

Association of Team Sports Participation With Long-term Mental Health Outcomes Among Individuals Exposed to Adverse Childhood Experiences

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IMPORTANCE Adverse childhood experiences (ACEs) are associated with long-term poor mental health. Less is known about factors that improve long-term mental health among those with ACEs.

OBJECTIVE To evaluate, among those exposed to ACEs, whether team sports participation during adolescence is associated with better mental health in adulthood and whether the association between team sports participation and mental health varies by sex.

DESIGN, SETTING, AND PARTICIPANTS This study used data from 9668 individuals who participated in waves 1 (1994-1995) and 4 (2008) of the National Longitudinal Study of Adolescent to Adult Health. Individuals were included if they had complete data on exposure to ACEs (physical and sexual abuse, emotional neglect, parental alcohol misuse, parental incarceration, and living with a single parent) and a valid sample weight. Statistical analysis was performed from November 6, 2017, to January 4, 2019.

MAIN OUTCOMES AND MEASURES The association between team sports participation in grades 7 to 12 (wave 1) and diagnosis of depression and/or anxiety and current depressive symptoms (determined by Center for Epidemiologic Studies Depression scale-10 scores) at ages 24 to 32 years (wave 4) among individuals exposed to ACEs. Multivariable logistic regression models were weighted based on propensity scores for factors associated with team sports participation and controlled for individual, family, and school characteristics. Interaction terms tested whether associations between team sports participation and mental health varied by sex.

RESULTS Of 9668 individuals included in the study (4470 male [50.0%]; mean [SD] age, 15.2 [1.75] years), 4888 (49.3%) reported 1 or more ACE and 2084 (21.3%) reported 2 or more ACEs. Among those with ACEs, team sports participation during adolescence was significantly associated with lower odds of receiving a diagnosis of depression (unadjusted rate, 16.8% vs 22.0%; propensity score-weighted [PSW] adjusted odds ratio [aOR], 0.76; 95% CI, 0.59-0.97) or anxiety (11.8% vs 16.8%; PSW aOR, 0.70; 95% CI, 0.56-0.89) and having current depressive symptoms (21.9% vs 27.5%; PSW aOR, 0.85; 95% CI, 0.71-1.01). There were no significant differences in associations between team sports participation and mental health by sex. Stratified analyses showed significant associations for all outcomes among males (depression: PSW aOR, 0.67 [95% CI, 0.46-0.99]; anxiety: PSW aOR, 0.66 [95% CI, 0.45-0.96]; depressive symptoms: PSW aOR, 0.75 [95% CI 0.56-0.99]) but only 1 outcome among females (anxiety: PSW aOR, 0.73; 95% CI, 0.54-0.98).

CONCLUSIONS AND RELEVANCE Among individuals affected by ACEs, team sports participation in adolescence was associated with better adult mental health. Team sports may be an important and scalable resilience builder.

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Adverse childhood experiences (ACEs) classically include physical or emotional neglect or abuse, sexual abuse, domestic abuse, exposure to household substance misuse or mental illness, parental separation or divorce, and parental incarceration.¹ Adverse childhood experiences are common, with about half of children experiencing 1 and one-quarter experiencing 2 or more.^{2,3} Physical and mental health problems are more prevalent among those with ACEs throughout the life course.³⁻⁶ Risk increases in a graded fashion for multiple mental health conditions (including depression and anxiety)^{2,7} that are associated with worse life and health outcomes.^{8,9} Furthermore, the association between ACEs and mental health is thought to be one pathway through which parental ACEs might influence child health.¹⁰ Therefore, interventions to prevent ACEs or ameliorate their effects have the potential to improve health throughout the life course.¹¹⁻¹⁵

Little is known, however, about what factors improve long-term outcomes for those exposed to ACEs. Physical activity in childhood and adolescence has been shown to have benefits for mental health, including improvements in depressive symptoms,¹⁶⁻¹⁹ stress,¹⁶ and self-esteem.¹⁸⁻²⁰ Team sports in particular are thought to lead to improved mental health because of their social nature and resulting social support.^{20,21} However, it is not known whether team sports participation among the subgroup of youths exposed to ACEs is associated with improved mental health outcomes. For example, ACEs may affect children in ways that could alter or limit the benefits of sports participation.

We sought to examine whether, among those affected by ACEs, team sports participation during adolescence is associated with improved adult mental health. We hypothesized that team sports participation in the context of ACEs may be associated with improved mental health outcomes through direct physiologic alterations, promotion of resilient characteristics, and/or improved social support. Because studies have shown differential effects of ACEs by sex²² and differential benefits of physical activity on mental health by sex,^{20,23,24} we also examined whether the association between team sports and mental health varies by sex.

