detail (Table 4). Those who achieved ≥5 bouts per week of MVPA were less likely to (1) have sexual intercourse, including sex without birth control, (2) smoke cigarettes, (3) get drunk frequently or drive while drunk, (4) use illegal drugs other than marijuana, (5) be truant, or (6) fail to wear a seatbelt. However, they were more likely to engage in violence (ARR: 1.10; CI: 1.03–1.17). For the more favorable outcomes, those with ≥5 bouts per week MVPA were (1) less likely to have low self-esteem (ARR: 0.83; CI: 0.80–0.86), (2) more likely to work outside of the home during the summer (though less likely to work ≥15 hours/week during the school year) and more likely to engage in housework, (3) more likely to achieve grades of “A” in math and science, and (4) more likely to sleep ≥8 hours per night.

DISCUSSION
This nationally representative study provides evidence that engaging in a diverse range of physical activities is
## TABLE 1
ARRs Estimating the Association Between Adolescent PA Patterns and Adolescent Risk Behaviors

<table>
<thead>
<tr>
<th></th>
<th>Total Sample (n = 11,957), Mean (± SE)</th>
<th>TV/Video and Gaming (n = 2,494): Cluster 1</th>
<th>Skaters and Gamers (n = 1,119): Cluster 2</th>
<th>Sports With Parents (n = 1,681): Cluster 3</th>
<th>Uses Recreation Center (n = 1,309): Cluster 4</th>
<th>Limited TV Decisions (n = 1,522): Cluster 5</th>
<th>Reports Few Activities (n = 2,897): Cluster 6</th>
<th>Active in School (n = 935): Cluster 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Has had sexual intercourse</td>
<td>0.36 (± 0.017)</td>
<td>1.0</td>
<td>0.86 (0.78–0.94)</td>
<td>0.83 (0.76–0.91)</td>
<td>1.08 (1.01–1.16)</td>
<td>0.71 (0.64–0.79)</td>
<td>1.07 (1.00–1.13)</td>
<td>1.01 (1.02–1.11)</td>
</tr>
<tr>
<td>No birth control</td>
<td>0.07 (± 0.005)</td>
<td>1.0</td>
<td>0.74 (0.59–0.94)</td>
<td>0.70 (0.55–0.89)</td>
<td>0.83 (0.67–1.03)</td>
<td>0.73 (0.58–0.92)</td>
<td>1.09 (0.89–1.33)</td>
<td>0.96 (0.74–1.24)</td>
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<tr>
<td>Delinquency</td>
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<tr>
<td>Violence scale ≥ 11b</td>
<td>0.28 (± 0.009)</td>
<td>1.0</td>
<td>0.96 (0.87–1.05)</td>
<td>0.88 (0.80–0.97)</td>
<td>1.06 (0.95–1.17)</td>
<td>0.83 (0.75–0.92)</td>
<td>0.82 (0.73–0.91)</td>
<td>0.99 (0.88–1.12)</td>
</tr>
<tr>
<td>Property damage scale ≥ 11b</td>
<td>0.34 (± 0.009)</td>
<td>1.0</td>
<td>0.91 (0.83–1.01)</td>
<td>0.79 (0.73–0.86)</td>
<td>1.00 (0.89–1.13)</td>
<td>0.79 (0.73–0.86)</td>
<td>0.84 (0.77–0.91)</td>
<td>1.00 (0.90–1.10)</td>
</tr>
<tr>
<td>Smoked ≥ 5 cigarettes in last month</td>
<td>0.24 (± 0.013)</td>
<td>1.0</td>
<td>0.80 (0.71–0.91)</td>
<td>0.61 (0.54–0.69)</td>
<td>0.82 (0.71–0.95)</td>
<td>0.69 (0.62–0.78)</td>
<td>0.96 (0.89–1.04)</td>
<td>0.82 (0.71–0.95)</td>
</tr>
<tr>
<td>Alcohol</td>
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<tr>
<td>Has been drunk at least once</td>
<td>0.44 (± 0.014)</td>
<td>1.0</td>
<td>0.85 (0.77–0.93)</td>
<td>0.85 (0.78–0.93)</td>
<td>1.00 (0.91–1.10)</td>
<td>0.70 (0.64–0.77)</td>
<td>0.93 (0.86–1.01)</td>
<td>1.00 (0.90–1.10)</td>
</tr>
<tr>
<td>Drunk more than once per month</td>
<td>0.11 (± 0.008)</td>
<td>1.0</td>
<td>0.74 (0.60–0.92)</td>
<td>0.85 (0.71–1.02)</td>
<td>0.95 (0.76–1.19)</td>
<td>0.61 (0.50–0.75)</td>
<td>0.99 (0.86–1.16)</td>
<td>1.04 (0.80–1.33)</td>
</tr>
<tr>
<td>Driven while drunk</td>
<td>0.05 (± 0.005)</td>
<td>1.0</td>
<td>0.60 (0.40–0.90)</td>
<td>0.82 (0.61–1.10)</td>
<td>0.90 (0.68–1.21)</td>
<td>0.60 (0.42–0.85)</td>
<td>1.34 (1.09–1.64)</td>
<td>0.90 (0.65–1.24)</td>
</tr>
<tr>
<td>Drugs</td>
<td></td>
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<tr>
<td>Uses marijuana ≥ 1 time per week</td>
<td>0.07 (± 0.005)</td>
<td>1.0</td>
<td>0.75 (0.54–1.03)</td>
<td>0.52 (0.39–0.69)</td>
<td>0.77 (0.62–0.96)</td>
<td>0.66 (0.52–0.83)</td>
<td>0.97 (0.80–1.17)</td>
<td>0.90 (0.70–1.15)</td>
</tr>
<tr>
<td>Has used illegal drugs other than marijuana</td>
<td>0.03 (± 0.003)</td>
<td>1.0</td>
<td>0.68 (0.42–1.09)</td>
<td>0.55 (0.37–0.82)</td>
<td>0.56 (0.36–0.87)</td>
<td>0.42 (0.27–0.64)</td>
<td>0.89 (0.70–1.13)</td>
<td>0.77 (0.51–1.18)</td>
</tr>
<tr>
<td>Truant ≥ 5 times in last school year without an excuse</td>
<td>0.06 (± 0.005)</td>
<td>1.0</td>
<td>0.77 (0.60–0.98)</td>
<td>0.58 (0.46–0.74)</td>
<td>0.76 (0.62–0.95)</td>
<td>0.58 (0.45–0.75)</td>
<td>0.86 (0.72–1.02)</td>
<td>0.74 (0.56–0.98)</td>
</tr>
<tr>
<td>Does not always wear a seatbelt</td>
<td>0.49 (± 0.013)</td>
<td>1.0</td>
<td>0.86 (0.80–0.92)</td>
<td>0.82 (0.77–0.87)</td>
<td>0.97 (0.91–1.04)</td>
<td>0.91 (0.86–0.97)</td>
<td>0.95 (0.87–0.99)</td>
<td>0.88 (0.82–0.95)</td>
</tr>
</tbody>
</table>

