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ORIGINAL RESEARCH

Sport Participation for Academic Success: Evidence From the Longitudinal Study of Australian Children

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Background: We aimed to identify long-term patterns of sport participation (overall, team, and individual sport) from childhood into adolescence, and to examine the association between these patterns and academic outcomes. ***Methods:*** This cohort study used data from the Longitudinal Study of Australian Children in wave 3 (4–5 y) to wave 9 (20–21 y). The participants were a nationally representative sample of 4241 children. We conducted latent class analyses to identify sport participation trajectories and assessed the association between these trajectories and academic outcomes. ***Results:*** Continued sport participation was associated with lower odds of being absent from school (OR = 0.44; 95% confidence intervals [CIs], 0.26 to 0.74), better performance on attention ($B = -0.010$; 95% CIs, –0.019 to –0.002) and working memory ($B = -0.013$; 95% CIs, –0.023 to –0.003), higher numeracy ($B = 20.21$; 95% CIs, 14.56 to 25.86) and literacy scores ($B = 9.42$; 95% CIs, 2.82 to 16.02), higher end of school academic performance ($B = 3.28$; 95% CIs, 1.47 to 5.09), and higher odds of studying at university (OR = 1.78; 95% CIs, 1.32 to 2.40). Team sport participation was associated with reduced absenteeism, better performance on attention and working memory, and being awarded the Higher School Certificate. Whereas individual sport participation was associated with higher literacy scores and end of school academic performance. ***Conclusions:*** Team and individual sport participation both benefit academic outcomes, but differently. Given the decline in sport participation during adolescence, these findings highlight the need to develop educational policies to establish an environment that promotes sport participation, which in turn could improve academic outcomes.

Keywords: adolescent, exercise, academic performance, school

Education has a positive effect on health across all life stages.[1] High educational attainment improves health through better employment opportunities, improved economic conditions, increased psychosocial resources, and a healthier lifestyle.[2] Unsurprisingly, there is causal evidence that high educational attainment reduces the risk of mortality.[3,4] For these reasons, identifying the modifiable determinants of children and adolescents' educational outcomes should be a priority for parents, caregivers, teachers, policy makers, and society.

Physical activity positively improves academic performance in children and adolescents.[5] Sport participation is a distinct type of physical activity, and a recent systematic review and meta-analysis of 115 studies found evidence for a positive association between sport participation and academic performance.[6] However, most of the included studies were low-quality and cross-sectional designs.[6]

The few longitudinal studies were shown to generally support positive relationships between sport and academic performance.[6] For example, Ishihara et al[7] reported that sport participation in grade 7 was associated with improvements in academic performance from grade 7 to grade 9 in Japanese children. Dyer et al[8] found that sport participation in the previous year predicted improved academic achievement in English and mathematics for grades 10, 11, and 12 students in the United States. Similarly, Kari et al[9] reported that sport participation at age 15 years was positively associated with students' Grade Point Averages at age 15 years in Finnish children, when controlling for students' previous Grade Point Average. However, other longitudinal studies have reported conflicting results.[6] Hughes et al[10] found that sport participation in grade 8 was not related to academic performance in grade 9 for children in the United States. It is important to note that not all experiences participating in sport are positive, some children experience injuries, stress, anxiety, and social pressures during sport participation.[11] These inconsistent findings could be due to the lack of consideration of the different experiences and types of sport participation.

It is currently unclear how team and individual sport differentially affect academic performance.[6] Individual and team sport require and develop different skills during childhood and adolescence. While both individual and team sport participation appear to be beneficial for academic performance, individual sport participation has been shown to be more beneficial.[7] The additional benefit of individual sport may be explained by self-regulation, which is a set of behavioral skills (eg, the ability to focus on a task) that contribute to academic performance, that has been shown to be developed through individual sport more than team sport.[12] A cross-sectional study of children aged 8–12 years in Belgium found that those participating in team sport had higher executive function

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compared with children participating in individual sport.[13] Team sports may influence academic performance through different mechanisms, such as improved social and mental health.[14,15] Team sports are associated with a greater level of emotional social support, sense of belonging, higher self-esteem, social network, and social interaction.[16] While there is some evidence for the different effects of team and individual sport on academic performance, these few studies have been limited to a narrow range of outcomes.