Methods

Study Design and Data

We used the National Longitudinal Study of Adolescent to Adult Health (Add Health)²⁵ to compare the emergence of 3 different adult mental health outcomes (diagnosis of depression, diagnosis of anxiety, and depressive symptoms) among those with ACEs during childhood who did and did not participate in team sports during adolescence. We used survey data from wave 1 (collected during the 1994-1995 school year, when respondents were in grades 7-12) to examine participation in team sports during adolescence and data from wave 4 (collected in 2008 when respondents were 24-32 years of age) to examine adult mental health. The study was approved by the UCLA Institutional Review Board, with a waiver of informed consent because the study was a secondary analysis of deidentified data.

Key Points

Question Is team sports participation during adolescence associated with better long-term mental health outcomes among individuals exposed to adverse childhood experiences?

Findings In this study of 9668 individuals from a nationally representative database, among those with adverse childhood experiences, team sports participation during adolescence was significantly associated with better adult mental health outcomes, especially for males, including lower likelihood of having ever received a diagnosis of depression or anxiety and having current depressive symptoms.

Meaning The findings suggest that participation in team sports is associated with better adult mental health outcomes among individuals exposed to adverse childhood experiences.

Study Sample

We included individuals with data from the wave 1 in-school interview (n = 90 118), wave 1 in-home interview (n = 15 355), and wave 4 in-home interview (n = 11 681) who had complete data on exposure to ACEs (9887), had been exposed to 1 or more ACE (n = 5009), and had a valid sample weight (n = 4888). To provide context for the analytic sample, the demographics are given with 4870 participants with complete data and a valid sample weight who did not report ACEs and were thus excluded from our analytic sample (Table 1). Adverse childhood experiences included sexual abuse, physical abuse (more than 2 incidents), emotional neglect (more than 10 incidents), parental alcohol misuse (5 or more drinks on 1 occasion in the past month), parental incarceration, and living with a single parent. Physical abuse was defined as more than 2 incidents and emotional neglect as more than 10 incidents according to definitions in a previous Add Health analysis.²⁶

Outcomes

Three self-reported mental health outcomes were examined in wave 4: having ever received a diagnosis of depression, having ever received a diagnosis of anxiety, and screening positive for current depressive symptoms according to the 10-item subscale of the Center for Epidemiologic Studies Depression scale (CES-D-10). A score of 10 or more on the CES-D-10 was considered to be a positive screen result for depression, which corresponds with the clinical cutoff.²⁷

Independent Variables

The primary independent variable was participation in team sports during adolescence. Participation was determined based on the answer to the following wave 1 in-school questionnaire item: "Are you participating/do you plan to participate in the following teams (check all that apply): baseball/softball, basketball, cheerleading/dance team, field hockey, football, ice hockey, soccer, swimming, tennis, track, volleyball, wrestling, other sport."²⁵ Adolescents were designated as participating in team sports if they selected 1 or more sport.

Covariates were selected based on their potential to be associated with both sports participation and mental health, including age, race/ethnicity, sex, parental education, family

Table 1. Descriptive Statistics for Individuals Exposed to ACEs and Adolescents Not Reporting ACEs^a

Characteristic	ACEs (n = 4888)	No ACEs (n = 4780)	P Value
Age in wave 1, mean (SD)	15.17 (1.74)	15.25 (1.75)	.21
Male	2147 (48.0)	2323 (52.0)	.003
Race/ethnicity			
White	2385 (61.6)	2927 (74.8)	<.001
Black	1380 (21.7)	748 (10.1)	<.001
Hispanic	769 (10.8)	674 (9.0)	.07
Asian, Native American, or other	353 (5.9)	427 (6.0)	.84
Parental education			
High school or less	2384 (51.6)	1944 (44.4)	<.001
Some college	1481 (31.5)	1369 (28.1)	.01
College graduate or more	982 (17.0)	1402 (27.5)	<.001
Family structure			
2 Parents	2496 (52.9)	4607 (96.3)	<.001
Single mom	1901 (36.6)	74 (1.4)	<.001
Single dad or other	491 (10.5)	99 (2.3)	<.001
Gap in health insurance	3002 (63.0)	2194 (46.1)	<.001
School region			
West	995 (15.3)	1000 (14.8)	.72
Midwest	1287 (31.9)	1157 (26.8)	.10
South	1928 (38.3)	1908 (42.6)	.07
Northeast	678 (14.6)	715 (15.9)	.38
School type			
Public	4565 (93.6)	4334 (91.3)	.05
Private	323 (6.4)	446 (8.7)	
School mean daily attendance			
≥95%	1508 (37.1)	1766 (43.5)	
90%-94%	2253 (44.0)	2178 (46.2)	<.001
85%-89%	816 (10.8)	688 (7.6)	
75%-84%	300 (8.1)	117 (2.7)	
Participation in other activities	2567 (51.2)	2794 (58.2)	<.001
School connectedness, points, mean (SD) ^b	21.77 (4.42)	22.90 (4.01)	<.001
Self-esteem, points, mean (SD) ^c	18.70 (3.04)	19.09 (2.66)	<.001
Feeling socially accepted, points, mean (SD) ^d	4.07 (0.81)	4.11 (0.71)	.07
Feeling friends care, points, mean (SD) ^e	4.22 (0.81)	4.32 (0.71)	<.001
Times played sport in past week			
0	1421 (26.9)	1272 (24.1)	
1-2	1376 (27.5)	1330 (28.1)	
3-4	927 (20.5)	924 (20.8)	.09
≥5	1164 (25.0)	1251 (27.0)	
Times exercised hard in past week			
0	265 (5.1)	209 (4.0)	
1-2	1010 (21.2)	989 (21.3)	
3-5	1425 (31.3)	1378 (30.3)	.37
6-7	678 (16.7)	813 (17.9)	
>7	1033 (25.7)	1036 (26.4)	