a RRs were adjusted for age, gender, race/ethnicity, parental education, and household income.

b Per Felson and Haynie.40
These findings have important health implications because they can guide effective interventions aimed at coexisting health behaviors and overall lifestyle effects.

For example, the 2 clusters of adolescents characterized by (1) having limited decision-making related to TV and (2) engaging in sports with their parents were most associated with reductions in a wide range of risky behaviors (especially compared with adolescents with high TV/video viewing and video/computer gaming), thus emphasizing the important role of parental participation in regular activities, particularly in the realm of PA and sedentary behavior. The clusters of adolescents who (1) reported few activities, (2) were active in school, and (3) used a recreation center were associated with the reduction of some risky behaviors (compared with those with high TV/video viewership), although this finding was not entirely consistent. Higher low self-esteem was clear for the clusters of adolescents actively engaged in skating/gaming, playing sports with their parents, using a recreation center, and participating in school-based activities. Clearly, active lifestyles that revolve around a range of activities (excluding TV and other screen-based activities) have some positive associations with a broad

### Table 2

<table>
<thead>
<tr>
<th>Total Sample, Mean (± SE)</th>
<th>TV/Video and Gaming: Cluster 1</th>
<th>Skaters and Gamers: Cluster 2</th>
<th>Sports With Parents: Cluster 3</th>
<th>Uses Recreation Center: Cluster 4</th>
<th>Limited TV Decisions: Cluster 5</th>
<th>Reports Few Activities: Cluster 6</th>
<th>Active in School: Cluster 7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total sample</strong></td>
<td>0.56 (± 0.010)</td>
<td>1.0</td>
<td>0.83 (0.78–0.89)</td>
<td>0.74 (0.70–0.79)</td>
<td>0.85 (0.80–0.90)</td>
<td>0.96 (0.91–1.01)</td>
<td>1.00 (0.96–1.04)</td>
</tr>
<tr>
<td><strong>Males</strong></td>
<td>0.51 (± 0.011)</td>
<td>1.0</td>
<td>0.85 (0.79–0.93)</td>
<td>0.72 (0.66–0.78)</td>
<td>0.83 (0.76–0.89)</td>
<td>0.93 (0.86–1.01)</td>
<td>1.01 (0.94–1.09)</td>
</tr>
<tr>
<td><strong>Females</strong></td>
<td>0.60 (± 0.013)</td>
<td>1.0</td>
<td>0.79 (0.69–0.90)</td>
<td>0.76 (0.69–0.84)</td>
<td>0.88 (0.80–0.97)</td>
<td>0.98 (0.92–1.04)</td>
<td>1.01 (0.96–1.06)</td>
</tr>
</tbody>
</table>

