High School Sports Participation and Mental Health Outcomes: Do Girls Benefit More?

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ABSTRACT

Many American teenagers suffer from mental illnesses, but participating in organized sports is a promising intervention to improve adolescents' mental well-being. This paper serves to examine the relationship between high school sports participation and adolescents' mental well-being by using regression and instrumental variable analyses. The data are from a nationally representative survey of high school students in the United States.. Findings suggest that the physical and social aspects of sports participation benefits a number of mental health outcomes (e.g., sadness/hopelessness, contemplating suicide, ability to concentrate) and for certain outcomes these benefits may be greater for female students. These findings are discussed in the context of declining sports participation rates among U.S. high school students; school policy makers could implement more team-based extracurricular activities to promote the mental health of students in U.S. high schools.

KEYWORDS

Sports participation, mental health, team sports, gender

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INTRODUCTION

Adolescence is a time of turbulence for most American youth. While it is normal to feel a variation in emotions during this developmental period, more several mental health issues can also manifest during this time, severely diminishing students' quality of life or even threatening their lives.[1] [2][3] Suicide is a highly prevalent cause of death among American teenagers, and mental illnesses also tend to carry over into adulthood, which signals the importance of early prevention.[4] [5]

Sports participation is a potential strategy for improving adolescents' mental health outcomes, and since most high schools have athletics programs, sports participation is a widely accessible mental health intervention. In addition to having better physical health, high school students who participate in sports teams demonstrate stronger academic, socializing, and psychological abilities.[6] They also tend to perform better in areas such as time management, leadership, teamwork, and self-confidence.[7] Furthermore, studies have shown that sports participation in high school can have a profound positive impact in adult life because high school athletes tend to continue physical activities long after graduation.[8] Although past research suggests that sports participation supports adolescents' mental health, the precise reasons for this benefit are not entirely. Research studies that clarify how and for whom sports improves mental health outcomes would offer guidance in designing high school athletics programs so that they provide the utmost benefit to students' well-being.

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[1] "Child and Adolescent Mental Health," National Institute of Mental Health, accessed August 16, 2020, https://www.nimh.nih.gov/health/topics/child-and-adolescent-mental-health/index.shtml.

[2] "Child and Adolescent," National Institute of Mental Health.

[3] "Adolescent Mental Health Basics," U.S. Department of Health & Human Services, last modified May 14, 2020, accessed August 16, 2020, https://www.hhs.gov/ash/oah/adolescent-development/mental-health/adolescent-mental-health-basics/index.html.

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[5] "Suicidal Behavior," MentalHealth.gov, last modified February 26, 2018, accessed August 16, 2020, https://www.mentalhealth.gov/what-to-look-for/suicidal-behavior.

[6] Randy Boyes et al., "Gender-specific Associations Between Involvement in Team Sport Culture and Canadian Adolescents' Substance-use Behavior," Science Direct, last modified December 2017, accessed June 28, 2020, https://www.sciencedirect.com/science/article/pii/S2352827317301398?via%3Dihub.

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[8] Steve Amaro, "Participation in High School Athletics Has Long-lasting Benefits," National Federation of State High School Associations, last modified January 22, 2020, accessed June 28, 2020, https://www.nfhs.org/articles/participation-in-high-school-athletics-has-long-lasting-benefits/.

LITERATURE REVIEW

Previous studies have generally found that students' sports participation is linked to better mental health outcomes. For example, organized sports participation is shown to decrease the risk of anxiety, depression, and the feeling of hopelessness.[9] It is thought that students' participation in team sports equips them to better handle their stress, frustration, and depression by releasing these emotions through athletic practices. [10] There is also evidence supporting that sports participation fosters stronger attachment with the school and better physical well-being, thus resulting in high self-esteem, which is a key indicator of future success.[11] Moreover, a longer time of involvement in sports teams can offer even more mental health benefits. A longitudinal study found that " adolescents who participated in team sports for a longer period of time reported lower depressive symptoms in early adulthood.[12]

There are a variety of possibilities for why participation in sports could benefit mental health. For one, simply being physically active can have a positive effect on one's mental health. A previous study concluded that physical activity can improve one's mood; people reported feeling "more content, more awake and calmer"[13] after being physically active as opposed to inactive. Exercising also decreases stress and enhances overall cognitive function. Studies have shown that physical activity can provide energy, improve alertness, and help concentrate. Exercising reduces stress by prompting the brain to produce endorphins, which are chemicals that can reduce stress, produce euphoria and improve one's ability to sleep.[14] At little as five minutes of aerobic exercise can produce anti-anxiety effects.[15] In addition, although the level of

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[9] Kathleen E. Miller et al., "Gender and Racial/Ethnic Differences in Predicting Adolescent Sexual Risk: Athletic Participation versus Exercise," Journal of Health and Social Behavior 43, no. 4 (2002): 438, https://doi.org/10.2307/3090236.