(continued)

Table 1. Descriptive Statistics for Individuals Exposed to ACEs and Adolescents Not Reporting ACEs^a (continued)

Characteristic	ACEs (n = 4888)	No ACEs (n = 4780)	P Value
Dependent variables			
Depression diagnosis	876 (19.1)	589 (13.2)	<.001
Males	242 (12.6)	185 (8.3)	
Females	634 (25.0)	404 (19.7)	
Anxiety diagnosis	628 (14.0)	476 (11.5)	.02
Males	163 (7.8)	139 (7.4)	
Females	465 (19.7)	337 (15.9)	
Depressive symptoms	1132 (24.0)	681 (14.5)	
Males	396 (21.1)	279 (11.5)	<.001
Females	736 (27.4)	402 (17.8)	
Age at diagnosis of depression, mean (SD)	20.5 (5.5)	21.4 (5.1)	NA
Age at diagnosis of anxiety, mean (SD)	22.64 (4.9)	22.50 (4.9)	NA
Depression diagnosis before wave 1	126 (2.4)	54 (1.2)	.006
Anxiety diagnosis before wave 1	43 (0.9)	24 (0.5)	.07
Wave 1 depressive symptoms	1372 (26.6)	943 (18.1)	<.001

Abbreviations: ACE, adverse childhood experience; NA, not applicable.

^a Data are presented as number/total number (percentage) of individuals unless otherwise indicated. Sample weights were applied. No ACEs includes the general adolescent population in National Longitudinal Study of Adolescent to Adult Health²⁵ who did not report ACEs.

^b Uses responses to 6 statements to create a scale measure of school connectedness: "How much do you agree or disagree with the following statements?" "You feel close to people at your school," "you feel like you are a part of your school," "you are happy to be at your school," "the teachers at your school treat students fairly," and "you feel safe in your school," with responses on a 5-point scale ranging from 1 (strongly agree) to 5 (strongly disagree) (reverse coded), and "How much do you feel that your teachers care about you?" with responses ranging from 1 (not at all) to 5 (very much). Higher scores indicate greater school connectedness.²⁸

^c Uses responses to 5 statements to create a scale measure of self-esteem: "Do you agree or disagree with the following statement?" "You have a lot of good

qualities," "you have a lot to be proud of," "you like yourself just the way you are," and "you feel loved and wanted," with responses on a 5-point scale ranging from 1 (strongly agree) to 5 (strongly disagree) (reverse coded), and "How often was the following been true over the past week? You felt that you were just as good as other people," with responses ranging from 0 (never or rarely) to 3 (most of the time or all of the time). Higher scores indicate greater self-esteem.²⁸

^d Uses responses to the following statement to create a scale measure of self-esteem: "Do you agree or disagree with the following statement? You feel socially accepted," with answers ranging from 1 (strongly agree) to 5 (strongly disagree) (reverse coded). Higher scores indicate greater feelings of social acceptance.²⁹

^e Uses responses to the following statement to create a scale measure of feeling friends care: "How much do you feel that your friends care about you?" with answers ranging from 1 (not at all) to 5 (very much). Higher scores indicate greater feeling that friends care.²⁹

structure, an indicator for having a gap in health insurance at any wave, and school characteristics (region, public or private, and average daily attendance).

Potential mediators included variables that are associated with changes in psychosocial support (school connectedness, self-esteem, feeling socially accepted, and feeling that friends care)^{28,29} and possible physiologic changes (level of physical activity over the past week, times exercised hard over the past week).

Statistical Analysis

Univariate analyses examined distributions of the 3 outcome variables, primary regressor, and covariates. Bivariate analyses included χ^2 tests and analysis of variance. Separate multivariable logistic regressions examined the association between participating in team sports in adolescence and each of the 3 adult mental health outcomes, controlling for the covariates listed above. All statistical analyses were performed in Stata, version 15.1 (StataCorp). The *svy* and *subpop* option was used to adjust for survey design elements including stratification, clustering, and weighting. We included a gen-

der \times sports participation interaction term in the models and conducted sex-stratified analyses to explore whether the association between team sports and mental health varies by sex.

