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# Prospective Associations between Sport Participation and Indices of Mental Health across Adolescence

**Scott Graupensperger**[1], **Jordan Sutcliffe**[2], **Stewart A. Vella**[2]

[1]Department of Psychiatry and Behavioral Sciences, University of Washington; Seattle, WA

[2]School of Psychology, University of Wollongong, Wollongong, NSW, Australia.

## Abstract

Youth sport offers physical and psychosocial components that may be beneficial for adolescents' mental health, but the prospective directionality between sport participation and mental health has not been clearly established. The current study examined longitudinal associations between sport participation (individual and team sport) and mental health indices (depressive symptoms, anxiety symptoms, emotional symptoms, hyperactivity symptoms, conduct problems, peer problems, and prosocial behavior) across adolescence (ages 12–17) in a nationally representative Australian sample of 3956 participants at T1 ($M_{age}$ = 12.41 years, $SD$ = 0.49; 49% female), 3537 at T2 ($M_{age}$ = 14.41 years, $SD$ = 0.49; 49% female), and 3089 at T3 ($M_{age}$ = 16.46 years, $SD$ = 0.51; 49% female). Using random intercept cross-lagged panel modeling, several significant within-person effects were found. Notably, greater participation in team sport prospectively predicted fewer symptoms of depression and anxiety at subsequent timepoints. This study increases the understanding of how sport participation may relate to mental health among adolescents and provides critical evidence to inform policy.

## Introduction

Organized sport participation is a popular, accessible activity for promoting health-related behaviors in young people (Logan & Cuff, 2019), and there is evidence that sport may be particularly beneficial for mental health (e.g., Panza et al., 2020). This is important because it is estimated that 10–20% of adolescents experience symptoms of a mental health disorder in any given year (Kieling et al., 2011). Although depression and anxiety account for over half of the total burden associated with mental health disorders (Rehm & Shield, 2019), the World Health Organization encourages a broader view of mental health, defined as "a state

*Please direct correspondence to Dr. Scott Graupensperger: graups@uw.edu.

Authors' Contributions

SG conceived the study, performed the data analyses and coordinated the first draft of the manuscript and its submission; JS organized the data and helped conceive the study, assisted with the interpretation of the results, and participated in manuscript drafting; SV contributed to study conception, the interpretation of the findings and manuscript drafting. All authors read and approved the final manuscript.

Conflicts of Interest

The authors report no conflicts of interest.

Compliance with Ethical Standards

Ethical standards were adhered to in all aspects of the Longitudinal Study of Australian Children. For more information on specific procedures and ethical clearance, please visit: https://growingupinaustralia.gov.au/

of well-being in which the individual realizes his/her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his/her community" (WHO, 2014). Mental health is thus conceptualized in terms of the presence/absence of both wellbeing and mental health problems or illness (Westerhof & Keyes, 2010). Although sport participation appears to be a salient context for the promotion of mental health, the prospective directionality of this relationship remains unclear among adolescents. This study therefore estimates prospective associations across adolescence between sport participation (individual and team sport) and several indices of mental health.

## Prevalence of Mental Health in Adolescence

The global burden associated with mental health disorders is vast, and has remained stable despite major increases in mental health care expenditures over recent decades (Meadows et al., 2019). Indeed, it is estimated that more than one billion people have been personally affected by a mental health disorder and, in terms of disability-adjusted life years, mental health disorders account for approximately 20% of all years lived with a disability (Rehm & Shield, 2019). For perspective, mental health disorders account for 15–30% of disability-adjusted life years lost during the first 30 years of life (Kieling et al., 2011). Recent reports highlight the pervasiveness of mental health disorders among adolescents in developed countries, and there is evidence that the prevalence has continued to climb across the past several decades (e.g., Mojtabai et al., 2016). Adolescence is also a pivotal period for prevention efforts given some have estimated that approximately 50% of mental health disorders develop before age 14 (Kessler et al., 2005).

Untreated mental health disorders in adolescence can negatively impact personal development, educational attainments, and quality of life (Slominski et al., 2011). Despite this knowledge, current efforts to treat and prevent mental health disorders are often inadequate, even in highly developed countries. For example, a study in Australia designed to examine the adequacy of mental health treatment for adolescents estimated that only 11.6% of youth with a mental health disorder had enough contact with health providers to even sufficiently complete the minimally adequate treatment (MAT) assessment (Sawyer et al., 2019). Moreover, treatment is often resource-intensive and primarily allocated to youth with the most severe impairment. As adolescent mental health remains an unmitigated public health priority, there is a need to identify economical prevention programs and strategies that can effectively reach many adolescents. One relatively cost-effective public platform that can benefit adolescent mental health is organized recreational sport (Panza et al., 2020).

## Youth Sport and Mental Health

Organized sport is among the most popular activities for school-aged youth (Aubert et al., 2018). Researchers have accordingly investigated how sport participation relates to healthy youth development, including indices of mental health (Vella, 2019). Despite increasing attention to how sport participant may relate to mental health, research in this area has largely focused on elite sport (Vella & Swann, 2020), which is problematic as less than 6% of athletes are considered elite (NCAA, 2019). As such, the high prevalence of sub-elite or community-based sport (i.e., approximately 94% of athletes) offers a unique opportunity to

address youth mental health. Altogether, there is mounting evidence that sport participation is associated with mental health among youth (see review Panza et al., 2020), and this should be of primary focus for researchers in recreational sport domains (Vella & Swann, 2020).

Sport participation may be constructive for adolescents due to the inherent physical activity, the social relationships and friendships that can be made in this setting, and the sense of identity and belongingness that can be derived from sport participation – all of which have been empirically tied to increased mental health and well-being (Ahn & Fedewa, 2011; Graupensperger, Benson, et al., 2020; Graupensperger, Panza, et al., 2020). By contrast, adolescent athletes' mental health may be jeopardized by inadequate or abusive relationships with other social agents in the youth sport environment (e.g., coaches and parents; Macdonald et al., 2012). Similarly, overly intense or laborious sport participation, such as an unusually high number of hours dedicated to sport per week, may lead to perceptions of overtraining and decreased wellbeing (Merglen et al., 2014). Although the aforementioned literature shines a light on the salience of sport participation for youth mental health, studies have often focused narrowly on traditional mental health outcomes (e.g., depression, anxiety). A broader conceptualization of mental health that encompasses emotional and behavioral difficulties may be particularly valuable in adolescent sport participants given the high prevalence of these difficulties in adolescence (Costello et al., 2005).