[10] Jhon Guarin, "The Effect of Team Sports on Mental Health in Adolescents" (master's thesis, State University of New York, 2018), 7, accessed August 21, 2020, https://digitalcommons.brockport.edu/cgi/viewcontent.cgi?article=1065&context=pes_synthesis.

[11] Allison J. Tracy and Sumru Erkut, "Gender and Race Patterns in the Pathways from Sport Participation to Self-Esteem," Sociological Perspectives 45, no. 4 (2002): 461, https://doi.org/10.1525/sop.2002.45.4.445.

[12] Guarin, "The Effect," 18.

[13] "How to Look After Your Mental Health Using Exercise," Mental Health Foundation, accessed September 3, 2020, https://www.mentalhealth.org.uk/publications/how-to-using-exercise#:~:text=Participation%20in%20regular%20physical%20activity,people%20experiencing%20mental%20health%20problems.

[14] "Physical Activity Reduces Stress," Anxiety and Depression Association of America, accessed September 3, 2020, https://adaa.org/understanding-anxiety/related-illnesses/other-related-conditions/stress/physical-activity-reduces-st#:~:text=Exercise%20and%20other%20physical%20activity,your%20body%20to%20produce%20endorphins.

[15] "Physical Activity," Anxiety and Depression Association of America.

the "stress hormone" cortisol rises during exercising for one's body is under pressure, regular exercising can diminish that effect and reduce subsequent stress.[16]

In addition to the biological effects of exercise, the social aspects of sports participation plays a role in improving mental health. Past scholars have argued that while sports can allow adolescents to ameliorate their problems, this mechanism is the most effective when one is on a team.[17] The community aspect of sports participation can promote the feelings of comfort and acceptance, thus reducing negative emotions such as insecurity. On the contrary, the study found that participating in individual sports is less effective in reducing anxiety and depression. Another longitudinal study of students from grade 4 to 7 suggests that participation in team-based extracurricular activities, not limited to sports, can have mental health benefits, which mostly come from the sense of belonging.[18] Overall, these findings suggest the possibility that the social features of high school sports support mental health in ways that would exceed the benefits of exercise alone, but this possibility has not been rigorously investigated by research.

However, sports participation may also lead to risky behaviors, which might, in turn, negatively affect teenagers' mental health. Sports participation is actually associated with higher risk of alcohol, cigarettes, and drug consumption. A study of Canadian high school students concluded that e-cigarette users are actually more likely to engage in physical activities than their non-smoking counterparts, especially for males.[19] Moreover, Canadian adolescent girls who participate in team sports are more likely to maintain a healthy diet, but are also more likely to participate in binge drinking and drug use.[20] A similar phenomenon exists among US high school students as well. High school athletes are at an increased risk to use smokeless tobacco, alcohol, steroids, and diet pills, but are less likely to use other substances such as inhalants, cocaine, and

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[16] Ann Hagell, *The connections between young people's mental health and sport participation: Scoping the evidence*, 7, 2016, accessed September 3, 2020, http://www.youngpeopleshealth.org.uk/wp-content/uploads/2016/11/AYPH-health-and-sport-review-Nov-2016.pdf.

[17] Emily Pluhar et al., "Team Sport Athletes May Be Less Likely To Suffer Anxiety or Depression than Individual Sport Athletes," Journal of sports science & medicine 18, no. 3 (August 1, 2019), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6683619/#:~:text=Organized%20sports%20correlate%20more%20positively,et%20al.%2C%202017).

[18] Eva Oberle et al., "Benefits of Extracurricular Participation in Early Adolescence: Associations with Peer Belonging and Mental Health," Journal of Youth and Adolescence 48, no. 11 (August 22, 2019), https://doi.org/10.1007/s10964-019-01110-2.

[19] Sandra Milicic et al., "Examining the Association Between Physical Activity, Sedentary Behavior and Sport Participation With E-Cigarette Use and Smoking Status in a Large Sample of Canadian Youth," Nicotine & Tobacco Research 21, no. 3 (March 2019): 285, accessed June 30, 2020, https://doi.org/10.1093/ntr/ntx238.

[20] Erica Y. Lau et al., "Protective or Risky? The Longitudinal Association of Team Sports Participation and Health-Related Behaviours in Canadian Adolescent Girls," National Library of Medicine, May 28, 2019, 616, accessed July 1, 2020, https://doi.org/10.17269/s41997-019-00221-4.

smoked tobacco.[21] Males are particularly inclined to use steroids and females to diet pills because they promote more favorable body images. Therefore, sports participation could also generate negative effects on mental health by encouraging adolescents to partake in these risky behaviors.