To account for children who participate in team sports potentially being inherently different from those who do not, we weighted the analyses for participation in team sports based on propensity scores. Candidate variables for the propensity score-weighted model included factors thought to be associated with participation in extracurricular activities based on a review of the literature; these factors were mapped to variables in Add Health.³⁰ First, associations were examined among potential variables; if the associations were moderate or strong, an index was created when possible, and when not possible, the variable with the strongest bivariate association with team sports participation was used. The components of the propensity score were sex, race/ethnicity, parental education, whether the adolescent played a sport with his or her father in the past month, region, urbanicity, school size, and neighborhood connectedness. The propensity score was developed according to published methods for propensity score-weighted analyses with complex surveys.³¹ The method involved using the sur-

vey weight as a covariate in the propensity score model, calculating the propensity score, assessing the score's balance across the 2 groups, weighting the 2 groups by the score, and multiplying the propensity score by the survey weight to obtain a new weight. Each outcome was then modeled using *svyset* in Stata with the new weight.

In sensitivity analyses, we compared the propensity score-weighted analysis with models without propensity score weighting. We assessed for reverse causality by accounting for baseline mental health in wave 1, excluding those with a diagnosis of the relevant condition at baseline when modeling diagnosis of depression or anxiety and controlling for baseline CES-D-10 score when modeling depression symptoms. To examine whether team sports participation might be a proxy for participation in any school-related activities, we modeled whether participation in other activities (such as orchestra, band, chorus, and drama club) was associated with each mental health outcome. We also assessed for a dose-response relationship, with the dose being number of sports in which individuals participated, and examined the association of specific sport types with each mental health outcome.

We tested whether each mediating variable was significantly associated with team sports participation and each mental health outcome and whether the associations between team sports participation and mental health diminished when the variable was included in the model. We used the Karlson-Holm-Breen method to determine the degree to which the mediating variable affected the association between team sports participation and each adult mental health outcome.³² Statistical significance was set at $P \leq .05$, and 2-sided tests were used. Missing data represented less than 1% for all variables in our primary analyses. Statistical analysis was performed from November 6, 2017, to January 4, 2019.

Results

Of 9668 individuals included in the study (4470 male [50.0%]; mean [SD] age, 15.2 [1.75] years), 4888 (49.3%) individuals reported 1 or more ACE and 2084 (21.3%) reported 2 or more ACEs. The most common ACE was having a single parent (2670; 27.2%), followed by parental incarceration (1657; 16.7%) and parental alcohol misuse (1177; 13.5%). Sexual abuse was least common (488; 5.2%), followed by physical abuse (925; 9.1%) and emotional neglect (1097; 11.2%). Table 1 shows the descriptive statistics for the study population (those with 1 or more ACEs) and compares it with the Add Health population who did not have ACEs (excluded from the analytic sample). The population affected by ACEs included significantly fewer non-Hispanic white individuals, more black individuals, lower parental education, and higher rates of gaps in health insurance. Individuals exposed to ACEs also had lower levels of participation in team sports and other school-related activities.

Frequency of Mental Health Outcomes

At baseline (wave 1), adolescents with ACEs were significantly more likely to have received a diagnosis of depression (126 [2.4%] vs 54 [1.2%], $P = .006$) and have current depressive symptoms

(1372 [26.6%] vs 943 [18.1%], $P < .001$) compared with adolescents without ACEs (Table 1). Baseline rates of having received a diagnosis of anxiety were not significantly different between the 2 groups (43 [0.9%] vs 24 [0.5%], $P = .07$). In adulthood, those with a history of ACEs had high rates of all 3 mental health outcomes, with 876 (19.1%) having received a diagnosis of depression, 628 (14.0%) having received a diagnosis of anxiety, and 1132 (24.4%) having current depressive symptoms. The mean (SD) age at diagnosis was 20.5 (5.5) years for depression and 22.6 (4.9) years for anxiety.

Team Sports Participation During Adolescence and Adult Mental Health

Team sports participation during adolescence was associated with significantly lower odds of having ever received a diagnosis of depression (unadjusted rate, 16.8% vs 22.0%; propensity score-weighted adjusted odds ratio [aOR], 0.76; 95% CI, 0.59-0.97) and having ever received a diagnosis of anxiety (unadjusted rate, 11.8% vs 16.8%; propensity score-weighted aOR, 0.70; 95% CI, 0.56-0.89). Team sports participation was not significantly associated with current depressive symptoms after full adjustment (unadjusted rate, 21.9% vs 27.5%; propensity score-weighted aOR, 0.85; 95% CI, 0.71-1.01).