Beyond symptoms of depression and anxiety, involvement in organized sport has implications for emotional and behavioral problems among youth and adolescents. For example, it has been reported that youth who experience behavioral difficulties are less likely to participate in sport (Vella et al., 2017). Specifically, the authors of this study report that externalizing problems (i.e., behavioral and attentional problems) at age 12 predicted lower sport participation rates at age 14. This finding is troubling as highly hyperactive adolescents may particularly benefit from sport participation as the inherent physical activity can curb the inattentiveness and impulsivity seen in these youth (Putukian et al., 2011). Indeed, one study found that hyperactive youth experienced fewer symptoms of internalizing problems, affective problems, and symptoms of depression and anxiety when enrolled in three or more community sports (Kiluk et al., 2009). Collectively, there are clear associations between involvement in organized sport and broad mental health outcomes; however, researchers need to clarify the prospective direction of such associations. Does sport involvement enhance adolescents' mental health, or do adolescents with better mental health engage in more sport?

A recent meta-analysis highlighted that the majority of studies examining the association between sport participation and mental health problems (depression and anxiety) have been cross-sectional (Panza et al., 2020). One study did report a bidirectional association between sport and mental health (Vella et al., 2017), though this research only entailed two waves of data and was therefore unable to disentangle within- and between-person effects that are critical when assessing prospective directionality of effects (Hamaker et al., 2015). As such, there remains a need to clarify the prospective directionality of mental health and sport through longitudinal research and to examine whether these effects differ between adolescent boys and girls.

Generally, there is considerable evidence that sex differences exist with respect to depression, anxiety, and emotional and behavioral difficulties (for reviews, see Altemus et al., 2016; Bor et al., 2014). For example, while some studies report more mental health problems among adolescents boys than adolescent girls (i.e., 15.9% compared to 12.8%; Lawrence et al., 2015), others report the opposite (e.g., Geelen et al., 2015). Similarly, another study found that adolescent girls (compared to boys) experience more negative sport-related social experiences (e.g., teasing, body shaming) that may contribute to mental health and attrition from sport involvement (Slater & Tiggeman, 2011). Using meta regression, a recent review found that published studies with a higher percentage of male participants reported stronger inverse associations between sport involvement and anxiety symptoms (Panza et al., 2020). As a final point, it appears as though favorable psychosocial outcomes are more salient in team sports compared to individual sport; however, this typically varies between sex (Eime et al., 2013). Taken together, while there is initial evidence that the link between sport and mental health may differ for boys and girls, there is a need to further explore potential sex differences.

## The Current Study

There remains a lack of understanding about the prospective directionality of associations between mental health and sport participation among adolescents. As such, the purpose of the current study was to estimate prospective associations across adolescence between sport participation (individual and team sport) and several indices of mental health. A second exploratory aim entailed testing whether associations between sport participation and mental health differed between adolescent boys and girls. The current study applies a broad conceptualization of mental health that includes depressive symptoms, anxiety symptoms, emotional symptoms, hyperactivity symptoms, conduct problems, peer relationship problems, and prosocial behavior. Sport participation is currently operationalized as the amount of sport (i.e., continuous indicator) to assess linear associations in a more comprehensive manner relative to assessing binary indicators of sport participation (Panza et al., 2020). Although it was anticipated that sport participation would be associated with more favorable scores on mental health indices, the novelty of this specific research question makes it difficult to propose specific hypotheses pertaining to the direction of prospective effects and the extent that the associations would be more salient at the between- or within-person level.

## Method

### Participants

These data were drawn from Wave 5 (T1; 12 or 13 years of age), Wave 6 (T2; 14 or 15 years of age) and Wave 7 (T3; 16 or 17 years of age) of the Longitudinal Study of Australian Children (LSAC; K cohort). In the first stage of recruitment, Australian postal codes were used as the primary sampling unit and were stratified by state location (rural/urban). Then, participants were recruited from the nation’s largest database (the Medicare database) to ensure a representative national sample prior to being randomly selected and invited to participate in the ongoing LSAC study. The analytic sample included 3956 participants at T1

($M_{age}$ = 12.41 years, $SD$ = 0.49; 49% female; 2.9% indigenous), 3537 at T2 ($M_{age}$ = 14.41 years, $SD$ = 0.49; 49% female; 2.4% indigenous), and 3089 at T3 ($M_{age}$ = 16.46 years, $SD$ = 0.51; 49% female; 2.2% indigenous). For more information on the LSAC, please visit https://growingupinaustralia.gov.au/.

## Procedures

Data were collected by trained staff using self-report questionnaires from either the child or the primary parent (i.e., primary parents self-identified as the parent that knows the child best). Data from Waves 5–7, spanning ages 12–17 years were examined. The research methodology and survey content of LSAC were reviewed and approved by the Australian Institute of Family Studies Ethics Committee, which is a Human Research Ethics Committee registered with the National Health and Medical Research Council. Informed consent was obtained from all participants.

## Measures

**Sport participation.—**Sport participation was measured using self-reported items pertaining to regular participation in organized team and individual sports. Sport participation variables were assessed via parent-report at T1 but were self-reported by the participant at T2 and T3[1]. Participants were asked "In the last 12 months, have you regularly participated in team sport (e.g., football, cricket, or netball)?", and subsequently, "In the last 12 months, have you regularly participated in individual sport (e.g., tennis, karate, or gymnastics)?" Adolescents could answer either "yes" or "no" for each item.

Furthermore, at T1 and T2, participants self-reported how many days per week they were involved in team or individual sport (e.g., "How many days are you involved in team sport in a typical week?"). In addition, participants were asked how many hours they allocated to sport during a typical day (e.g., "On this day/these days, about how many hours did you spend going to team sport?"). Participants could choose between 1 (*up to one hour a day*), 2 (*more than one hour but less than 2 hours a day*), or 3 (*more than 2 hours a day*). The LSAC survey included a slightly different item at T3 (Wave 7); participants were only asked to self-report how many hours they participated in sport in a typical week (e.g., "In a typical week, how many hours would you spend doing team sport, including practice or training where relevant?"). Response options were 1 (*less than one hour*), 2 (*between one and three hours*), 3 (*more than three hours but less than five*), 4 (*between five and ten hours*), 5 (*more than ten and less than fifteen*), or 6 (*fifteen hours of more*). To reach consistency with these measures of sport participation across time points, sport participation was calculated at T1 and T2 by multiplying (a) days involved in sport per week by (b) hours spent in sport during a typical participation day to obtain weekly hours of sport participation. These scores were then recoded accordingly to align with the six response options used at T3, as described above.

