The Relation Between Physical Activity and Mental Health Among Hispanic and Non-Hispanic White Adolescents

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Objective: To assess the relation of physical activity (PA) with feelings of sadness and suicidal thoughts and behaviors among Hispanic and non-Hispanic white adolescent boys and girls.

Design: Cross-sectional study using a modified 2001 Youth Risk Behavior Survey.

Participants: One thousand eight hundred seventy Hispanic and non-Hispanic white adolescents, aged 14 to 18 years, attending high school in Nueces County, Texas.

Main Outcome Measure: Logistic regression analysis was used to assess the relation between PA, including moderate and vigorous PAs, strength and toning, total PA, physical education class, and participation in team sports, and the dependent variables feelings of sadness and considering, planning, and attempting suicide.

Results: More boys reported participating in PA than girls (P<.001), and more girls than boys reported feelings of sadness and considering and planning suicide (P<.001). Greater attendance in physical education class was inversely related to feelings of sadness (odds ratio [OR], 0.80 [95% confidence interval (CI), 0.68-0.94]); participation in more total PA sessions per week was associated with a lower risk of considering suicide (OR, 0.72 [95% CI, 0.65-0.79]); and higher levels of vigorous PA (OR, 0.73 [95% CI, 0.57-0.93]), total PA (OR, 0.65 [95% CI, 0.48-0.87]), and strength and toning activity (OR, 0.64 [95% CI, 0.42-0.99]) were associated with a lower risk of planning suicide.

Conclusions: These findings are consistent with a beneficial effect of PA on feelings of sadness and suicidal behaviors in Hispanic and non-Hispanic white boys and girls. Physical activity may be considered as part of an intervention strategy to improve adolescent health as a whole.


MENTAL HEALTH DISTURBANCES, including non-clinical depression, anxiety traits, feelings of sadness, or temporary mood disorders, are associated with morbidity and mortality in the adolescent population. The prevalence of mental health disturbances among children and adolescents remains significantly high. The 2001 Centers for Disease Control and Prevention Youth Risk Behavior Survey (YRBS) indicates that 28.3% of US high school students felt sad or hopeless enough to discontinue doing some usual activities. Another study reported that 21% of US children aged 9 to 17 years possess at least 1 diagnosable mental or addictive disorder associated with minimum functional impairment. Approximately 5% of all 9- to 17-year-olds have been diagnosed as having fully developed chronic depression, which is associated with extreme functional impairment. Furthermore, the use of prescription psychotropic medication, particularly selective serotonin reuptake inhibitors and other antidepressant drugs, progressively increased between 1995 and 1999 by 62% and 195%, respectively, among employer-insured children and adolescents.

Diagnosed mood disorders significantly increase the risk of suicide. Among students who completed the YRBS, 19% seriously considered attempting suicide, 14.8% made a suicide plan, and 8.8% attempted suicide. The age-specific mortality rate for suicide among 15- to 19-year-olds in 2000 was 8.2 per 100000, which, although lower than in 1990, remains the third leading cause of death in this age group.

The detrimental consequences arising from mental health disorders and suicide strongly imply a need to identify strategies to reduce this public health problem. Participation in physical activity (PA) has been associated with positive mood, greater self-esteem, and greater physical and psychological well-being. Academic grade
performance is positively associated with participation in PA, and may also enhance self-esteem. Activity may imbue adolescents with energy, as sedentary individuals report fatigue, perhaps a consequence of poor physical fitness. Additionally, participation in PA and team sports activities may provide adolescents with a social network that tends to support and protect them from depression. Therefore, PA has been suggested as a potential protective agent that may reduce the prevalence of mental health disturbances and suicidal behaviors among adults and adolescents. Prior studies in adolescents have not, however, examined these relations in large samples of adolescents or in Hispanic youth. The present study explores the hypothesis that PA, physical education class (PE), and participation in team sports are inversely associated with feelings of sadness, suicidal thoughts, and suicidal behaviors among a large sample of Hispanic and non-Hispanic white girls and boys living in Nueces County, Texas.