In summary, there is currently limited and inconsistent longitudinal evidence for the relationship between sport participation and academic performance in children and adolescents. Further, none of the studies have examined long-term sport participation throughout childhood and into adolescence. It is also unclear whether participation in individual and team sport influences a broad range of academic outcomes, including school absenteeism, school completion, academic performance at the end of school, and university enrollment. The primary aim of the current study was to identify long-term patterns of sport participation from childhood into adolescence and to examine the association between these patterns and academic outcomes. A secondary aim was to identify patterns of children and adolescents' participation in team and individual sport and explore the effect of these patterns on academic outcomes.

Methods

Sample

Data were obtained from wave 3 to wave 9 of the K-Cohort (initially ages 4–5 y) of the Longitudinal Study of Australian Children (LSAC).[17] The K-Cohort was used because all educational outcomes were available from participants in this cohort (ie, university enrollment in wave 9). The LSAC is a nationally representative longitudinal study of child development funded by the Australian Government Department of Social Services. The sampling frame for the survey was all individuals in the Medicare Australia database (the universal health scheme which includes all Australian residents). A 2-stage clustered design was used, first randomly selecting postcodes and then randomly proportionally selecting children within each postcode. LSAC K-Cohort data collection (n = 4983) began in 2004 when children were aged 4–5 years, and data were collected every 2 years with relatively consistent response rates (wave 7 = 62%; wave 8 = 61%; wave 9 = 52%). A total of 4241 (85%) children were included in this study (see flow diagram in Supplementary Figure S1 [available online]). The Australian Institute of Family Studies Ethics Committee provided ethics approval for the LSAC, and all participants provided written informed consent.

Findings are reported following the Strengthening the Reporting of Observational Studies in Epidemiology statement (Supplementary Table S1 [available online]).[18]

Measures

Sport Participation

Sport participation (waves 3–7) was measured by 2 items assessing regular participation in team and individual sport. Parents/carers were asked "In the last 12 months, has the child participated in team sport regularly?" and "In the last 12 months, has the child participated in individual sport regularly?" "Regularly means at least once a week, for 3 months or more, for example, a sport season." Responses were used to classify children's participation as yes or no for (1) sport participation (either team sport, individual sport, or both), (2) individual sport participation, and (3) team sport participation. The child may have participated in these sports either in school or out of school.

Educational Outcomes

Executive function (wave 7) was measured using 3 computer-based tasks from the Cogstate Assessment Battery (https://www.cogstate.com/). The identification task was used to assess attention, which involves the child being shown 30 joker playing cards within 2 minutes and being asked to decide as quickly as possible whether the card is red or not. The One Back Memory task was used to measure visual attention and working memory, which involves the child being shown 30 playing cards within 2 minutes and being asked to immediately decide whether the card is the same as the previous card or not. The Groton Maze task was used to assess problem solving and required the child to learn a hidden pathway through a 10×10 grid of tiles, in which they must find the path using trial and error, and once the pathway has been uncovered, to repeat the maze 4 times. The outcome is the total number of errors made across the 5 attempts through the maze. See Yu and Daraganova[19] for detailed information about how the tasks were administered and scored, and their reliability and validity in LSAC.

Academic performance during year 9 of school (wave 7) was measured using the National Assessment Program—Literacy and Numeracy (NAPLAN) results. NAPLAN is a national standardized numeracy and literacy test given to all students in Australia in grades 3 (8–9 y), 5 (10–11 y), 7 (12–13 y), and 9 (14–15 y). Literacy is made up of 4 domains: grammar, reading, writing, and spelling. This study used grammar to represent literacy as grammar as it is a foundational language skill that predicts both reading comprehension[20] and writing skills,[21,22] making it an important aspect of literacy.[23] In 2016 (wave 7), the mean year 9 NAPLAN numeracy score was 588.9 (SD = 66.8) and the mean year 9 grammar score was 569.3 (SD = 66.6).

Absent days (wave 7) were assessed by asking the child to respond to "I was absent from school without parental permission," and responses were grouped into the following categories: never/rarely (1–2 times) and often (3+ times).

Awarded the Higher School Certificate (HSC; wave 8) or equivalent at the end of school was measured by asking the child: "Have you received any of these certificates?" with response options including "ACT Senior Secondary Certificate" "NSW HSC," "Victorian Certificate of Education" "Victorian Certificate of Applied Learning" "Queensland Year 12 Certificate," "South Australian Certificate of Education," "Western Australian Certificate of Education," "Tasmanian Certificate of Education," "Northern Territory Certificate of Education," and "None of the above." Responses were categorized into yes or no. The HSC is the credential awarded to secondary school students who successfully complete senior high school-level studies (years 11 and 12 or equivalent), which, in Australia, typically involves 13 years of schooling.