**Anxiety symptoms.—**Anxiety symptomology was assessed using the eight-item version of the Spence Children's Anxiety Scale (SCAS-C8; Reardon et al., 2018; Spence et al.,

[1]Within the LSAC, items that pertain to involvement in community sport transitioned from parent-reported to child-reported in Wave 6.

2003). Items address symptoms of DSM–IV anxiety disorders, including generalized anxiety, social phobia, panic and agoraphobia, and physical injury fears. Items were rated on a 4-point scale: 0 (*never*), 1 (*sometimes*), 2 (*often*), or 3 (*always*). The SCAS-C8 had strong internal validity at each of the three waves ($\alpha$ = 0.87 at T1, 0.89 at T2, and 0.92 at T3).

**Depressive symptoms.—**Depressive symptoms were assessed using the Short Mood and Feelings Questionnaire (SMFQ; Angold et al., 1995). Participants were asked to report the presence and severity of depressive symptoms within the last two weeks on the basis of the DSM-IV criteria. The questionnaire consists of 13 items and each item was scored as 0 (*not true*), 1 (*sometimes true*), or 2 (*true*). A summed score of the 13 items represents an index of depressive symptomology ranging from 0 – 26, where 0 reflects no symptoms. The SMFQ showed strong internal validity at each of the three waves ($\alpha$ = 0.92 at T1, 0.94 at T2, and 0.95 at T3).

**Emotional and behavioral difficulties.—**Emotional and behavioral difficulties were measured with the 25-item Strength and Difficulties Questionnaire (SDQ; Goodman et al., 2000). The SDQ entails five subscales (five items each): prosocial behavior, emotional symptoms, peer relationship problems, conduct problems, and hyperactivity/inattention. Items were reported on a 3-point scale ranging from 0 (*not true*), 1 (*somewhat true*), or 2 (*certainly true*), and were summed within each subscale (i.e., scores range from 0 – 10 for each subscale). The SDQ has been supported in previous adolescent samples (Van Roy et al., 2008), but confirmatory factor analysis (CFA) was conducted to confirm its factor structure within the current sample. The CFA (reported in full in Table S1 of the supplemental online materials) confirmed that the 5-factor model was an excellent fit to the data at each time point. Model fit indices were nearly identical at all three time points: RMSEA = .07, CFI = .98, TLI = .98, SRMR = .01. At each time point, all items loaded significantly onto the theorized factors at $p < .001$.

## Analyses

Preliminary analyses entailed identifying correlates of attrition, descriptively examining mean scores on study variables across adolescence, and calculating bivariate correlations. The primary analyses focused on estimating prospective longitudinal effects between sport participation and mental health indices across adolescence. This was accomplished through random intercepts cross-lagged panel modeling (RI-CLPM), which is a nuanced form of longitudinal structural equation modeling that treats responses across time as nested within individuals (Hamaker et al., 2015). RI-CLPM advances traditional cross-lagged approaches by disentangling time-variant associations (within-person) from stable trait-like differences between participants. Specifying random intercepts as latent variables (with factor loadings set to 1) parses out between-person effects and enables accurate estimation of intra-individual associations across time that reflect prospective directional effects (Curran & Bauer, 2011). This contemporary latent variable approach is a critical advancement over cross-lagged models that imprecisely estimate a combined effect of within- and between-person associations that are subject to inference errors and ecological fallacy (Curran & Bauer, 2011).

Separate RI-CLPMs were fit for each of the associations of interest using Mplus version 8.0 and were estimated using maximum likelihood estimation with robust standard errors to correct for any potential non-normality in the data (Muthén & Muthén, 2018). The effects estimated in these models are depicted in Figure 1. The correlation path between the two latent random intercepts (BP path) estimates the between-person association between sport participation and the mental health indices, which accounts for stable trait-like differences between participants. Controlling for these trait-level associations, several within-person effects are then estimated. Autoregressive paths (AR) estimate the extent that within-person deviations in study constructs can be predicted by deviations from participants' own expected values on these constructs at prior timepoints. Correlations between variables at a given timepoint estimate contemporaneous covariance (CV paths). Note that autoregressive and contemporaneous associations are not currently in focus but are necessary to include when computing RI-CLPMs. Finally, central to the focus of this research, the cross-lagged paths (CL) estimate prospective longitudinal associations between sport participation and mental health indices. To enhance interpretation of these longitudinal analyses, the within-person associations were constrained to equality across the three timepoints. This parsimonious model is justified given the three measurement occasions are equally spaced across adolescence (i.e., two-year intervals).

To test whether associations differed by sex, invariance testing was conducted using multiple-group analysis in Mplus (Muthén & Muthén, 2018). This step entailed comparing (a) constrained models with paths fixed to equivalence by sex to (b) unconstrained models where effects could differ by sex. A significant $\chi^2$ test would indicate superior model fit in the unconstrained model and, when this was the case, invariance was probed by fitting separate models for boys and girls to examine sex differences.

All RI-CLPMs were robust to potential nonnormality in the data as the models were fit using maximum-likelihood estimation with robust standard errors. Because there was attrition (i.e., 10.6% from T1 to T2 and 21.9% from T1 to T3), full-information maximum likelihood (FIML) estimation was used, allowing for use of cases with partially missing data (i.e., those individuals missing data at T2 or T3) and provides accurate and unbiased parameter estimates under the assumption that data were missing at random after accounting for model covariates (Enders, 2011). Furthermore, several studies have used simulation to demonstrate that when correlates of missingness are included in the analyses, FIML will yield unbiased estimates of parameters and standard errors (see example simulations in Enders, 2010, and Schafer & Graham, 2002). Handling missing data with FIML and therefore including cases with partially missing data is preferred over listwise/casewise deletion as excluding participants who had missing waves ignores key information and could bias model estimates (Little et al., 2014). Model fit was assessed using the following indices: root-mean-square error of approximation (RMSEA), comparative fit index (CFI), and standardized root-mean-square residual (SRMR).