**METHODS**

**STUDY DESIGN**

This study analyzed data from the Healthy Youth/Healthy Adults Study, a cross-sectional study conducted by the Corpus Christi-Nueces County Health District in Corpus-Christi, Tex, in collaboration with the University of Minnesota School of Public Health in Minneapolis. The primary goals of the Healthy Youth/Healthy Adults Study included determining the prevalence of overweight and obesity among adolescents attending high school in Nueces County and administering a modified YRBS questionnaire to determine the prevalence of risky health behaviors among these adolescents. The study protocol was approved by the Corpus Christi-Nueces County Health District internal review board and the University of Minnesota human subjects committee. Consent was obtained from all children and their parents/guardians.

**POPULATION**

The target population was students in Nueces County high schools. A weighted sampling scheme was implemented to include a larger sample from smaller, rural schools. Twelve of 25 schools in Nueces County were randomly selected to participate in the study. A convenience sample of classrooms was selected from courses required for 9th and 10th grade students.

The study sample was 1870 students who completed the survey of 2000, mostly 9th and 10th graders in these classes (93.5% response rate), including 1344 Hispanic students (71.9%), 406 non-Hispanic white students (21.7%), 90 African American students (4.8%), 17 Pacific Islander students (0.9%), 9 Asian students (0.5%), and 4 American Indian students (0.2%). Because of the small numbers of other race groups (n = 120), only Hispanic and non-Hispanic white students were analyzed. Other exclusions were sex not reported (n = 4), surveys incomplete (n = 26), and height and weight measurements missing (n = 329); 1391 students (74.3%) were included in the analysis.

**MEASURES**

**Body Mass Index**

Weight was measured without shoes to the nearest quarter pound using a physician balance scale. Height was measured to the nearest quarter inch using a physician portable scale stadiometer. Body mass index was calculated as weight in kilograms/height in meters squared.

**Physical Activity Questions**

- **Vigorous Activity:** On how many of the past 7 days did you exercise or participate in physical activity for at least 20 minutes that made you sweat and breathe hard, such as basketball, soccer, running, swimming laps, fast bicycling, fast dancing, or similar aerobic activities?
- **Moderate Activity:** On how many of the past 7 days did you participate in physical activity for at least 30 minutes that did not make you sweat or breathe hard, such as fast walking, slow bicycling, skating, pushing a lawn mower, or mopping floors?
- **Strengthening and Toning:** On how many of the past 7 days did you do exercises to strengthen or tone your muscles, such as push-ups, sit-ups, or weight lifting?
- **Physical Education:** In an average week when you are in school, on how many days do you go to physical education classes?
- **Team Sports:** During the past 12 months, on how many sports teams did you play? (Include any teams run by your school or community groups.)

**Mental Health Questions**

- **Feelings of Sadness:** During the past 12 months, did you ever feel so sad or hopeless almost every day for 2 weeks or more in a row that you stopped doing some usual activities?
- **Considering Suicide:** During the past 12 months, did you ever seriously consider attempting suicide?
- **Planning Suicide:** During the past 12 months, did you make a plan about how you would attempt suicide?
- **Attempting Suicide:** During the past 12 months, how many times did you actually attempt suicide?

**Youth Risk Behavior Survey**

Trained personnel administered a modified 2001 YRBS self-report instrument to students during regular school hours. A subset of YRBS data was used in the analyses, including demographic information (age, sex, and race/ethnicity), grades achieved in school (A-F), and smoking and drinking habits in the past 30 days (yes or no). Students were asked 5 questions about participation in PA and 4 questions about feelings of sadness and suicide behaviors (Figure).

**Physical Activity**

Frequency of moderate and vigorous PAs, strength and toning, participation in PE, and participation in sports teams were reported. Moderate PA, total PA, PE, and sports teams were grouped dichotomously, while vigorous PA and strength and toning activity were grouped into tertiles.