It is also possible that the benefits of sports participation may differ by student characteristics, such as gender. Previous studies have also found that more boys are involved in physical activities than girls.[22] It is also identified that girls are at higher risk of mental illnesses such as depression and anxiety.[23] A study has found that girls in high school have the highest level of psychological distress among all students in middle school and high school. A report by the World Health Organization has concluded that young girl's anxiety over their body shape could lead to a higher risk of depression and eating disorders.[24] The prevalence of depression and anxiety among girls could also result from a lack of autonomy over their lives, such as feeling unsafe in their neighborhood or facing gender-based violence and discrimination in their families.[25] Perhaps because girls are at a higher risk for a number of mental health issues, girls might be more likely to benefit from team sports participation[26] For example, one study found that girls' participation in team sports was associated with reduced odds of low self-esteem, low life satisfaction and psychological distress.[27] However, there remains little research examining the differential benefits of sports participation by gender, highlighting a need for research in this area.

RESEARCH QUESTIONS

This review of the literature reveals two notable gaps in existing scholarship regarding the link between adolescents' sports participation and their mental health. First, although research suggests that the social and physiological aspects of sports may support mental health, past research has not adequately disentangled these two facets of sports participation. As such, it is not entirely clear what drives the link between sports participation and mental health: should school administrators encourage students simply to exercise or to engage in team-based athletics?

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[21] Mike C. Parent et al., "Racial Disparities in Substance Use by Sport Participation Among High School Students," National Library of Medicine, November 2016, 980, accessed July 1, 2020, https://doi.org/10.15288/jsad.2016.77.980.

[22] Guddal et al., "Physical Activity,".

[23] Björnsdóttir, "Sports Participation," 3.

[24] Department of Gender and Women's Health, World Health Organization, Gender and Mental Health, 2, June 2002, https://www.who.int/gender/other_health/genderMH.pdf.

[25] Department of Gender and Women's Health, World Health Organization, Gender and Mental, 2.

[26] Guddal et al., "Physical Activity,".

[27] Guddal et al., "Physical Activity,".

Research that better differentiates the social and physiological facets of sports participation would provide an answer to this important practical question.

Second, it is unclear whether certain student populations may receive a greater benefit from participating in sports. It is critical to examine this issue because school administrators may be wise to devote their limited resources to the students who are more likely to experience improvements in their well-being.

Given these two gaps in research, the present study, I explores the following research questions:

1. In which ways do the physical and social components of sports participation predict adolescents' mental health? (i.e., ability to concentrate, feelings of safety, depression/suicide)
2. Do the benefits of sports participation on mental health differ by gender?

METHODOLOGY

Data

Data for the present study are acquired from the Youth Risk Behavior Survey (YRBS). This survey is created by the Centers for Disease Control and Prevention, in order to provide data that represent 9th through 12th grade students in public and private schools in the United States. Sp data is collected every 2 years with the latest update in 2017; this study uses data from the 2017. The YRBS monitors six categories of healthy behaviors among US teenagers and adults, ranging from substance use to dietary habits. The data is collected on a voluntary and anonymous basis. In 2017, A total of 14,765 students from 144 high schools across all 50 states in the US provided usable questionnaires. The overall response rate of the 2017 national YRBS is 60%, with a 75% school response rate and a 81% student response rate. Overall, this sample is reasonably representative of students in the United States.

Table 1: Summary Statistics

Variables	Observations	Mean	Std. Dev.	Min	Max
Number of sports teams	11,720	0.984	1.137	0	3.5
Sports team	11,720	0.547	0.500	0	1
Physical Activity	11,665	3.763	2.531	0	7
Am Indian/Alaska Native	11,492	0.009	0.097	0	1
Asian	11,492	0.045	0.207	0	1
Black or African American	11,492	0.170	0.395	0	1
Native Hawaiian/Other PI	11,492	0.008	0.496	0	1
White	11,492	0.439	0.089	0	1
Hispanic/Latino	11,492	0.115	0.309	0	1
Multiple - Hispanic	11,492	0.157	0.353	0	1
Multiple - Non-Hispanic	11,492	0.056	0.232	0	1
Age	11,652	15.964	1.257	12	18
Female	11,631	0.514	0.500	0	1
BMI	10,467	23.715	5.228	11.546	62.371
Difficulty Concentrating	10,668	0.323	0.468	0	1
Feeling Unsafe	11,687	0.163	0.789	0	7
Being Bullied	11,631	0.182	0.386	0	1
Feeling Sad or Hopeless	11,603	0.319	0.466	0	1
Consider Suicide	11,584	0.177	0.381	0	1
Attempt Suicide	796	0.340	0.474	0	1

The table shows that only 54.7 percent of all students participate in at least one sports team, and a number of students participate in more than one sports team. The survey targets a very diverse student body, with more than half nonwhite students. Students in the sample are 12 to 18 years old, and the average age is approximately 16. Overall, mental health issues are prevalent among high school students. One third of students have difficulty concentrating and feel sad or hopeless, and about one fifth have been bullied on campus.