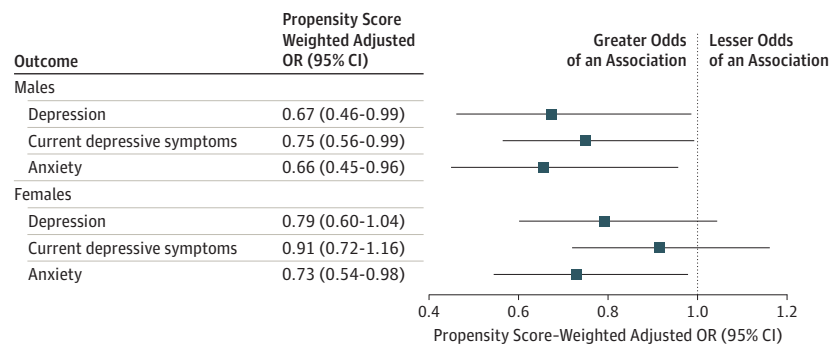
Differential Associations by Sex

The association between team sports and better mental health was not significantly different for males and females (a team sports participation \times gender interaction term was not significant for any of the 3 mental health outcomes) (depression: propensity score-weighted aOR, 0.86 [95% CI, 0.57-1.30]; anxiety: propensity score-weighted aOR, 0.89 [95% CI, 0.55-1.48]; current depressive symptoms: propensity score-weighted aOR, 0.83 [95% CI, 0.59-1.18]). However, sex-stratified analyses revealed a greater number of significant associations between team sports participation and mental health for boys than for girls (Figure). Among boys with ACEs, team sports participation during adolescence remained significantly associated with lower odds of each mental health outcome (depression: propensity score-weighted aOR, 0.67 [95% CI, 0.46-0.99]; anxiety: propensity score-weighted aOR, 0.66 [95% CI, 0.45-0.96]; depressive symptoms: propensity score-weighted aOR, 0.75 [95% CI, 0.56-0.99]), whereas for girls, team sports participation was only significantly associated with lower odds of having ever received a diagnosis of anxiety (propensity score-weighted aOR, 0.73; 95% CI, 0.54-0.98) (Figure).

Sensitivity Analyses

To assess for reverse associations, we accounted for baseline mental health. The association between participation in team sports and mental health remained significant for anxiety and was nearly significant for depression diagnosis and current depressive symptoms (eTable 1 in the Supplement). To examine whether team sports participation might be associated with participation in any school-related activities, we modeled whether participation in other activities was associated with each mental health outcome. Unlike participation in team sports, participation in other school-based activities was not

Figure. Association of Participation in Team Sports With Depression, Current Depressive Symptoms, and Anxiety Among Males and Females



Sample weights have been applied. Overlapping 95% CIs demonstrate no statistically significant difference between the effect sizes for males vs females. Data were adjusted for age in wave 1, race/ethnicity (non-Hispanic white, black, Hispanic, and Asian, Native American, or other), sex, parental education (high school or less, some college, and college graduate or more), family structure (2 parents, single mom, and single dad or other), gap in health insurance between

wave 1 and wave 4, region, and school characteristics (public or private and mean daily attendance). Depression was defined as having received a diagnosis of depression; current depressive symptoms, a score of 10 or higher on the 10-item subscale of the Center for Epidemiologic Studies Depression scale; and anxiety, having received a diagnosis of anxiety.

Table 2. Mediation of the Association Between Team Sports Participation and the 3 Mental Health Outcomes^a

Mediating Variable	Depression, %	P Value	Current Depressive Symptoms, %	P Value	Anxiety, %	P Value
School connectedness	14.9	.003	16.7	.003	10.3	.01
Self-esteem	11.0	.007	29.0	<.001	7.8	.02
Social acceptance	14.6	.002	20.6	.001	10.0	.01
All	22.6	<.001	35.8	.001	15.8	.002

^a Sample weights were applied. Data were adjusted for age in wave 1, race/ethnicity (non-Hispanic white, black, Hispanic, and Asian, Native American, or other), sex, parental education (high school or less, some college, and college graduate or more), family structure (2 parents, single mom, and single dad or other), gap in health insurance between wave 1 and wave 4,

region, and school characteristics (public or private and mean daily attendance). Depression was defined as having received a diagnosis of depression; current depressive symptoms, a score of 10 or higher on the 10-item subscale of the Center for Epidemiologic Studies Depression-10 scale; and anxiety, having received a diagnosis of anxiety.

significantly associated with lower odds of any of the mental health outcomes in adulthood (eTable 2 in the Supplement). We also assessed for a dose-response relationship between number of sports in which individuals participated and each mental health outcome (eTable 3 in the Supplement). Although there was a consistent association for those participating in 1 or 2 sports, there was not consistent evidence of a dose-response relationship. Furthermore, we examined the association between specific sport types and each mental health outcome (eTable 4 in the Supplement). Although limited by cell sizes, the 4 largest sports had negative associations with each mental health outcome, with basketball and football having significant associations. Thus, the results do not seem to be driven by a particular sport.