## Results

Descriptive statistics and bivariate correlations are displayed in Table 1. On average, adolescents in this sample engaged in more hours of team sport than individual sport. Mean

depression scores increased across adolescence (i.e., T1 = 4.06, T2 = 5.43, T3 = 7.52), but note that mean values were well below the threshold used to indicate the presence of depression (i.e., 12 or higher; Angold et al., 1995). However, a substantial portion of the sample did score 12 or higher, which is indicative of considerable depressive symptoms (i.e., T1 = 9.38%, T2 = 17.13%, T3 = 27.89%). Similarly, symptoms of anxiety increased across adolescence, on average (i.e., T1 = 1.72, T2 = 1.75, T3 = 1.85), but mean scores fell below scale midpoints at all timepoints (i.e., scale scores ranged from 1 – 4). Pertaining to difficulties (emotional, hyperactive, conduct, and peer problems), slight increases were seen across adolescence, but all mean scores were relatively low and below scale midpoints. Hyperactive problems were the most widely reported among adolescents. Finally, the sample scored relatively high on prosocial behavior at all three timepoints.

Prior to the main analyses, the extent to which attrition was associated with key study variables was estimated. Attrition was not significantly associated with participant sex ($\chi^2$ = 0.26, $p$ = 0.61), T1 team sport participation ($t$ = 2.00, $p$ = 0.05), or T1 individual sport participation ($t$ = −0.93, $p$ = 0.35). However, attrition was greater among participants with higher depression scores at T1 ($t$ = −3.23, $p$ < .001), more conduct problems at T1 ($t$ = −4.63, $p$ < .001), and more emotional problems at T1 ($t$ = −2.46, $p$ = .04). Because these T1 measures are included in the primary analytic models, estimates using FIML account for differential attrition associated with these variables. The results of models based on listwise deletion of cases with partially missing data are reported in the online supplement and are similar to the results using FIML to include all available cases.[2]

Results from the RI-CLPM examining associations between team sport participation and mental health indices are shown in Table 2. At the between-person level, team sport participation was inversely related to all indices of mental health problems and positively associated with prosocial behavior. Central to the aims of this study, prospective within-person paths revealed that team sport participation negatively predicted symptoms of depression and anxiety at later timepoints. A bidirectional effect was found for emotional symptoms whereby team sport participation inversely predicted emotional symptoms at later timepoints and emotional symptoms inversely predicted team sport participation at later timepoints. No significant prospective associations were identified for the remaining mental health indices. Multiple-group analyses found significant invariance by sex for the associations between team sport participation and depressive symptoms (described below), but there was no evidence for sex differences in regard to any of the other mental health indices.

The results for individual sport participation are displayed in Table 3. At the between-person level, inverse associations were found between individual sport participation and depressive symptoms, anxiety symptoms, emotional symptoms, hyperactivity symptoms, and conduct problems. However, there was scant evidence of within-person effects. The only significant prospective association identified at the within-person level was that emotional symptoms inversely predicted individual sport at later timepoints. As with team sport, multiple-group

[2]Note that the primary findings from the sensitivity analyses conducted using only complete cases did not differ from the models reported in the manuscript, which used full information maximization likelihood to retain all cases and all available information.

analysis revealed invariance by sex for the association between individual sport participation and depressive symptoms, but no significant sex differences were found for any of the other mental health indices.

### Sex Differences

To further probe the significant invariance between sport participation and depressive symptoms, separate RI-CLPMs were fit for boys and girls (Table 4). The team sport models revealed a strong inverse association between team sport participation and depressive symptoms at the between-person level for boys (but no significant prospective associations), and a prospective association indicating team sport participation inversely predicted depressive symptoms for girls (but no significant between-person association). This finding indicates that boys who typically participate in more team sport also typically report fewer symptoms of depression, but directionality cannot be inferred. Alternatively, team sport participation for girls may protect against later reports of depressive symptoms, but there was no significant trait-level association. Pertaining to individual sport, there was a strong inverse between-person association for boys, but a *positive* prospective within-person association indicating that individual sport participation may predict increased depression at later timepoints. The contradicting associations at the between and within-person levels indicate that, although boys who typically engage in more individual sport typically report lower levels of depression, greater deviations from one's expected amount of sport participation (e.g., more than usual) are predictive of increased deviations from one's expected level of depression at subsequent timepoints (e.g., more symptoms of depression than usual). For girls, there was no significant between-person association between individual sport and symptoms of depression, but there was a significant within-person effect. However, in contrast to team sport, the direction of this prospective within-person effect was reversed: Depressive symptoms among girls inversely predicted individual sport participation at later timepoints. Taken together, unconstrained models revealed that the nature of associations between sport participation and depressive symptoms may differ between boys and girls and may vary by sport type (i.e., team or individual).

## Discussion

Adolescent illbeing is a pervasive public health issue observed worldwide, and therefore cost-effective solutions are highly sought. One economic and highly accessible activity that can benefit adolescent mental health is organized sport (Panza et al., 2020). In the last decade, there has been a rapid proliferation of mental health research in sport domains, often highlighting the complexity of this relationship. However, the directionality of the relationship between sport participation and adolescents' mental health remains unclear, and therefore the current study used contemporary longitudinal analyses to examine these associations in a large and nationally representative sample of Australian adolescents. As a result, the findings from this study provide novel clarity with respect to the prospective associations across adolescence between sport participation (individual and team sport) and an array of mental health outcomes.

Although it has been speculated that sport participation can have constructive effects on adolescents' mental health and well-being, this study provides critical evidence for the direction of these effects, or lack thereof depending on the specific mental health index. Depression and anxiety disorders are of primary concern for adolescents (Kieling et al., 2011), and the current results provide evidence for a directional effect such that team sport participation prospectively predicts fewer symptoms of depression and anxiety, but not vice versa. Conversely, no directional effects were detected for individual sport with respect to symptoms of depression and anxiety. The results also indicated a bidirectional effect between team sport and emotional symptoms, such that more team sport involvement prospectively predicted fewer emotional symptoms, while more emotional symptoms prospectively predicted less team sport involvement. Interestingly, there was a directional effect for individual sport such that more emotional symptoms prospectively predicted less individual sport involvement, but not vice versa. Taken together, adolescents with emotional symptoms may understandably be less likely to continue with sport but, antithetically, these data also show that playing more team sport could potentially reduce ones' emotional symptoms.