Table 2: Selected Items from the 2017 Youth Risk Behavior Survey

Independent Variable of Interest
Sport Participation
During the past 12 months, on how many sports teams did you play? (Count any teams run by your school or community groups.)
Independent Variables
Physical Activity
During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?
Age
How old are you?
Gender
What is your sex?
Race
Are you Hispanic or Latino?
What is your race?
BMI
How tall are you without your shoes on?
How much do you weigh without your shoes on?
Outcome Variables
Difficulty Concentrating
Because of a physical, mental, or emotional problem, do you have serious difficulty concentrating, remembering, or making decisions?
Feeling Unsafe
During the past 30 days, on how many days did you not go to school because you felt you would be unsafe at school or on your way to or from school?
Bullying Experience
During the past 12 months, have you ever been bullied on school property?
Feeling Sad of Hopeless
During the past 12 months, did you ever feel so sad or hopeless almost every day for two weeks or more in a row that you stopped doing some usual activities?
Suicidal Behaviors
During the past 12 months, did you ever seriously consider attempting suicide?
If you attempted suicide during the past 12 months, did any attempt result in an injury, poisoning, or overdose that had to be treated by a doctor or nurse?

Measures

Table 2 presents the questions from the YRBS instruments. This section describes the details of the variables as defined for my estimations below.

Independent Variable of Interest:

- **Sports Participation**: Sports participation was measured by the question shown above. One way to code the answers to this question is to convert them into a dichotomous variable, where answering "0" is coded to "0", and answering "1", "2", and "3 or more" are coded to "1." Alternatively, these responses could be kept as a continuous variable, where the values are 0, 1, 2, and 3.5, this last one is an assumption about the unknown distribution of sports teams within "3 or more". I include both measures of sports participation in my analysis. Prior literature only participation as a dummy variable.

Independent Variables:

- **Physical Activity:** This outcome is measured by answers to this question shown above. Students answer this question by choosing a number of days ranging from "0" days to "7 days," which are coded as they are.
- **Race**: The answers to variables were computed from two questions shown above. The data set codes these two questions into eight options. The eight options are coded into eight dummy variables: American Indian/Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White, Hispanic/Latino, Multiple - Hispanic/Latino, Multiple - Non-Hispanic/Latino.
- **Age**: This outcome is measured by answers to this question shown above. Students answer this question by choosing an age ranging from "12 years old or younger" to "18 years old or older."
- **Gender**: This outcome is measured by answers to this question shown above. Students answer this question with "female" (1) or "male" (0).
- **BMI (instrumental variable)**: students' height and weight were measured, and YRBS provided a calculation for BMI: BMI = height (m) ^ 2 / weight (kg).

Outcome Variables:

- **Having difficulty concentrating:** This outcome was measured by the question shown above. Students answered this question with "yes" or "no". A "yes" is coded with 1 and a "no" is coded with 0.
- **Feeling unsafe**: This outcome was measured by the question shown above. Students answered this question by choosing from "0 days", "1 day", "2 or 3 days", "4 or 5 days", and "6 or more days." "0 days" and "1 day" are coded as they are. "2 or 3 days" is coded as 2.5, "4 or 5 days" is coded as 4.5, and "6 or more days" is coded as 7.
- **Bullying experiences**: This outcome was measured by the question shown above. Students answer this question with "yes" or "no". A "yes" is coded with 1 and a "no" is coded with 0.
- **Feeling sad or hopeless:** This outcome was measured by the question shown above. Students answer this question with "yes" (1) or "no" (0).

- **Considered suicide:** This outcome was measured by answers to this question shown above. Students answer this question with "yes"(1) or "no"(0).
- **Attempt suicide:** This outcome was measured by answers to this question shown above. Students answer this question with "I did not attempt suicide", "yes" (1), or "no" (0). In my analysis, the focus is on the 796 students who answered "yes" or "no".

Method

Models were estimated using Ordinary Least Squares regression:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_K X_{Ki} + \varepsilon_i$$

Y_i is the dependent variable, which in the context of this paper are the seven outcomes that are associated with a student's mental health status. My main explanatory variable of interest, X_{1i}, is sports participation. X_{2i}, through X_{Ki}, represents the other control variables. In my analysis of the first research question, physical activity, gender, race, and age are controlled. In my analysis of the second research question, the sensitivity analysis, and the instrumental analysis, gender, race, and age are controlled.