### Table 3

<table>
<thead>
<tr>
<th>Mean (± SE)</th>
<th>TV/Video and Gaming: Cluster 1</th>
<th>Skaters and Gamers: Cluster 2</th>
<th>Sports With Parents: Cluster 3</th>
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<th>Limited TV Decisions: Cluster 5</th>
<th>Reports Few Activities: Cluster 6</th>
<th>Active in School: Cluster 7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Work</strong></td>
<td>0.59 (± 0.017)</td>
<td>1.0</td>
<td>1.15 (1.07–1.24)</td>
<td>1.15 (1.08–1.21)</td>
<td>1.18 (1.11–1.26)</td>
<td>1.03 (0.97–1.09)</td>
<td>1.09 (1.02–1.16)</td>
</tr>
<tr>
<td>Work ≥15 hours/week school year</td>
<td>0.25 (± 0.020)</td>
<td>1.0</td>
<td>0.98 (0.88–1.09)</td>
<td>0.86 (0.78–0.95)</td>
<td>1.09 (0.99–1.19)</td>
<td>0.92 (0.83–1.01)</td>
<td>1.14 (1.06–1.24)</td>
</tr>
<tr>
<td>Work ≥15 hours/week summer</td>
<td>0.45 (± 0.023)</td>
<td>1.0</td>
<td>1.03 (0.96–1.10)</td>
<td>1.07 (1.01–1.13)</td>
<td>1.16 (1.09–1.23)</td>
<td>0.93 (0.86–1.01)</td>
<td>1.12 (1.05–1.19)</td>
</tr>
<tr>
<td>Housework ≥5 times per wk</td>
<td>0.37 (± 0.008)</td>
<td>1.0</td>
<td>1.53 (1.39–1.69)</td>
<td>1.35 (1.22–1.50)</td>
<td>1.12 (1.00–1.25)</td>
<td>1.26 (1.16–1.37)</td>
<td>0.94 (0.86–1.02)</td>
</tr>
<tr>
<td>Academic grades</td>
<td>Most recent grade in math; A</td>
<td>0.28 (± 0.010)</td>
<td>1.0</td>
<td>1.03 (0.91–1.16)</td>
<td>1.23 (1.09–1.37)</td>
<td>1.11 (0.99–1.24)</td>
<td>1.02 (0.89–1.17)</td>
</tr>
<tr>
<td>Academic grades</td>
<td>Most recent grade in English; A</td>
<td>0.30 (± 0.012)</td>
<td>1.0</td>
<td>0.91 (0.80–1.05)</td>
<td>1.23 (1.09–1.38)</td>
<td>1.06 (0.95–1.19)</td>
<td>1.03 (0.92–1.14)</td>
</tr>
<tr>
<td>Sleeps ≥8 hours per night</td>
<td>0.59 (± 0.012)</td>
<td>1.0</td>
<td>1.11 (1.05–1.18)</td>
<td>1.18 (1.12–1.23)</td>
<td>0.98 (0.90–1.07)</td>
<td>1.08 (1.02–1.14)</td>
<td>0.92 (0.86–0.98)</td>
</tr>
</tbody>
</table>

**a** Per Shier et al.**b** RRs were adjusted for age, race/ethnicity, parental education, and household income.
array of favorable health-related risk behaviors. PA in adolescence is tied to a complex web of not only metabolic processes, but behavioral and social processes as well. These physical activities may contribute to reductions in other risky behaviors through a variety of mechanisms such as providing role models, peer networks, opportunities for teamwork, social development, problem-solving, and effective outlets for energy.