Although both team and individual sport were linked to better mental health at the between-person level, the evidence of a predictive association for team but not individual sport (depression and anxiety) supports previous studies that have concluded team involvement can have particularly positive effects on youth social and psychological health (see review Eime et al., 2013). It is nevertheless plausible that some youth would excel more in team settings while others may prefer individual participation, especially considering that team settings can entail negative social experiences such as bullying (Evans et al., 2016). Indeed, sport participation is beneficial to most youth's mental health, but not all (Panza et al., 2020). Thus, a critical next step is to better understand the heterogeneity in associations between sport involvement and mental health. A more robust understanding of the underlying protective mechanisms of sport for youth mental health will allow researchers and policy makers to implement specifically tailored sport participation opportunities with the goal of benefitting *all* who participate.

## Sex Differences

A secondary aim of the current study was to examine the extent that associations between sport participation and mental health differ between adolescent boys and girls. To address this, multiple-group analysis, a structural equation modeling technique that can be applied and interpreted similarly to a moderation analysis, was used to detect invariance by participant sex. Models for all mental health indices were invariant by sex, except for depression: The association between sport participation and depression differed significantly for boys and girls (for both team and individual sport). Stratifying the sample by sex revealed that only boys who tend to play more sport – team or individual – also tend to experience fewer symptoms of depression. Alternatively, a prospective predictive association was found for girls' participation in team sport, whereby greater team sport involvement predicted fewer symptoms of depression at subsequent timepoints. This extends previous longitudinal research reporting that, in comparison to boys, girls reported greater psychosocial benefit from participating in organized sport (Vella et al., 2014). Altogether,

team sport is associated with lower levels of depression for boys but a predictive constructive effect of team sport participation on depressive symptoms was only found for girls.

Results also revealed notable sex differences pertaining to the association between *individual* sport and depressive symptoms. Although between-person associations indicated that boys who tend to play more individual sport tend to report fewer depressive symptoms, the within-person effects indicated the opposite – timepoints in which boys engaged in relatively more individual sport predicted *greater* depressive symptoms at subsequent timepoints. This complex finding nevertheless partially aligns with a recent findings that there may be higher prevalence of anxiety and depression in individual sport athletes, relative to team sport athletes (Pluhar et al., 2019). The authors speculated that these differences may have been due to athletes' varying types of motivation to participate in sport, whereby individual athletes more often report goal-oriented motives for participation rather than for fun. Therefore, there are likely additional moderating variables (e.g., motivation) that would provide clarity to the associations between sport participation and mental health among adolescents.

With regard to adolescent girls, no significant between-person effects were uncovered for either individual or team-sport participation. However, within-person effects indicated that greater depressive symptoms prospectively predicted less subsequent involvement in individual sport. This finding warrants comparison to previous work that found higher reports of mental health problems (i.e., social physique anxiety and disordered eating) in individual female athletes in comparison to team sport female athletes (Haase, 2011). The authors comment that individual sports may lend to more social evaluation, and in turn, more concern for self-presentation. In effect, team sports may allow for diffusion of evaluation and perceived security among female athletes (Haase, 2009). Taken together, there may be additional elements to consider with regard to protecting the mental health of individual female athletes.

## Implications

The overall takeaway of the current study is that adolescent sport participation is indeed linked to more favorable scores on indices of mental health, including downstream constructive effects that highlight the longitudinal value of sport participation. Sport is widely accessible for youth and emerging adults, and therefore sport should be lauded for its potential to protect mental health, particularly among recreational and/or sub-elite athletes (who represent the vast majority of athletes; Vella & Swann, 2020). Nevertheless, while these data provide sound evidence that sport can have psychosocial benefits for adolescents, there remains a need to further identify what comprises an ideal youth sport experience. Additionally, the promising findings reported herein highlight the need to better understand whether similar directional trends of improved mental health persist through early adulthood (Jewett et al., 2014). Furthermore, this study has also elucidated several methodological considerations. Given that statisticians have recently raised concerns regarding the interpretability of traditional cross-lagged models (Berry & Willoughby, 2017), a contemporary approach (i.e., RI-CLPM) that more accurately estimates prospective

directional effects by factoring-out the trait-level between-person associations was employed (Hamaker et al., 2015). This methodology enabled us to uncover that the association between mental health and sport participation may exist at both the between- and within-person levels, depending on the index of mental health. This holds important implications for the methodology used in future studies as researchers continue to examine long-term effects of sport participation.

### Limitations

Alongside notable strengths of the current study, including a large and nationally representative longitudinal sample of adolescents, several limitations warrant mention. First, it should be noted that beyond an estimate of hours per week, few details pertaining to the nature of adolescents' sport involvement were available, which limited the research team's ability to examine how factors such as competitive level of sport may affect the association between participation and indices of mental health. Indeed, recent work has noted the need to develop more detailed and rigorous measures to assess sport participation (Panza et al., 2020). Related to measurement limitations, mental health constructs as presently measured are subject to potential ceiling/floor effects, so there is a need for the field to further improve fine-grained measurement of mental health. A second limitation is that these data were self-report and observational across time, so although directional prospective associations were identified, causal inference is not warranted without further experimental design (e.g., manipulating amount of sport involvement). Another limitation is that the LSAC dataset, despite being nationally representative, does not entail variables pertaining to participant race/ethnicity, which limited the ability to identify potential disparities and, as such, it is critical that future studies and largescale data collection efforts record participant race/ethnicity. Lastly, these longitudinal data enabled the use of innovative structural equation modeling techniques, but only in 2-year intervals that may not capture more immediate benefits of sport participation. A more detailed understanding of the associations between sport and mental health could be derived from intensive longitudinal sampling, such as daily-diary studies that could estimate within-person associations (i.e., is mental health better on days in which adolescents play sports?).

## Conclusion

There has been a lack of understanding with respect to the directionality of the relationship between organized youth sport participation and adolescent mental health. In this study, novel insight with respect to the prospective associations between participation in organized sport (team and individual) and indices of mental health is offered. Using contemporary analytic modeling and a large representative sample of Australian adolescents, between-person evidence that adolescents who participate in more team or individual sport report more favorable mental health were uncovered. Additionally, within-person effects showed that team sport participation prospectively predicted fewer symptoms of depression and anxiety. Lastly, notable gender differences include the finding that boys who play more sport (team or individual) also tend to experience fewer symptoms of depression, whereas only team sport prospectively predicted fewer symptoms of depression among girls. Taken together, the currents study provides additional clarity surrounding the directionality of

effects between sport participation and mental health, though it is encouraged that scholars continue this line of inquiry with robust experimental and longitudinal designs. Such studies are critically important in providing a body of evidence upon which policy can be articulated and implemented in order to maximize the benefits and minimize the detriments of sport participation on mental health worldwide.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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### Data Sharing Declaration

The data that support the findings of this study are available from the Longitudinal Study of Australian Children, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available without application procedures.