I also utilize an instrumental variable approach because there are factors in the error term that are still correlated with sports participation. Therefore, the coefficient estimates reflect associations, not causal relationships. The goal of instrumental variable estimation is to utilize plausibly exogenous variation in sports participation in order to make my results more casually interpretable. This approach requires an instrumental variable, which must satisfy two conditions that will be subsequently discussed in greater detail.

RESULTS

OLS regressions

Table 3: Regression Results for Sports Teams and Physical Activity

	(1) Difficulty Concentrating				(2) Being Bullied				(3) Sad or Hopeless				(4) Feeling Unsafe				(5) Consider Suicide				(6) Attempt Suicide			
	B	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Female	0.131***	0.009	0.123***	0.009	0.0562***	0.007	0.055***	0.008	0.197***	0.009	0.192***	0.009	0.005	0.015	0.0006	0.015	0.102***	0.007	0.096***	0.007	0.077**	0.036	0.082**	0.037
Number of sports teams	-0.029***	0.004	-0.022***	0.004	0.000	0.003	0.003	0.004	-0.027***	0.004	-0.024***	0.004	0.015*	0.008	0.020**	0.008	-0.018***	0.003	-0.012***	0.003	0.010	0.015	0.009	0.016
Physical active	---	---	-0.009***	0.002	---	---	-0.003	0.002	---	---	-0.005***	0.0019	---	---	-0.006*	0.003	---	---	-0.007***	0.002	---	---	0.001	0.007
Am Indian/Alaska Native	0.051	0.048	0.048	0.048	0.023	0.042	0.023	0.042	0.063	0.045	0.061	0.045	0.159	0.103	0.157	0.103	0.044	0.040	0.041	0.040	0.038	0.146	0.040	0.146
Asian	-0.018	0.022	-0.022	0.022	-0.062***	0.017	-0.061***	0.017	-0.011	0.021	-0.013	0.021	0.021	0.030	0.020	0.031	-0.019	0.017	-0.021	0.017	0.153	0.113	0.152	0.113
Black or African American	-0.006	0.013	-0.012	0.012	-0.082***	0.010	-0.082***	0.010	-0.026**	0.012	-0.029**	0.012	0.112***	0.023	0.106***	0.023	-0.034***	0.010	-0.038***	0.010	0.041	0.047	0.036	0.048
Native Hawaiian/Other PI	0.008	0.050	0.008	0.051	-0.082**	0.035	-0.081**	0.035	-0.015	0.046	-0.015	0.046	0.201*	0.114	0.202*	0.114	0.033	0.041	0.033	0.042	-0.295***	0.030	-0.295***	0.031
Hispanic/Latino	0.018	0.015	0.017	0.015	-0.093***	0.011	-0.092***	0.011	0.016	0.014	0.016	0.014	0.071***	0.023	0.071***	0.023	-0.051***	0.011	-0.053***	0.011	0.064	0.066	0.070	0.067
Multiple - Hispanic	0.037***	0.014	0.037***	0.014	-0.027**	0.011	-0.027**	0.011	0.044***	0.013	0.043***	0.013	0.140***	0.024	0.138***	0.024	0.009	0.011	0.008	0.011	0.062	0.048	0.070	0.048
Multiple - Non-Hispanic	0.098***	0.021	0.096***	0.021	0.024	0.018	0.025	0.018	0.094***	0.020	0.093***	0.020	0.037	0.029	0.037	0.029	0.051***	0.017	0.050***	0.017	0.037	0.062	0.037	0.062
Age	-0.001	0.004	-0.002	0.004	-0.027***	0.003	-0.027***	0.003	0.005	0.003	0.005	0.003	-0.010	0.007	-0.011	0.007	-0.002	0.003	-0.003	0.003	0.003	0.013	0.004	0.013
Constant	0.282***	0.061	0.336***	0.063	0.612***	0.049	0.621***	0.050	0.146**	0.057	0.175***	0.058	0.250**	0.119	0.275**	0.121	0.171***	0.047	0.214***	0.048	0.181	0.219	0.157	0.224
Observations	10,301		10,341		11,306		11,359		11,352		11,300		11,431		11,378		11,333		11,282		764		759	
R-squared	0.032		0.030		0.024		0.024		0.056		0.057		0.006		0.007		0.027		0.029		0.016		0.017	
Adj. R^2	0.031		0.029		0.023		0.023		0.056		0.056		0.006		0.006		0.026		0.028		0.003		0.003	
RMSE	0.460		0.461		0.384		0.384		0.452		0.452		0.760		0.758		0.374		0.373		0.467		0.468	

Notes:
*** p<0.01, ** p<0.05, * p<0.1
Race 5 is omitted, which stands for white

Table 3 reports the OLS regression results comparing the effects of physical activity and sports participation on mental health outcomes.