Mediating Variables

To better identify the pathways through which team sports participation might improve mental health, we tested whether the associations between sports participation and the study outcomes were mediated by increased psychosocial support, physiologic changes, or both. Candidate mediators included school connectedness, self-esteem, feeling socially accepted, feeling as if friends care, level of physical activity over the past week, and times exercised hard over the past week. We examined each candidate mediator in

each model and used the Karlson-Holm-Breen method³² to quantify the proportion of the association between sports participation and mental health that was mediated (Table 2). School connectedness (depression, 14.9%; current depressive symptoms, 16.7%; and anxiety, 10.3%), self-esteem (depression, 11.0%; current depressive symptoms, 29.0%; and anxiety, 7.8%), and feeling socially accepted (depression, 14.6%; current depressive symptoms, 20.6%; and anxiety, 10.0%) significantly mediated the association between team sports and all 3 mental health outcomes; together, they mediated 15.8%-35.8% of the association.

Discussion

In this analysis of a large nationally representative database, 49% of adolescents experienced 1 or more ACEs, which is similar to rates found in other large-scale analyses.^{2,3} Children affected by ACEs had poor mental health outcomes, with greater numbers of ACEs being associated with higher frequencies of ever having received a diagnosis of depression or anxiety and depressive symptoms in adulthood. Despite this risk profile, team sports participation during adolescence was significantly associated with improved adult mental health, particularly for boys, suggesting that exposure to protective factors

in childhood might be associated with improved long-term mental health in this vulnerable population.

These findings suggest that children affected by ACEs might benefit from participating in team sports and other programs that provide psychosocial support. Given the infrastructure that exists for youth sports in the United States already, augmenting and expanding sports programs may be a relatively achievable and inexpensive strategy to mitigate the association of ACEs with health. Ensuring that such programs maintain access for youths at high risk for exposure to ACEs is an important consideration for policymakers and child health advocates. For example, sports programs that require high fees for participation or that are limited to high-resource neighborhoods might exacerbate, rather than mitigate, health disparities associated with ACEs. This is a growing concern given school budget challenges and the emergence and expansion of pay-to-play policies.^{33,34}

Clinicians might consider specifically encouraging patients with ACEs to participate in team sports or other activities that build social support, particularly those with a low likelihood for physical injury or concussion. The American Academy of Pediatrics¹³ suggests that pediatricians routinely screen for ACEs. Thus, clinicians may soon be tasked with providing recommendations to families affected by ACEs regarding how best to support the long-term health of their children. Identifying interventions that increase resilience for patients with ACEs may be critical for moving from merely documenting the associations between ACEs and negative health outcomes to preventing and/or improving those outcomes.

Our mediation analysis suggests that active variables associated with resilience building that could be targeted by other interventions include school connectedness, self-esteem, and feeling socially accepted. These same resilience factors might be enhanced by programs at the school- and community-level in line with the Centers for Disease Control and Prevention's Whole School, Whole Community, Whole Child model.³⁵ Given the population health and intergenerational health consequences of ACEs, identifying practical strategies to build resilience, rigorously evaluating such interventions, and then investing in evidence-based strategies to enhance resilience might yield significant health benefits for a substantial group of children and adults.

Limitations

This study is limited by the study design and variables available in Add Health. There was some loss to follow-up over the course of this study and incomplete data on certain variables. However, the proportion of missing data among all variables in the primary analyses was less than 1%. The team sports participation survey question asked about current and planned participation, which may not have occurred. This

likely biases our results toward the null hypothesis. Similarly, the sensitivity analyses accounting for baseline mental health may be overly conservative because adolescent mental health may be an intermediate outcome. We attempted to assess for dose-response using number of sports because the survey did not ask about intensity of participation, but this is an inadequate proxy. Number of sports often does not indicate intensity of participation. Involvement in 3 or more sports, for instance, may indicate a different nature of involvement (less intensive, less committed), limiting its use in a dose-response analysis. Alternatively, participating in more sports may increase stress owing to the large time commitment and could signal a more fragmented social support network. Regardless, there is little reason to expect a dose-response relationship in this context. In addition, components of the ACE indicator could be subject to recall and social desirability bias because they required recall of events before 18 years of age and address sensitive issues. These biases would tend to lead to underreporting of ACEs. However, it is reassuring that the rates of ACEs found are similar to those reported in other large-scale studies.^{2,3} Furthermore, although we controlled for contextual factors and conducted propensity score weighting for sports participation, unmeasured differences between adolescents who participate in sports and those who do not may remain and confound results. For example, an unmeasured confounder would need to have a propensity score-weighted aOR of 1.56 (95% CI, 1.21-2.78) for depression, 1.40 (95% CI, 1.00-2.19) for depressive symptoms, and 1.67 (95% CI, 1.51-3.00) for anxiety to account for our findings.