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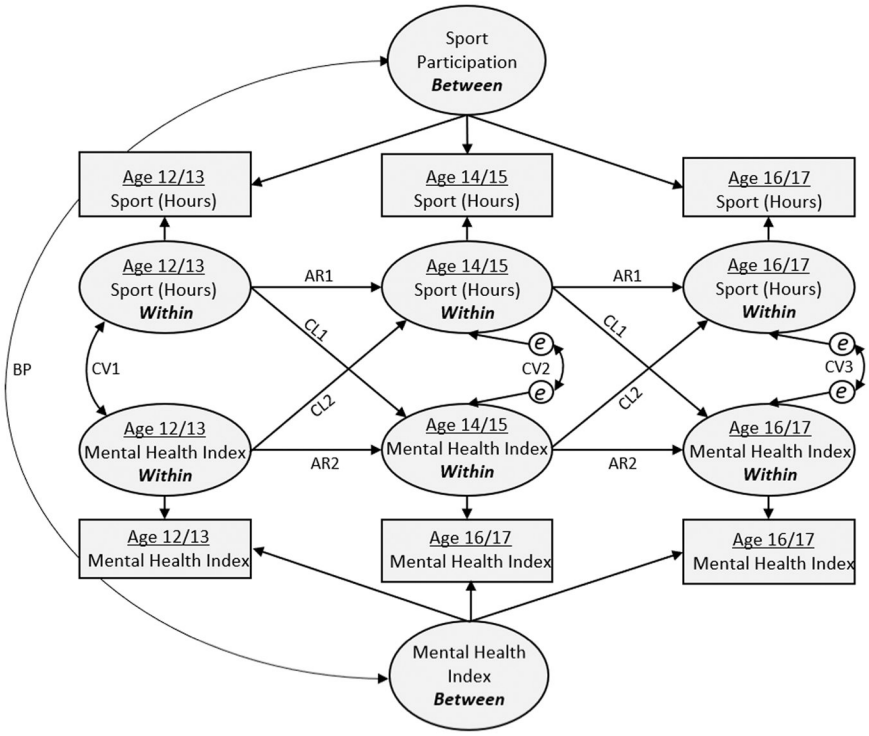


**Figure 1.**

Random intercept cross-lagged panel modeling approach to estimate prospective association between sport participation and mental health indices across three timepoints. BP = Between-Person Effect. AR = Within-Person Autoregressive Effects. CL = Within-Person Cross-Lagged Effects. CV = Within-Person Contemporaneous Covariance Estimates. AR and CL paths were constrained to equality between the three timepoints to facilitate parsimonious interpretation.

**Table 1.**

Means, standard deviations, and bivariate correlations

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. Team Sport Hours T1** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **2. Team Sport Hours T2** | .43** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **3. Team Sport Hours T3** | .45** | .53** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **4. Individual Sport Hours T1** | .06** | .03 | .03 | | | | | | | | | | | | | | | | | | | | | | | | |
| **5. Individual Sport Hours T2** | .05** | .02 | .06** | .38** | | | | | | | | | | | | | | | | | | | | | | | |
| **6. Individual Sport Hours T3** | .06** | .08** | .15** | .30** | .37** | | | | | | | | | | | | | | | | | | | | | | |
| **7. Depression Symptoms T1** | −.11** | −.08** | −.08** | −.04* | −.05** | −.05* | | | | | | | | | | | | | | | | | | | | | |
| **8. Depression Symptoms T2** | −.12** | −.07** | −.10** | −.08** | −.06** | −.10** | .31** | | | | | | | | | | | | | | | | | | | | |
| **9. Depression Symptoms T3** | −.05** | −.06** | −.07** | −.04* | .04* | .01 | .22** | .30** | | | | | | | | | | | | | | | | | | | |
| **10. Anxiety Symptoms T1** | −.12** | −.09** | −.10** | −.03* | −.05** | −.09** | .43** | .27** | .19** | | | | | | | | | | | | | | | | | | |
| **11. Anxiety Symptoms T2** | −.11** | −.10** | −.12** | −.06** | −.07** | −.10** | .29** | .53** | .30** | .46** | | | | | | | | | | | | | | | | | |

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **12. Anxiety Symptoms T3** | −.12** | −.12** | −.13** | −.03 | −.06** | −.08** | .23** | .35** | .40** | .38** | .58** | | | | | | | | | | | | | | | | |
| **13. Emotional Problems T1** | −.14** | −.10** | −.13** | −.07** | −.06** | −.10** | .43** | .28** | .21** | .71** | .44** | .35** | | | | | | | | | | | | | | | |
| **14. Emotional Problems T2** | −.13** | −.14** | −.18** | −.07** | −.07** | −.12** | .30** | .53** | .31** | .44** | .78** | .54** | .52** | | | | | | | | | | | | | | |
| **15. Emotional Problems T3** | −.13** | −.13** | −.16** | −.05* | −.08** | −.10** | .23** | .36** | .45** | .37** | .55** | .76** | .41** | .61** | | | | | | | | | | | | | |
| **16. Hyperactive Symptoms T1** | −.03 | −.03* | −.05** | −.07** | −.06** | −.07** | .35** | .23** | .18** | .31** | .19** | .17** | .38** | .23** | .20** | | | | | | | | | | | | |
| **17. Hyperactive Symptoms T2** | −.04* | −.04* | −.04* | −.07** | −.05** | −.07** | .31** | .35** | .22** | .23** | .32** | .24** | .28** | .39** | .28** | .61** | | | | | | | | | | | |
| **18. Hyperactive Symptoms T3** | −.03 | −.02 | −.02 | −.03 | −.04* | −.04* | .24** | .19** | .27** | .19** | .21** | .30** | .23** | .25** | .38** | .47** | .59** | | | | | | | | | | |
| **19. Conduct Problems T1** | −.05** | −.06** | −.07** | −.09** | −.04* | −.06** | .41** | .25** | .17** | .33** | .18** | .15** | .38** | .22** | .19** | .53** | .40** | .30** | | | | | | | | | |
| **20. Conduct Problems T2** | −.05** | −.07** | −.07** | −.08** | −.06** | −.06** | .32** | .39** | .20** | .21** | .31** | .19** | .25** | .36** | .23** | .42** | .53** | .33** | .56** | | | | | | | | |
| **21. Conduct Problems T3** | −.03 | .00 | −.01 | −.03 | .00 | −.01 | .26** | .25** | .25** | .13** | .15** | .21** | .16** | .17** | .27** | .32** | .37** | .44** | .47** | .55** | | | | | | | |
| **22. Peer Problems T1** | −.14** | −.12** | −.13** | −.05** | −.03 | −.04 | .38** | .19** | .15** | .39** | .20** | .16** | .42** | .22** | .20** | .27** | .19** | .18** | .37** | .24** | .18** | | | | | | |
| **23. Peer Problems T2** | −.16** | −.17** | −.17** | −.06** | −.06** | −.06** | .31** | .41** | .23** | .33** | .43** | .31** | .35** | .46** | .34** | .23** | .28** | .19** | .29** | .36** | .23** | .44** | | | | | |
| **24. Peer Problems T3** | −.16** | −.14** | −.17** | −.02 | −.02 | −.03 | .26** | .28** | .29** | .24** | .28** | .35** | .25** | .31** | .40** | .20** | .23** | .21** | .25** | .28** | .33** | .37** | .53** | | | | |