When not controlling for the amount of physical activity, participation in each additional sports team was strongly associated with a 2.9 percent lower probability of having *difficulty concentrating*. (B = -0.029, $p < 0.05$);when physical activity is controlled for, the size of the association is slightly diminished but remains statistically significant (B = -0.0218, $p < 0.05$).

I also tested a number of mental health outcomes related to depression. When not controlling for physical activity, participation in each additional sports team was strongly associated with a 2.74 percent lower probability of *feeling sad or hopeless* ($p < 0.05$); when physical activity is controlled for, the association slightly decreased (B = -0.0237, $p < 0.05$). When not controlling for physical activity, participation in each additional sports team was strongly associated with a 1.77 percent lower probability of *considering attempting suicide* ($p < 0.05$);when physical activity is controlled for, the association slightly decreased (B = -0.0122, $p < 0.05$). Models testing *attempted suicide* were not significant.

Lastly, I tested outcomes related to students' feelings of safety. When not controlling for physical activity, participation in each additional sports team was marginally associated with a 1.47 percent higher probability of *feeling unsafe* around campus ($p < 0.10$). When physical activity is controlled for, the association is stronger and the possibility if higher (B = 0.0197, $p < 0.05$). Models testing *whether students were bullied* were not significant.

Table 4: Regression Results for Gender-Sports Interaction

	(1) Difficulty Concentrating		(2) Being Bullied		(3) Sad or Hopeless		(4) Feeling Unsafe		(5) Consider Suicide		(6) Attempt Suicide	
	B	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Female	0.140***	0.012	0.045***	0.010	0.210***	0.011	-0.014	0.019	0.105***	0.010	0.099**	0.046
Number of sports teams	-0.025***	0.005	-0.005	0.004	-0.021***	0.005	0.006	0.010	-0.016***	0.004	0.023	0.022
Female x number of sports teams	-0.008	0.008	0.011	0.007	-0.014*	0.008	0.019	0.015	-0.003	0.006	-0.022	0.030
Am Indian/Alaska Native	0.051	0.048	0.022	0.042	0.063	0.045	0.158	0.103	0.045	0.040	0.042	0.146
Asian	-0.018	0.022	-0.062***	0.017	-0.011	0.021	0.021	0.030	-0.019	0.017	0.153	0.113
Black or African American	-0.006	0.012	-0.081***	0.010	-0.027**	0.012	0.113***	0.024	-0.034***	0.010	0.039	0.047
Native Hawaiian/Other PI	0.008	0.050	-0.082**	0.035	-0.015	0.046	0.200*	0.114	0.033	0.041	-0.291***	0.032
Hispanic/Latino	0.017	0.015	-0.093***	0.011	0.016	0.014	0.072***	0.023	-0.051***	0.011	0.064	0.066
Multiple - Hispanic	0.037***	0.013	-0.027**	0.011	0.044***	0.013	0.140***	0.024	0.009	0.011	0.063	0.048
Multiple - Non-Hispanic	0.097***	0.021	0.025	0.018	0.093***	0.020	0.037	0.029	0.051***	0.017	0.037	0.062
Age (years)	-0.001	0.004	-0.026***	0.003	0.005	0.003	-0.010	0.007	-0.002	0.003	0.003	0.013
Constant	0.280***	0.061	0.615***	0.049	0.142**	0.057	0.254**	0.119	0.171***	0.047	0.175	0.219
Observations	10,341		11,359		11,352		11,431		11,333		764	
R-squared	0.030		0.024		0.057		0.007		0.027		0.017	
Adj. R^2	0.029		0.023		0.056		0.006		0.026		0.002	
RMSE	0.461		0.384		0.452		0.760		0.374		0.467	

Notes:
*** p<0.01, ** p<0.05, * p<0.10
The reference group for race is white

Table 4 reports the OLS regression results for the sports-gender interaction term.

Female students are more likely to have *difficulty concentrating* than male students (B = 0.14, $p < 0.01$), but the interaction term between sports participation and female was not significant.

I also tested a number of mental health outcomes related to depression. Female students are in higher risk to *feel sad or hopeless* than males (B = 0.21, $p < 0.01$), and the interaction term was marginally significant (B = -0.014, $p < 0.1$). Female students are more likely to *consider suicide* than male students (B = 0.105, $p < 0.01$), but the interaction was not significant. Lastly, female students are more likely to *attempt suicide* than male students (B = 0.099, $p < 0.05$), but the interaction was not significant.

Female students reported being more likely to be bullied than males (B = 0.045, $p < 0.01$), but the interaction was not significant. There is no difference in the possibility of *feeling unsafe* between female and male students, and the interaction term is not statistically significant (B = 0.019, p = 0.225).