The variable “total PA sessions” was created to differentiate students who are active in some form on at least 6 days of the week vs students who are not. This variable combined moderate, vigorous, and strength and toning activity sessions for 1 week and was then grouped into “0 to 5 sessions” and “6 to 21 sessions.” The rationale for dichotomizing moderate and total PA was for statistical power, as few students reported moderate activity more than 2 days per week and few students reported more than 10 sessions of total PA per week.

**Mental Health**

Responses to the feelings of sadness and suicidal thoughts about considering or planning suicide were answered yes or no. However, responses to the last suicide question about attempting to commit suicide were grouped into 0, 1, 2 to 3, 4 to 5, or 6.
times. Because few students answered with multiple suicide attempts, subjects were divided into “ever attempted” and “never attempted.”

STATISTICAL ANALYSIS

Stata 7.0 (Stata Corporation, College Station, Tex) was used, taking the 2-stage sampling design into account. Two-tailed t tests were used to determine variation in the means of continuous variables. The Mantel-Haenszel χ² statistic was used to test for variation in the distributions of categorical variables. Logistic regression analysis was used to determine the relation between each PA variable and risk of feelings of sadness, considering suicide, planning suicide, or attempting suicide. Models were adjusted for confounding factors including age, sex, ethnicity, body mass index, school, classroom, smoking, drinking, and grades in school. The variables smoking, drinking, and grades in school were included in the regression models because previous studies have shown correlations with PA, feelings of sadness, and depression.10-12,15,16,20,21 Interactions between PA, sex, and ethnicity were tested.

RESULTS

DESCRIPTIVE STATISTICS

Students’ ages ranged from 14 to 18 years (mean, 15.4 years), with no difference by sex or race (Table 1). Seven hundred thirty-one subjects (53%) in the study population were male, and 1077 (77%) were Hispanic. Hispanic students had greater body mass index and received lower grades in school than did non-Hispanic white students (P<.01). More non-Hispanic white boys reported drinking alcohol than Hispanic boys (91 [56%] of 165 vs 243 [44%] of 566; P=.007), while more non-Hispanic white girls reported smoking cigarettes than Hispanic girls (52 [35%] of 149 vs 125 [25%] of 511; P=.01). Four hundred fifty-nine students (about 33%) reported using marijuana, cocaine, or inhalants, which was not different across sex or ethnicity (data not shown).

In Table 1, more boys than girls reported engaging in the highest levels of moderate PA (304 [44%] of 731 vs 205 [33%] of 660; P<.001), vigorous PA (328 [47%] of 731 vs 214 [34%] of 660; P<.001), strength and toning (228 [33%] of 731 vs 135 [21%] of 660; P<.001), and total PA (528 [72%] of 731 vs 386 [58%] of 660; P<.001), as well as participating in more days of PE each week (309 [45%] of 731 vs 235 [38%] of 660; P=.006) and team sports (415 [60%] of 731 vs 316 [50%] of 660; P<.001). Non-Hispanic white girls reported greater prevalence of frequent moderate PA than Hispanic girls (66 [44%] of 149 vs 139 [29%] of 511; P<.001). The frequency of vigorous PA among non-Hispanic white and Hispanic boys and girls was not different. More non-Hispanic white girls than Hispanic girls reported participating in team sports (88 [60%] of 149 vs 228 [48%] of 511; P=.01); there was no ethnic difference in boys.

In Table 2, more Hispanic girls reported feeling sad or hopeless than non-Hispanic white girls (205 [40%] of 511 vs 48 [32%] of 149; P=.08), and more non-Hispanic white boys reported considering suicide than Hispanic boys (28 [17%] of 165 vs 58 [10%] of 566; P=.02). Otherwise, there were no other racial differences among girls or boys for these characteristics. Dif-
ferences did exist between sexes, as more girls than boys reported feeling sad or hopeless (253 [38%] of 660 vs 164 [23%] of 731; \( P < .001 \)), considering suicide (153 [23%] of 660 vs 86 [12%] of 731; \( P < .001 \)), and planning suicide (109 [17%] of 660 vs 69 [10%] of 731; \( P < .001 \)). There was no difference between sexes for attempting suicide.