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| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **25. Prosocial Behavior T1** | .04** | .02 | .04* | .05** | −.02 | .02 | −.15** | −.01 | −.01 | −.00 | .06** | .03 | .00 | .05** | .01 | −.26** | −.16** | −.14** | −.31** | −.22** | −.22** | −.21** | −.11** | −.11** | | | |
| **26. Prosocial Behavior T2** | .05** | .03 | .06** | .03 | .01 | .04* | −.13** | −.08** | −.03 | −.02 | .04* | .05* | −.04* | .04* | −.01 | −.23** | −.22** | −.15** | −.26** | −.32** | −.26** | −.14** | −.18** | −.16** | .46** | | |
| **27. Prosocial Behavior T3** | .04* | .02 | .05* | .03 | .01 | .06** | −.07** | −.04 | −.03 | −.01 | .05* | .05* | −.02 | .04* | .03 | −.14** | −.11** | −.16** | −.19** | −.21** | −.26** | −.10** | −.14** | −.20** | .35** | .51** | |
| **28. Sex (Male= 1, Female= 2)** | −.** | −.11** | −.17** | .00 | −.01 | −.04* | .04** | .17** | .14** | .15** | .31** | .30** | .15** | .32** | .31** | −.05** | −.01 | −.03 | −.14** | −.07** | −.11** | −.06** | .08** | .07** | .26** | .25** | .21** |
| **Mean** | 1.4 | 1.31 | 1.41 | 0.68 | 0.60 | 0.61 | 4.06 | 5.43 | 7.52 | 1.72 | 1.75 | 1.85 | 2.51 | 2.94 | 3.41 | 3.63 | 3.81 | 4.09 | 1.50 | 1.50 | 1.68 | 1.38 | 1.59 | 1.94 | 7.76 | 7.65 | 7.72 |
| **SD** | 1.7 | 1.73 | 1.65 | 1.30 | 1.30 | 1.25 | 5.32 | 6.59 | 7.64 | 0.51 | 0.59 | 0.66 | 2.11 | 2.40 | 2.55 | 2.31 | 2.38 | 2.31 | 1.52 | 1.54 | 1.61 | 1.56 | 1.67 | 1.71 | 1.76 | 1.78 | 1.74 |
| **Possible Range** | 0 – 6 | 0 – 6 | 0 – 6 | 0 – 6 | 0 – 6 | 0 – 6 | 0 – 26 | 0 – 26 | 0 – 26 | 1 – 4 | 1 – 4 | 1 – 4 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 | 0 – 10 |

***Note***: T1 assessed at age 12/13; T2 assessed at age 14/15; T3 assessed at age 16/17.

* $p < .05$.

** $p < .01$.

**Table 2.**

Parameter estimates obtained from random intercept cross-lagged panel models examining prospective associations between team sport participation and mental health indices.

| | Depressive Symptoms | Anxiety Symptoms | Emotional symptoms | Hyperactivity Symptoms | Conduct Problems | Peer Problems | Prosocial Behavior |
|---|---|---|---|---|---|---|---|
| | ***B (SE)*** | ***B (SE)*** | ***B (SE)*** | ***B (SE)*** | ***B (SE)*** | ***B (SE)*** | ***B (SE)*** |
| **Between-Person Effects** | | | | | | | |
| (BP) Team Sport ↔ MH Index | −.59 (.16)*** | −.07 (.02)*** | −.32 (.07)*** | −.19 (.07)** | −.16 (.04)*** | −.37 (.05)*** | .14 (.05)** |
| **Prospective Within-Person Effects** | | | | | | | |
| (AR1) Team Sport → Team Sport | .09 (.04)** | .10 (.04)** | .10 (.04)** | .09 (.04)* | .09 (.04)** | .10 (.04)** | .09 (.04)* |
| (AR2) MH Index → MH Index | .18 (.04)*** | .48 (.04)*** | .49 (.03)*** | .34 (.03)*** | .22 (.05)*** | .28 (.04)*** | .26 (.03)*** |
| (CL1) Team Sport → MH Index | −.23 (.10)* | −.02 (.00)* | −.07 (.03)* | .04 (.03) | .03 (.02) | −.02 (.03) | −.02 (.03) |
| (CL2) MH Index → Team Sport | −.01 (.01) | −.12 (.07) | −.05 (.02)** | .02 (.02) | −.02 (.03) | −.03 (.03) | .00 (.03) |
| **Contemporaneous Within-Person Covariance Estimates** | | | | | | | |
| (CV1) Team Sport ↔ MH Index | −.32 (.15)* | −.04 (.02)** | −.18 (.07)*** | −.04 (.07) | −.02 (.04) | −.01 (.04) | .01 (.05) |
| (CV2) Team Sport ↔ MH Index | −.13 (.23) | −.04 (.02) | −.24 (.07)** | .02 (.07) | −.04 (.05) | −.12 (.06)* | −.06 (.06) |
| (CV3) Team Sport ↔ MH Index | −.18 (.20) | −.03 (.01)* | −.10 (.05) | .08 (.05) | .09 (.04)* | −.04 (.04) | −.02 (.04) |
| **Model Fit Indices** | | | | | | | |
| RMSEA | .028 | .058 | .048 | .029 | .031 | .049 | .032 |
| CFI | .993 | .980 | .988 | .996 | .995 | .986 | .994 |
| SRMR | .015 | .037 | .024 | .015 | .016 | .023 | .018 |
| **Invariance Test by Sex** | | | | | | | |
| Constrained Model $\chi^2$ (DF) | 41.74 (15) | 74.58 (15) | 50.95 (15) | 32.89 (15) | 33.23 (15) | 60.68 (15) | 45.92 (15) |
| Unconstrained Model $\chi^2$ (DF) | 24.84 (10) | 68.28 (10) | 46.20 (10) | 25.67 (10) | 28.61 (10) | 52.45 (10) | 41.35 (10) |
| $\Delta\chi^2$ | 16.91, $p = .005$ | 6.31, $p = .278$ | 4.74, $p = .448$ | 7.22, $p = .205$ | 4.72, $p = .452$ | 8.23, $p = .144$ | 2.56, $p = .472$ |