There has been work on associations between discrete measures of PA and risk behaviors in adolescents as well as research creating clusters of “healthy” and “unhealthy” habits in relation to a single PA measure in Belgians. Other work has examined relationships between substance use and sexual activity with combined categories of PA and sports participation in adolescents. Our earlier work has been the first to use cluster analyses to specifically examine these adolescent behaviors in a large, nationally representative cohort. The present work progresses to examine the association between these patterns and other health risk behaviors and suggests that involving an adolescent in an active lifestyle may reduce the likelihood that he or she will engage in unfavorable health-risk behaviors. In fact, this work shows that adolescents can be involved in a variety of different types of active lifestyles and yield similar benefits in terms of reduced risky behavior. For example, our previous research has shown that “alternative” activities such as the skating/gaming activity patterns are associated with very high levels of PA in adolescence. Although previous literature has used pattern analyses to examine the co-occurrence of multiple health behaviors (eg, PA, smoking, diet), few analyses have specifically explored the co-occurrence of PA- and sedentary-related factors. Our earlier work has been the first to use cluster analyses to specifically examine these adolescent behaviors in a large, nationally representative cohort. The present work progresses to examine the association between these patterns and other health risk behaviors and suggests that involving an adolescent in an active lifestyle may reduce the likelihood that he or she will engage in unfavorable health-risk behaviors. In fact, this work shows that adolescents can be involved in a variety of different types of active lifestyles and yield similar benefits in terms of reduced risky behavior. For example, our previous research has shown that “alternative” activities such as the skating/gaming activity patterns are associated with very high levels of PA in adolescence.

**TABLE 4**

<table>
<thead>
<tr>
<th>Risk Behaviors</th>
<th>&lt;5 Bouts per wk MVPA (n = 7971)</th>
<th>≥5 Bouts per wk MVPA (n = 3985)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has had sexual intercourse</td>
<td>1.0</td>
<td>0.95 (0.90–0.99)</td>
</tr>
<tr>
<td>Used no birth control in most recent sexual intercourse</td>
<td>1.0</td>
<td>0.87 (0.75–0.99)</td>
</tr>
<tr>
<td>Delinquency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Violence scale ≥1b</td>
<td>1.0</td>
<td>1.10 (1.03–1.17)</td>
</tr>
<tr>
<td>Property damage scale ≥1b</td>
<td>1.0</td>
<td>1.00 (0.94–1.06)</td>
</tr>
<tr>
<td>Smoked ≥5 cigarettes in last month</td>
<td>1.0</td>
<td>0.78 (0.72–0.84)</td>
</tr>
<tr>
<td>Alcohol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has been drunk at least once</td>
<td>1.0</td>
<td>0.97 (0.92–1.02)</td>
</tr>
<tr>
<td>Drunk more than once per month</td>
<td>1.0</td>
<td>0.84 (0.74–0.96)</td>
</tr>
<tr>
<td>Driven while drunk</td>
<td>1.0</td>
<td>0.72 (0.58–0.88)</td>
</tr>
<tr>
<td>Drugs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uses marijuana ≥1 time per week</td>
<td>1.0</td>
<td>0.85 (0.71–1.01)</td>
</tr>
<tr>
<td>Has used illegal drugs other than marijuana</td>
<td>1.0</td>
<td>0.73 (0.54–0.98)</td>
</tr>
<tr>
<td>Other risk behaviors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truant ≥5 times in last school year</td>
<td>1.0</td>
<td>0.76 (0.64–0.89)</td>
</tr>
<tr>
<td>Does not always wear a seatbelt</td>
<td>1.0</td>
<td>0.89 (0.86–0.93)</td>
</tr>
<tr>
<td>Self-esteem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low self-esteem</td>
<td>1.0</td>
<td>0.83 (0.80–0.86)</td>
</tr>
<tr>
<td>Other weekly activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work for pay outside of the home</td>
<td>1.0</td>
<td>1.07 (1.03–1.10)</td>
</tr>
<tr>
<td>Work ≥15 hours/week: school year</td>
<td>1.0</td>
<td>0.89 (0.83–0.95)</td>
</tr>
<tr>
<td>Work ≥15 hours/week: summer</td>
<td>1.0</td>
<td>1.04 (1.00–1.08)</td>
</tr>
<tr>
<td>Housework ≥5 times/week</td>
<td>1.0</td>
<td>1.26 (1.20–1.32)</td>
</tr>
<tr>
<td>Academic grades</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most recent grade in math: A</td>
<td>1.0</td>
<td>1.08 (1.01–1.15)</td>
</tr>
<tr>
<td>Most recent grade in English: A</td>
<td>1.0</td>
<td>1.06 (0.99–1.13)</td>
</tr>
<tr>
<td>Sleeps ≥8 hours/night</td>
<td>1.0</td>
<td>1.06 (1.03–1.10)</td>
</tr>
</tbody>
</table>

*R-Rs were adjusted for age, gender, race/ethnicity, parental education, and household income.

Per Felson and Haynie.
and truancy (compared with rates among high TV/video viewers). In addition, adolescents involved in a variety of physical activities do not report reduced rates of other necessary daily/weekly activities such as working for pay, doing housework, doing schoolwork, and/or sleeping.