ASSOCIATIONS BETWEEN PA AND MENTAL HEALTH VARIABLES

No significant interactions were found between PA variables and sex or ethnicity. As shown in Table 3, students who participated in 3 to 5 days per week of PE were less likely to feel sad than those participating in PE 0 to 2 days per week, after controlling for sex, ethnicity, age, school, classroom, body mass index, smoking, drinking, and grades earned in school.

Table 2. Feelings of Sadness and Suicidal Behaviors Among Adolescents According to Sex and Ethnicity*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All Girls (n = 660)</th>
<th>All Boys (n = 731)</th>
<th>Hispanic Girls (n = 511)</th>
<th>Non-Hispanic White Girls (n = 149)</th>
<th>Hispanic Boys (n = 566)</th>
<th>Non-Hispanic White Boys (n = 165)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felt sad or hopeless</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>253 (38)</td>
<td>164 (23)†</td>
<td>205 (40)</td>
<td>48 (32)</td>
<td>129 (23)</td>
<td>35 (21)</td>
</tr>
<tr>
<td>No</td>
<td>406 (62)</td>
<td>560 (77)†</td>
<td>305 (60)</td>
<td>101 (68)</td>
<td>430 (77)</td>
<td>130 (79)</td>
</tr>
<tr>
<td>Considered suicide</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>153 (23)</td>
<td>86 (12)†</td>
<td>120 (23.5)</td>
<td>33 (22)</td>
<td>58 (10)</td>
<td>28 (17)†</td>
</tr>
<tr>
<td>No</td>
<td>507 (77)</td>
<td>641 (88)†</td>
<td>391 (76.5)</td>
<td>116 (78)</td>
<td>506 (90)</td>
<td>135 (83)†</td>
</tr>
<tr>
<td>Planned suicide</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>109 (17)</td>
<td>69 (10)†</td>
<td>86 (17)</td>
<td>23 (16)</td>
<td>50 (9)</td>
<td>19 (12)</td>
</tr>
<tr>
<td>No</td>
<td>548 (83)</td>
<td>656 (90)†</td>
<td>424 (83)</td>
<td>124 (84)</td>
<td>511 (91)</td>
<td>145 (88)</td>
</tr>
<tr>
<td>Attempted suicide</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>109 (16)</td>
<td>101 (14)</td>
<td>86 (17)</td>
<td>23 (16)</td>
<td>77 (14)</td>
<td>24 (14)</td>
</tr>
<tr>
<td>No</td>
<td>551 (84)</td>
<td>630 (86)</td>
<td>425 (83)</td>
<td>126 (84)</td>
<td>489 (86)</td>
<td>141 (86)</td>
</tr>
</tbody>
</table>

*Values are expressed as number (percentage) of students.
†\( P < .001 \).
‡\( P < .05 \).

Table 3. Adjusted Odds Ratios of the Risk of Sadness, Considering Suicide, and Planning Suicide Among Hispanic and Non-Hispanic White Adolescents Participating in Physical Activity*