Academic performance at the end of school (wave 8) was measured using the Australian Tertiary Admission Ranks (ATAR). The ATAR is calculated from the results of a standardized test score in the HSC exams that students complete in years 11 and 12, their final years of secondary school. Each year, ATAR ranges from 0 to 99.95.

University enrollment (wave 9) was examined by asking the child: "Are you currently enrolled to study full-time or part-time?" with options "Yes" or "No." Those who answered yes were asked "What type of institute are you currently studying in?" with

response options including "Secondary School," "Technical or Further Educational Institution (including Technical and Further Education Colleges)," "University or Other Tertiary Institution," and "Other."

Demographic Characteristics

The demographic characteristics measured included sex, language spoken at home, Indigenous status, disability status, maternal education, area-based socioeconomic status (Socioeconomic Indexes for Areas), and remoteness (Accessibility and Remoteness Index of Australia). Socioeconomic status was derived from postcode of residence and categorized according to the Socioeconomic Indexes for Areas Index of Relative Socioeconomic Disadvantage,[24] and remoteness was classified using the Accessibility and Remoteness Index of Australia.[25]

Statistical Analysis

We calculated descriptive statistics, including weighted frequencies and proportions for categorical variables, and weighted means, and standard deviations for continuous variables across waves.

We conducted latent class analysis to identify distinct sport (overall sport, and team vs individual sport) participation trajectories from childhood to adolescence. We first fit a series of models with between 1 and 5 sport participation classes, and then assessed the goodness of fit using Akaike information criterion, Bayesian information criterion (BIC), and sample-size adjusted BIC to determine the optimal number of classes.

We then used multivariable multinomial logistic regression models to assess the association between demographic characteristics and sport participation trajectories, and we reported the effect size as multinomial odds ratios (mOR). Next, we assessed the association between identified sport participation trajectories for waves 3 to 6 with outcomes measured at wave 7, and participation trajectories for waves 3 to 7 with outcomes measured at waves 8 or Wave 9. We used linear and logistic regression models to examine the effect of sport participation class membership on educational outcomes for continuous and binary outcomes, respectively. Unstandardized coefficients are presented in the main text, and standardized coefficients are presented in Supplementary Table S10 (available online). As individuals cannot be assigned to latent classes with certainty, we used the 3-step Bolck–Croon–Hagenaars estimation method [26] to account for the classification uncertainty. All models were weighted by the Bolck–Croon–Hagenaars weight, and adjusted for sex, language spoken at home, Aboriginal status, maternal education, socioeconomic status, and remoteness. Models were conducted in Stata (version 17.0).[27]

Missing Data

To reduce potential bias introduced by missing data, we conducted analyses using multiple imputation. To be conservative, we created 20 imputed data sets[28,29] using the "mice" package in R (version 4.3.1).[30] See Supplementary Material S1 (available online) and Supplementary Figure S2 (available online) for further information on missing data.

Sensitivity Analyses

We ran a set of sensitivity analyses to test the robustness of the results. We repeated the linear and logistic regression models which examined the effect of sport participation class membership on educational outcomes: (1) with no adjustments to assess the extent of confounding; (2) excluding those who had a disability in wave 1, as children with physical disabilities have fewer opportunities and lower levels of sport participation, and children with learning disabilities have lower levels of academic achievement[31]; (3) for boys and girls separately, as boys tend to have higher levels of sport participation[32] and higher numeracy test scores, but lower literacy test scores[33]; (4) excluding children who attended a private school, as these children tend to have better sport and educational resources, facilities, and programs; and (5) controlling for previous academic performance scores where possible (ie, executive function and NAPLAN) to explore changes in academic performance.

Results

Sport Participation Latent Classes

Fit statistics for the 1- to 5-class latent class growth models are shown in Supplementary Table S2 (available online). The 3-class model was selected as the optimal solution. While the 4-class model showed minor improvements in Akaike information criterion, BIC, and sample-size adjusted BIC, this model resulted in small groups (<5%) in the imputed data sets.