Furthermore, causality could not be determined with our study design. Social determinants of health are difficult to isolate, even with comprehensive modeling. It is impossible to fully capture the social environment of a teenager, and this environment is constantly changing. Although team sports may help mitigate the effects of ACEs for some individuals, other factors likely play a role in mitigating these effects also, such as change in economic status and income level.³⁶

Conclusions

These findings appear to have important implications for pediatricians and parents of children exposed to ACEs. Given that participation in team sports was associated with improved adult mental health among those with ACEs, pediatricians might consider recommending team sports participation for patients with ACEs and parents might consider enrolling their children with ACEs in team sports. Similarly, policymakers and child health advocates may consider advocating to make these programs accessible, equitable, and strong.

ARTICLE INFORMATION

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REFERENCES

- Centers for Disease Control and Prevention. About the CDC-Kaiser ACE study. <https://www.cdc.gov/violenceprevention/acestudy/about.html>. Accessed July 2017.
- Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: the Adverse Childhood Experiences (ACE) study. *Am J Prev Med*. 1998;14(4):245-258. doi:10.1016/S0749-3797(98)00017-8
- Bethell CD, Newacheck P, Hawes E, Halfon N. Adverse childhood experiences: assessing the impact on health and school engagement and the mitigating role of resilience. *Health Aff (Millwood)*. 2014;33(12):2106-2115. doi:10.1377/hlthaff.2014.0914
- Gilbert R, Widom CS, Browne K, Fergusson D, Webb E, Janson S. Burden and consequences of child maltreatment in high-income countries. *Lancet*. 2009;373(9657):68-81. doi:10.1016/S0140-6736(08)61706-7
- Chen E, Miller GE. Stress and inflammation in exacerbations of asthma. *Brain Behav Immun*. 2007;21(8):993-999. doi:10.1016/j.bbi.2007.03.009
- Flaherty EG, Thompson R, Litrownik AJ, et al. Effect of early childhood adversity on child health. *Arch Pediatr Adolesc Med*. 2006;160(12):1232-1238. doi:10.1001/archpedi.160.12.1232
- Danese A, Moffitt TE, Harrington H, et al. Adverse childhood experiences and adult risk factors for age-related disease: depression, inflammation, and clustering of metabolic risk markers. *Arch Pediatr Adolesc Med*. 2009;163(12):1135-1143. doi:10.1001/archpediatrics.2009.214
- Bruce ML, Seeman TE, Merrill SS, Blazer DG. The impact of depressive symptomatology on physical disability: MacArthur Studies of Successful Aging. *Am J Public Health*. 1994;84(11):1796-1799. doi:10.2105/AJPH.84.11.1796
- Bardone AM, Moffitt TE, Caspi A, Dickson N, Stanton WR, Silva PA. Adult physical health outcomes of adolescent girls with conduct disorder, depression, and anxiety. *J Am Acad Child Adolesc Psychiatry*. 1998;37(6):594-601. doi:10.1097/00004583-199806000-00009
- Schickedanz A, Halfon N, Sastry N, Chung PJ. Parents' adverse childhood experiences and their children's behavioral health problems. *Pediatrics*. 2018;142(2):e20180023. doi:10.1542/peds.2018-0023
- Halfon N, Larson K, Lu M, Tullis E, Russ S. Lifecourse health development: past, present and future. *Matern Child Health J*. 2014;18(2):344-365. doi:10.1007/s10995-013-1346-2
- Szilagyi M, Halfon N. Pediatric adverse childhood experiences: implications for life course health trajectories. *Acad Pediatr*. 2015;15(5):467-468. doi:10.1016/j.acap.2015.07.004
- Garner AS, Shonkoff JP; Committee on Psychosocial Aspects of Child and Family Health; Committee on Early Childhood, Adoption, and Dependent Care; Section on Developmental and Behavioral Pediatrics. Early childhood adversity, toxic stress, and the role of the pediatrician: translating developmental science into lifelong health. *Pediatrics*. 2012;129(1):e224-e231. doi:10.1542/peds.2011-2662
- Shonkoff JP, Garner AS; Committee on Psychosocial Aspects of Child and Family Health; Committee on Early Childhood, Adoption, and Dependent Care; Section on Developmental and Behavioral Pediatrics. The lifelong effects of early childhood adversity and toxic stress. *Pediatrics*. 2012;129(1):e232-e246. doi:10.1542/peds.2011-2663
- Johnson SB, Riley AW, Granger DA, Riis J. The science of early life toxic stress for pediatric practice and advocacy. *Pediatrics*. 2013;131(2):319-327. doi:10.1542/peds.2012-0469
- Salmon P. Effects of physical exercise on anxiety, depression, and sensitivity to stress: a unifying theory. *Clin Psychol Rev*. 2001;21(1):33-61. doi:10.1016/S0272-7358(99)00032-X
- Motl RW, Birnbaum AS, Kubik MY, Dishman RK. Naturally occurring changes in physical activity are inversely related to depressive symptoms during early adolescence. *Psychosom Med*. 2004;66(3):336-342.