<table>
<thead>
<tr>
<th>Physical Activity</th>
<th>Felt Sad</th>
<th>Considered Suicide</th>
<th>Planned Suicide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate physical activity, d/wk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>3-7</td>
<td>0.83 (0.60-1.15)</td>
<td>0.89 (0.65-1.21)</td>
<td>0.88 (0.57-1.34)</td>
</tr>
<tr>
<td>Vigorous physical activity, d/wk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>2-4</td>
<td>1.10 (0.76-1.59)</td>
<td>0.92 (0.57-1.51)</td>
<td>0.62 (0.39-0.99)</td>
</tr>
<tr>
<td>5-7</td>
<td>1.01 (0.75-1.35)</td>
<td>0.81 (0.59-1.11)</td>
<td>0.73 (0.57-0.93)</td>
</tr>
<tr>
<td>Strength and toning activity, d/wk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>2-3</td>
<td>0.90 (0.56-1.46)</td>
<td>0.85 (0.66-1.10)</td>
<td>0.56 (0.37-0.84)</td>
</tr>
<tr>
<td>4-7</td>
<td>0.88 (0.58-1.33)</td>
<td>0.79 (0.55-1.12)</td>
<td>0.64 (0.42-0.99)</td>
</tr>
<tr>
<td>Total physical activity, sessions/wk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-5</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>6-21</td>
<td>0.94 (0.76-1.16)</td>
<td>0.72 (0.65-0.79)</td>
<td>0.65 (0.48-0.87)</td>
</tr>
<tr>
<td>Physical education class, d/wk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>3-5</td>
<td>0.80 (0.68-0.94)</td>
<td>0.75 (0.53-1.07)</td>
<td>0.72 (0.47-1.08)</td>
</tr>
<tr>
<td>Sports team participation, No. of teams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>≥1</td>
<td>0.92 (0.66-1.29)</td>
<td>0.75 (0.54-1.06)</td>
<td>0.62 (0.34-1.15)</td>
</tr>
</tbody>
</table>

*Values are expressed as odds ratio (95% confidence interval). Odds ratios were adjusted for age, race, sex, school, classroom, body mass index, smoking, drinking, and grades earned in school.
Physical activity behaviors were inversely associated with feelings of sadness and considering and planning suicide among Hispanic and non-Hispanic white students attending high school in Nueces County. High school students attending more PE sessions per week were less likely to report feelings of sadness. Participation in a greater number of total PA sessions was significantly associated with a lower risk of considering suicide, and higher levels of vigorous PA, strength and toning activity, and total PA were all associated with a decreased risk of planning suicide.

Much evidence supports an inverse association between PA and mental health behaviors in adults and adolescents, including greater self-esteem and psychological well-being.8-14,18,19,22-25 One cross-sectional study found that adolescents who participate in sports 2 to 3 times per week and belong to a sports club or adolescents who participate in sports every day were less likely to attempt suicide than those who participate in sports once a week or never.10 Another study conducted among high school students demonstrated associations between suicide risk and solitary activities, including watching television alone, time spent alone other than watching television, and having nothing to do for more than 1 hour; however, no association between athletic involvement and risk for suicide was found.22 Moderate sport involvement was associated with lower depression scores,23 and vigorous sport and recreational activity displayed an independent but weak association with positive emotional well-being.24

We observed no relation between PAs and risk of attempting suicide in Hispanic and non-Hispanic white adolescents. However, Unger27 reported an inverse association between participation in PA, along with sports team participation, and suicidal thoughts and behaviors among 9th through 12th grade boys but not girls. The study revealed that girls who exercised 6 to 7 days per week and did not participate in team sports were at the greatest risk of suicidal behaviors, while girls who participated in team sports in addition to exercising most frequently were also at a higher risk of reporting suicidal behaviors. The author of this study suggested that these results may be owing to a widespread perception of overweight and negative body image among adolescent girls who then exercise excessively to lose weight. Girls with this perception may then have poor self-esteem that may lead to depression or suicidal behaviors. Brown and Blanton17 also showed that college-aged women who were vigorously and moderately active were more likely to report suicidal behaviors than women who were not active. The reason for the lack of association between PA and attempted suicide in the current study is unclear. It is possible that the ethnic distribution of this study population may be a factor, because PA and suicide attempts may not have the same meaning in Hispanic girls or boys as they do in non-Hispanic white girls or boys or in populations with different ethnic distributions; the lack of ethnic differences in the mental health associations in this study may have resulted from the small number of non-Hispanic white students. National survey data show lower rates of depression and suicide in Mexican Americans than in non-Hispanic white adults.26