Sensitivity analysis

In addition to measuring sports participation as a continuous variable, I tested models that included it as a dummy variable. Prior research did not consider the number of sports teams as a continuous variable. There are two results where sports participation was statistically significant as a dummy, but not as a continuous variable, or vice versa. Such cases offer mixed evidence for our analysis. However, in general, there are no differences in results when using different measures of sports participation, which demonstrates that most of my regression models are robust and are not sensitive to the specific measure used.

Table 5: Sensitivity Analysis Results

	(1) Difficulty Concentrating		(2) Being Bullied		(3) Sad or Hopeless		(4) Feeling Unsafe		(5) Consider Suicide		(6) Attempt Suicide	
	B	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Sports team	-0.0634***	0.0127	-0.0197**	0.00993	-0.0526***	0.0114	0.00210	0.0212	-0.0458***	0.00913	0.0947*	0.0574
Female x sports team	-0.0175	0.0183	0.0123	0.0145	-0.0311*	0.0171	0.00791	0.0287	0.000975	0.0142	-0.153**	0.0709
Constant	0.292***	0.0613	0.631***	0.0492	0.151***	0.0571	0.280**	0.121	0.181***	0.0472	0.174	0.221
Observations	10,341		11,359		11,352		11,431		11,333		764	
R-squared	0.031		0.024		0.058		0.006		0.027		0.021	
Adj. R^2	0.0297		0.0230		0.0567		0.00507		0.0265		0.00708	
RMSE	0.461		0.384		0.452		0.760		0.373		0.466	

Notes:
*** p<0.01, ** p<0.05, * p<0.1.
This model include the the same co-variates as prior models.

Table 5 presents the results from the sensitivity analysis. When sports participation is a dummy variable, there is not a statistically significant result for the outcome "feeling unsafe." However, according to Table 3, when sports participation is a continuous variable, sports participation increases the possibility of feeling unsafe among all students ($B = 0.020$, $p < 0.05$).

When sports participation is measured as a dummy variable, participation in sports team is marginally associated with a higher probability of attempting suicide among male students ($B = 0.095$, $p < 0.10$). On the contrary, participation in sports team is moderately associated lower probability of attempting suicide among female students ($B = -0.058$, $p < 0.05$). This is inconsistent with when sports participation was measured as a continuous variable, that the interaction was not statistically significant.

Instrumental variable estimation

Body Mass Index (BMI) was used as an instrumental variable because it is associated with students' probability of participating in sports teams, and arguably not associated with the unobserved determinants of mental health outcomes.

With the exception of "attempted suicide," BMI fulfills the first condition for being a valid instrumental variable (IV) for each outcome: the first stage F-statistics exceeds 10. Therefore, the IV is strong for those outcomes; IV analyses were not conducted for the attempted suicide outcome given that it did not meet the first condition. It is not possible to fully test the second condition, that BMI is not correlated with other determinants of mental health outcomes, because the error term is unobservable. However, the second condition is certainly plausible.

Table 6: Instrumental Variable Regression Model

	(1) Difficulty Concentrating		(2) Being Bullied		(3) Sad or Hopeless		(4) Feeling Unsafe		(5) Consider Suicide		(6) Attempt Suicide	
	B	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Number of Sports teams	-0.323 ***	0.073	-0.230 ***	0.064	-0.291 ***	0.069	-0.296 ***	0.129	-0.332 ***	0.067	0.177	0.376
First stage F-statistics	55.354		53.729		56.400		56.100		56.400		2.016	
Observations	9,315		10,278		10,275		10,332		10,257		668	
RMSE	.566		.455		0.538		.779		.51138		.493	

Notes:
*** p<0.01, ** p<0.05, * p<0.1,
This model include the the same co-variates as prior models.

Table 6 presents the results from the instrumental variable estimation. Across the outcomes, the coefficients in the instrumental variable estimation are not only statistically significant but also larger than the OLS models, suggesting that the OLS underestimated the size of causal effect of sports participation on mental health outcomes.

DISCUSSION

The present study examined how sports participation impacts high school students' mental health - above and beyond the effects of exercise alone. Both the OLS and instrumental variable (IV) regression results show that sports participation decreases one's possibility of having difficulty concentrating, feeling sad or hopeless, and considering suicide. The OLS regression concludes that sports participation increases one's possibility of feeling unsafe. We find evidence that the exercising aspect and the social aspects of sports participation likely contribute to these effects. In addition, we examined whether female students benefit more from sports participation across a range of mental health outcomes. We find that female students are more likely to experience more negative mental health outcomes than their male counterparts. However, sports participation appears to confer a larger beneficial decrease for female students in experiences of feeling sad or hopeless.