Interpretation of this work is limited by several factors such as the use of self-reported behavioral measures in our analyses as well as the changing culture of adolescence and challenges to PA that have grown in the decade since this data were collected such as the proliferation of sedentary leisure opportunities. In addition, it is possible that, despite having a nationally representative sample, our exclusion criteria and the data missingness may have yielded an analysis sample that was not truly nationally representative in some respects. More in-depth analyses of the patterning and co-occurrence of health behaviors, including PA and sedentary behaviors is also warranted. Furthermore, the extent to which external factors (e.g., school and/or family environments) support active and healthful lifestyles patterns in adolescence is also important. Our findings suggest that many teen risk behaviors could be positively impacted by access to outlets for PA such as programs that provide resources and facilities for sport activities with parents, recreation centers, and school activities.

Burdette and Whitaker have called for attention to the benefits of PA beyond fitness and fatness and into the cognitive, social, and emotional realm. Although their work has focused on play in young children, Burdette and Whitaker’s work has clear relevance to the adolescent period. As we show in our results, encouragement of a wide range of activities has the potential for the reduction of an array of risky behaviors and the promotion of various positive behavioral outcomes. Effective activity promotion strategies may focus on determinants initiating shifts toward more healthful, sustainable overall behavior patterns rather than shifts focused on any single aspect of these patterns. Our findings highlight the ever-growing need to expand activity promotion efforts across the country, especially before this critical developmental period of adolescence. Additional effective activity promotion efforts are desperately needed in the school environment, as well as in noninstitutionalized environments such as the home and the community. Children and adolescents need to be exposed to a wide range of opportunities so that they can discover and have access to activities that are ultimately enjoyable and sustainable in the long-term.

This work provides important insight into targeting intervention strategies for risk behaviors. Although little research has examined patterns of activity-related behaviors, this issue is important in assessing overall lifestyle effects. Understanding the pattern of PA and sedentary behaviors in association with other dimensions of behavior provides critical information about protective health behaviors. It is clear that involvement in a range of PA and sedentary behaviors is associated with protective health behaviors, and that access to facilities and programs in support of parental involvement in PA and overall increases in PA participation may have positive benefits that extend well beyond weight and fitness.

ACKNOWLEDGMENTS

This work was funded by National Institute of Child Health and Human Development grants R01-HD39183, R01 HD041375, and K01 HD044263 and Robert Wood Johnson Foundation Active Living Research New Investigator Award 050752. This research uses data from Add Health, a program project designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris and funded by National Institute of Child Health and Human Development grant P01-HD31921 with cooperative funding from 17 other agencies.

Special acknowledgment is due Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Persons interested in obtaining data files from Add Health should contact Add Health (Carolina Population Center, 123 W Franklin St, Chapel Hill, NC 27516--2524; www.cpc.unc.edu/addhealth/contract.html).

REFERENCES


**THROUGH CHARITIES, DRUG MAKERS HELP PEOPLE—AND THEMSELVES**

“Mr. Kuhn, 52, who suffers from hemophilia, co-founded Patient Services in 1989 while working as a counselor at a Richmond, VA, hospital. He saw hemophiliacs struggling to pay rising premiums to maintain insurance coverage for Factor VIII, the blood-clotting protein they need to stay alive. The drug today costs about $100,000 a year. Mr. Kuhn approached companies making the drug for a donation to help patients pay premiums. ‘Our argument was, if you donate $50,000, we can keep these people insured and provide revenue for you,’ he says. Baxter and Armour Pharmaceutical Co., two of several companies that made the drug, each contributed $50,000 the first year. The program has grown steadily, now assisting people with 19 different chronic illnesses. Last year, Patient Services raised $22 million, helping nearly 20,000 patients pay premiums and co-payments. About $17 million of that came from 13 drug companies. When he makes his pitch to companies, Mr. Kuhn says he emphasized that they can make money by donating. During a 2003 visit to Genzyme, for instance, he brought along a chart showing how a donation would affect a patient who needs the company’s drug, Fabrazyme. Genzyme says the drug typically costs between $175,000 and $200,000 a year. The chart showed that if Genzyme donated $5,400 to cover the patient’s premium for a year, it would bring in about $185,000 by getting its drug paid for by the patient’s insurance. Genzyme signed up. ‘We wanted to do whatever we could to make sure all patients who needed our treatment could get it,’ says a spokesman for the company, based in Cambridge, Mass. He declined to say how much Genzyme donates to [Patient Services].”

Anand G. *Wall Street Journal.* December 2, 2005

Noted by JFL, MD
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