Another important finding of this study was the association between PE participation and a lower risk of sadness. This is of particular public health interest given that many schools are currently cutting back on PE funding, and many schools do not require PE after the 8th grade. To date, no other studies have been published that show an association between PE and feelings of sadness and suicidal behaviors, especially among Hispanic adolescents. The results of this study suggest that PE may be beneficial in decreasing the risk of sadness and suicidal behaviors among 9th and 10th grade students. Conversely, adolescents with fewer mental health problems may be more likely to seek out and engage in various forms of PA. However, causality cannot be inferred because temporality between exposure and outcome cannot be determined in this cross-sectional study design. Nevertheless, intervention studies have shown that participation in PA reduces anxiety and depression in adolescents.8,12-14 This study was also not designed to measure the quality of the PE lessons. One cannot overlook the fact that the content of PE lessons has been shown to increase PA levels27 and may affect mental health outcomes as well. Additionally, although the state of Texas requires that students complete 3 semesters of PE meeting 5 days per week prior to high school graduation,28 we cannot differentiate in this study between the students who were enrolled in PE to fulfill a requirement or enrolled because they voluntarily elected to take it.

Strengths of this study include the examination of several PA measures. The majority of studies on this topic focus mainly on sports involvement or vigorous PA as an indicator for PA behaviors; however, PA embraces much more than just sports involvement or vigorous activity. The present study addresses this by examining participation in moderate and vigorous PA, strength and toning activity, total PA, PE, and team sports. This study also provides insight into a predominantly Hispanic population (77%). To date, no other studies have looked at the associations of PA with sadness and suicide behaviors in a large Hispanic or other minority population. In addition, weight and height were not based on self-report but measured by trained staff.

The associations observed in the present study should be interpreted with caution. Because this study was cross-
Feelings of sadness and suicidal behaviors are components of mental health disturbances that contribute to morbidity and mortality in the adolescent population. Because feelings of sadness and suicidal behaviors among adolescents remain high, an important public health goal is to identify strategies or effective means to prevent and reduce the prevalence of these behaviors. This study reports the relationship of a variety of PAs with sadness and suicidal behaviors among a large sample of Hispanic and non-Hispanic white adolescents. The results suggest that PA may assist in reducing feelings of sadness and other mental health disturbances in a predominantly Hispanic population.

sectional, it is impossible to determine the temporal relationship between PA and feelings of sadness and suicidal behaviors. Also, because the responses were based on self-report, it is possible that some respondents may have over-reported or underreported PA or sadness and suicidal behaviors in an effort to provide more "socially desirable" answers. Additionally, the YRBS instrument may not be as precise as other methods used to measure PA or mental health parameters, including pedometers, doubly labeled water, or the Centers for Epidemiologic Studies Depression Scale. Furthermore, the validity and reliability of the YRBS have not been verified in a predominantly Hispanic population. However, within the limitations of the study design, the results of this study reveal an interesting and potentially important relationship between PA behavior with sadness and suicidal intentions. It is possible that PAs often take place with other peers and thus increase social exposure and self-esteem. Other mechanisms by which PA may affect mental health or well-being include positive physiological responses from endorphin and/or monoamine production.

CONCLUSION

The results of the present study suggest that higher levels of PA is one factor that is associated with a decreased risk of sadness and suicidal intentions among Hispanic and non-Hispanic white adolescents living in Nueces County. Promotion of PA may be a useful part of intervention programs that include the reinforcement of other protective factors such as efficient social skills or a high self-esteem and aim at improving adolescents' health as a whole. Thus, future studies should examine the effects of a global health-promoting approach on the prevalence of sadness and suicidal thoughts and behaviors among adolescents.

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REFERENCES