There are a number of reasons why the social aspects of sports participation could reduce students' likelihood of feeling sad or hopeless and contemplating suicide. For example, sports participation encourages a sense of peer belonging. Team sports in particular can create connectedness and togetherness by having individuals pursue a common goal as a collective group.[28] Such environments of support and mutual care could have played a vital role in reducing feelings related to depression. It is notable that these benefits increase as individuals participate in additional sports teams, which could be explained by the fact that each incremental sports team expands students' sense of community and belonging even further, thus reducing risk factors related to depression.

Interestingly, we find that the more sports teams students participate in, the more likely they are going to feel unsafe and not attend school, but they are no more or less likely to be bullied. Together, these findings suggest that sports participants' unsafe feelings do not originate from bullying related to their sports involvement. However, the sensitivity analyses yielded mixed results for the relationship between sports participation and feeling unsafe. For this reason, findings for this outcome should be replicated in another sample, In addition, future research should examine possible mechanisms for this finding other than bullying.

We find that female high school students are at higher risk for a range of mental health issues, highlighting the importance of intervening to improve female's mental health. Our findings are consistent with those in previous literature, but given that our sample is recent and nationally-representative, this study illustrates that mental health remains an important issue for female students. There are a number of possible explanations for this disparity, such as female's higher exposure to gender-based violence, lower social ranking, and anxiety over body image.

[28] What Sways Women to Play Sports, 19, https://www.womeninsport.org/wp-content/uploads/2015/04/What-Sways-Women-To-Play-Sport.pdf.

However, rapid technological and cultural shifts are changing the experiences of high school students, making it important for future research to identify the current causes of these disparities in order to identify targeted solutions.

Our study finds little evidence that participating in sports has a greater benefit for female students. As a single exception, we find that sports participation has a greater reduction on feelings of sadness or hopelessness for female students. One possible explanation is that female students' sports participation can contribute a sense of empowerment and ownership of their own bodies. Through competing and practicing on the athletic fields, female students can no longer see themselves as reproductive resources for men, but rather strong and independent individuals who can participate openly and equally within their communities.[29] Another possible explanation addresses the physical benefits of sports participation. Constant exercising could help to improve female students' body image, which will, in turn, boost their level of satisfaction and hope. If students participate in a number of sports teams all year around, they are much more likely to stay in good shape and maintain a high level of confidence and self-esteem. Although sports participation may be a modestly effective approach for addressing female's particular mental health needs, overall this study suggests that alternative solutions are necessary to solve prevalent issues related to female students' mental health.

LIMITATIONS

This study offers a number of important contributions, but it is also necessary to acknowledge its limitations. First, including sports team participation and exercise in the same model is imperfect in estimating the social impacts of sports. Ideally, the study would include a direct measure of students' social integration on their sports teams. Second, sports are not the only group activities that might confer community membership benefits. For example, cultural affinity groups, student government groups, or science clubs can also provide a collaborative and friendly atmosphere that improves students' mental health. Controlling for participation in such clubs would more precisely estimate the impacts of sports team participation. Lastly, there is a possible selection bias in that students who choose to play sports are different in unobservable ways. There might be unobservable factors, such as more parental involvement or better socioeconomic status, that is associated with sports participation. Even though instrumental variables estimation can mitigate such biases, future research could attempt to control such unobservable factors.

CONCLUSION

This research yields crucial findings regarding sports participation and its mental health outcomes in U.S. high schools. Sports participation is shown to have an incremental beneficial effect on students' mental health. Notably, the study helps to identify and distinguish the physical effect and social effect of sports participation. Female students are more vulnerable to

[29] "Women, Gender Equality and Sport," Women 2000 and Beyond, December/January 2007, 10, https://www.un.org/womenwatch/daw/public/Women%20and%20Sport.pdf.

mental health issues but receive a bigger benefit from participating in sports with respect to feelings of sadness and hopelessness.

These conclusions have important implications for school officials and policy makers when allocating funds and resources. In 2018, high school sports participation rate dropped for the first time in three decades, and data from 2019 found that the number of students who took part in interscholastic sports decreased by more than 43,000 than the year before. Part of this trend stems from a lack of opportunities at the high school; nearly 1 in 5 schools do not offer athletics programs.

These trends are troubling given that we find causal benefits of sports participation on students' mental health, but they can be combated in a number of ways. First, access to sports programs could be increased across the nation. Second, given the social benefits of sports participation, U.S. high schools could also allocate more resources to extracurricular activities that also provide the sense of community and mutual support. Students could have the freedom and a space on their schedules to develop and participate in various clubs and social groups. For students who are not athletically talented, they could participate in other team activities to receive the benefit of being in a community. Lastly, considering that females may benefit more than males in certain respects, U.S. high schools should invest in more athletic and after-school programs that are suitable for female students, such as dance club, cheer-leading teams, gymnastics club, women singing clubs, and female empowerment organizations. Overall, this research study represents a significant contribution to the field's understandings of how to promote adolescents' education and psychological well-being.

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