***Note:*** MH = Mental health.

*$p < .05$,

**$p < .01$,

***$p < .001$.

**Table 3.**

Parameter estimates obtained from random intercept cross-lagged panel models examining prospective associations between individual sport participation and mental health indices.

| | Depressive Symptoms | Anxiety Symptoms | Emotional symptoms | Hyperactivity Symptoms | Conduct Problems | Peer Problems | Prosocial Behavior |
|---|---|---|---|---|---|---|---|
| | ***B (SE)*** | ***B (SE)*** | ***B (SE)*** | ***B (SE)*** | ***B (SE)*** | ***B (SE)*** | ***B (SE)*** |
| **Between-Person Effects** | | | | | | | |
| (BP) Ind. Sport ↔ MH Index | −.35 (.12)** | −.03 (.01)** | −.15 (.05)** | −.11 (.05)* | −.08 (.03)** | −.05 (.03) | .05 (.05) |
| **Prospective Within-Person Effects** | | | | | | | |
| (AR1) Ind. Sport → Ind. Sport | .12 (.04)*** | .12 (.04)*** | .12 (.04)*** | .12 (.04)*** | .12 (.04)*** | .12 (.04)*** | 12 (.02)*** |
| (AR2) MH Index → MH Index | .17 (.04)*** | .48 (.04)*** | .49 (.03)*** | .34 (.03)*** | .22 (.02)*** | .29 (.04)*** | .26 (.03)*** |
| (CL1) Ind. Sport → MH Index | .12 (.12) | −.01 (.00) | −.04 (.01) | −.04 (.03) | .01 (.01) | −.02 (.03) | .00 (.01) |
| (CL2) MH Index → Ind. Sport | −.01 (.01) | −.07 (.05) | −.03 (.01)* | −.02 (.01) | −.01 (.02) | −.03 (.02) | .01 (.02) |
| **Contemporaneous Within-Person Covariance Estimates** | | | | | | | |
| (CV1) Ind. Sport ↔ MH Index | .11 (.14) | −.01 (.02) | −.05 (.06) | −.10 (.06) | −.07 (.03)* | −.06 (.04) | .12 (.08) |
| (CV2) Ind. Sport ↔ MH Index | −.11 (.15) | −.02 (.02) | −.06 (.05) | −.01 (.05) | −.03 (.03) | −.07 (.04) | .03 (.07) |
| (CV3) Ind. Sport ↔ MH Index | −.32 (.19) | −.01 (.01) | −.06 (.05) | −.01 (.04) | −.05 (.03) | −.01 (.04) | .05 (.04) |
| **Model Fit Indices** | | | | | | | |
| RMSEA | .032 | .046 | .031 | .006 | .021 | .031 | .015 |
| CFI | .984 | .982 | .993 | .999 | .997 | .991 | .994 |
| SRMR | .020 | .035 | .018 | .009 | .013 | .018 | .027 |
| **Invariance Test by Sex** | | | | | | | |
| Constrained Model $\chi^2$ (DF) | 42.85 (15) | 62.45 (15) | 45.04 (15) | 14.74 (15) | 20.60 (15) | 37.96 (15) | 26.13 (15) |
| Unconstrained Model $\chi^2$ (DF) | 28.83 (10) | 51.98 (10) | 34.89 (10) | 12.13 (10) | 17.82 (10) | 27.04 (10) | 20.77 (10) |
| $\Delta\chi^2$ | 14.09, $p = .015$ | 10.47, $p = .063$ | 10.15, $p = .071$ | 2.61, $p = .760$ | 2.79, $p = .734$ | 10.92, $p = .053$ | 5.36, $p = .374$ |

***Note:*** Ind. Sport = Hours of individual sport participation. MH = Mental health.

* $p < .05$,

** $p < .01$,

*** $p < .001$.

**Table 4.**

Unconstrained random intercept cross-lagged panel model estimating prospective associations between sport participation and depressive symptoms stratified by sex.

| | Team Sport Participation | | Individual Sport Participation | |
|---|---|---|---|---|
| | Boys | Girls | Boys | Girls |
| | *B (SE)* | *B (SE)* | *B (SE)* | *B (SE)* |
| **Between-Person Effects** | | | | |
| (BP) Sport ↔ Depression | −.81 (.22)*** | −.24 (.21) | −.52 (.15)*** | −.17 (.20) |
| **Prospective Within-Person Effects** | | | | |
| (AR1) Sport → Sport | .05 (.06) | .16 (.04)*** | .13 (.05)** | .10 (.05)*** |
| (AR2) Depression → Depression | .03 (.06) | .26 (.05)*** | .03 (.06) | .24 (.05)** |
| (CL1) Sport → Depression | −.08 (.15) | −.24 (.13)* | .33 (.16)* | −.07 (.17) |
| (CL2) Depression → Sport | .01 (.01) | −.02 (.01) | .00 (.01) | −.02 (.01)** |
| **Contemporaneous Within-Person Covariance Estimates** | | | | |
| (CV1) Sport ↔ Depression | −.30 (.19) | −.35 (.22) | .27 (.18) | −.06 (.23) |
| (CV2) Sport ↔ Depression | .31 (.37) | −.21 (.28) | .51 (.22)* | −.60 (.22)** |
| (CV3) Sport ↔ Depression | .20 (.32) | .25 (.24) | .32 (.28) | −.41 (.23)** |
| **Model Fit Indices** | | | | |
| RMSEA | | .027 | | .031 |
| CFI | | .993 | | .985 |
| SRMR | | .017 | | .020 |

Note:

*$p < .05$,

**$p < .01$,

***$p < .001$.