- Dishman RK, Hales DP, Pfeiffer KA, et al. Physical self-concept and self-esteem mediate cross-sectional relations of physical activity and sport participation with depression symptoms among adolescent girls. *Health Psychol*. 2006;25(3):396-407. doi:10.1037/0278-6133.25.3.396
- Crews DJ, Lochbaum MR, Landers DM. Aerobic physical activity effects on psychological well-being in low-income Hispanic children. *Percept Mot Skills*. 2004;98(1):319-324. doi:10.2466/pms.98.1.319-324
- Eime RM, Young JA, Harvey JT, Charity MJ, Payne WR. A systematic review of the psychological and social benefits of participation in sport for children and adolescents: informing development of a conceptual model of health through sport. *Int J Behav Nutr Phys Act*. 2013;10:98. doi:10.1186/1479-5868-10-98
- Taliaferro LA, Rienzo BA, Miller MD, Pigg RM Jr, Dodd VJ. High school youth and suicide risk: exploring protection afforded through physical activity and sport participation. *J Sch Health*. 2008;78(10):545-553. doi:10.1111/j.1746-1561.2008.00342.x
- Almuneef M, ElChoueiry N, Saleheen HN, Al-Eissa M. Gender-based disparities in the impact of adverse childhood experiences on adult health: findings from a national study in the Kingdom of Saudi Arabia. *Int J Equity Health*. 2017;16(1):90. doi:10.1186/s12939-017-0588-9
- Asztalos M, De Bourdeaudhuij I, Cardon G. The relationship between physical activity and mental health varies across activity intensity levels and dimensions of mental health among women and men. *Public Health Nutr*. 2010;13(8):1207-1214. doi:10.1017/S1368898009992825
- Hands BP, Parker H, Larkin D, Cantell M, Rose E. Male and female differences in health benefits derived from physical activity: implications for exercise prescription. *J Womens Health Issues Care*. 2016;5(4). doi:10.4172/2325-9795.1000238
- Harris, KM. The National Longitudinal Study of Adolescent to Adult Health (Add Health), Waves I & II, 1994-1996; Wave III, 2001-2002; Wave IV, 2007-2009 [machine-readable data file and documentation]. Chapel Hill, NC: Carolina Population Center, University of North Carolina at Chapel Hill. doi:10.3886/ICPSR27021.v9.
- LeTendre ML, Reed MB. The effect of adverse childhood experience on clinical diagnosis of a substance use disorder: results of a nationally representative study. *Subst Use Misuse*. 2017;52(6):689-697. doi:10.1080/10826084.2016.1253746
- Musliner KL, Singer JB. Emotional support and adult depression in survivors of childhood sexual abuse. *Child Abuse Negl*. 2014;38(8):1331-1340. doi:10.1016/j.chiabu.2014.01.016
- Resnick MD, Bearman PS, Blum RW, et al; Findings from the National Longitudinal Study on Adolescent Health. Protecting adolescents from harm. *JAMA*. 1997;278(10):823-832. doi:10.1001/jama.1997.03550100049038
- Babiss LA, Gangwisch JE. Sports participation as a protective factor against depression and suicidal ideation in adolescents as mediated by self-esteem and social support. *J Dev Behav Pediatr*. 2009;30(5):376-384. doi:10.1097/DBP.0b013e3181b33659
- Feldman AF, Matjasko JL. The role of school-based extracurricular activities in adolescent development: a comprehensive review and future directions. *Rev Educ Res*. 2005;75(2):159-210. doi:10.3102/00346543075002159
- Dugoff EH, Schuler M, Stuart EA. Generalizing observational study results: applying propensity score methods to complex surveys. *Health Serv Res*. 2014;49(1):284-303. doi:10.1111/1475-6773.12090
- Kohler U, Karlson KB, Holm A. Comparing coefficients of nested nonlinear probability models. *Stata J*. 2011;11(3):420-438. doi:10.1177/1536867X1101100306
- Eyler AA, Piekarz-Porter E, Serrano NH. Pay to play? state laws related to high school sports participation fees. *J Public Health Manag Pract*. 2019;25(3):E27-E35. doi:10.1097/PHH.0000000000000813
- C.S. Mott Children's Hospital, the University of Michigan Department of Pediatrics and Communicable Diseases, and the University of Michigan Child Health Evaluation and Research (CHEAR) Unit. C.S. Mott Children's Hospital national poll on children's health: pay-to-play sports keeping lower-income kids out of the game. 2012 <http://www.mottnpch.org/sites/default/files/documents/05142paytoplayreport.pdf>. Accessed July, 2018.
- Centers for Disease Control and Prevention, Division of School Health. Whole school, whole community, whole child. Updated March 1, 2018. <https://www.cdc.gov/healthyyouth/wsccl/>. Accessed July, 2018.
- Child Welfare Information Gateway. Protective factors approaches in child welfare. Washington, DC: US Dept of Health and Human Services; 2014. https://cswsp.org/wp-content/uploads/2018/10/protective_factors.pdf. Accessed October, 2018.