For the 3-class models, the average classification probabilities were 0.89 for class 1, 0.75 for class 2, and 0.91 for class 3. Class 1 was labeled as the nonparticipants (n = 1011; 23.8%), where sport participation remained low across all ages (mean = 21%; Figure 1). Class 2 was labeled as the dropouts (n = 1092; 25.8%), where the majority participated in sport at 8–11 years, and this dropped to 12% by 14–15 years. Class 3 was labeled as the continued participants (n = 2138; 50.4%), where over 90% participated in sport at 8–11 years, and this remained relatively high (over 80%) at 16–17 years.

When including team and individual sport participation, the 4-class model was selected as the optimal solution (Supplementary Table S3 [available online]). The average classification probabilities were 0.86 for class 1, 0.72 for class 2, 0.80 for class 3, and 0.74 for class 4. Class 1 was labeled as the nonparticipants (n = 1299; 30.6%), where team and individual sport participation remained low across all ages (Figure 2). Class 2 was labeled as individual sport participants (n = 549; 12.9%), where participants were more likely to participate in individual sport compared with team sport across all ages. Class 3 was labeled as team sport participants (n = 1553; 36.6%), where participants were more likely to participate in team sport compared with individual sport across all ages. Class 4 was labeled as both sport participants (n = 792; 18.7%), where participants were likely to participate in team and individual sport across all ages, with a higher likelihood of team sport participation.

Predictors of Sport Participation Latent Class

Compared with children who did not participation in sport (ie, nonparticipants), demographic characteristics associated with higher odds of continued sport participation were being male (mOR = 2.20; 95% confidence interval [CIs], 1.86 to 2.60), speaking English at home (mOR = 2.10; 95% CIs, 1.61 to 2.75), not identifying as Aboriginal and/or Torres Strait Islander (mOR = 1.87; 95% CIs, 1.08 to 3.24), not having a disability (mOR = 1.56; 95% CIs, 1.26 to 1.92), high maternal education (university level mOR = 4.09; 95% CIs, 3.08 to 5.43), living in the least disadvantaged areas (mOR = 2.68; 95% CIs, 1.84 to 3.89), and living in regional areas (mOR = 1.28; 95% CIs, 1.06 to 1.54; Table 1).

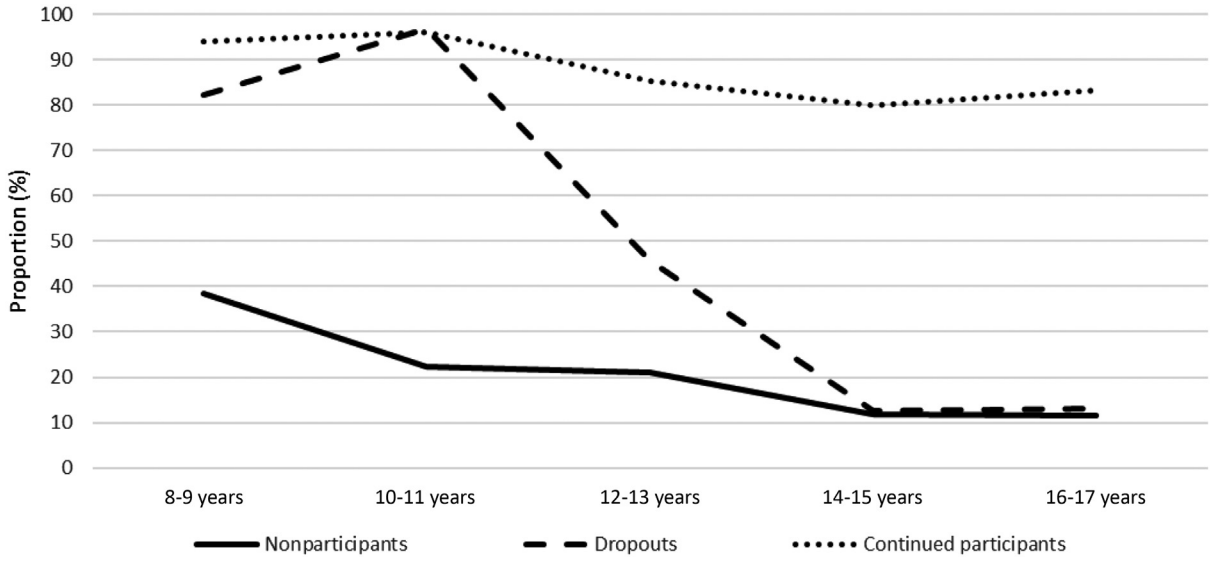

Figure 1 — Probabilities of participating in sport for each class over time.

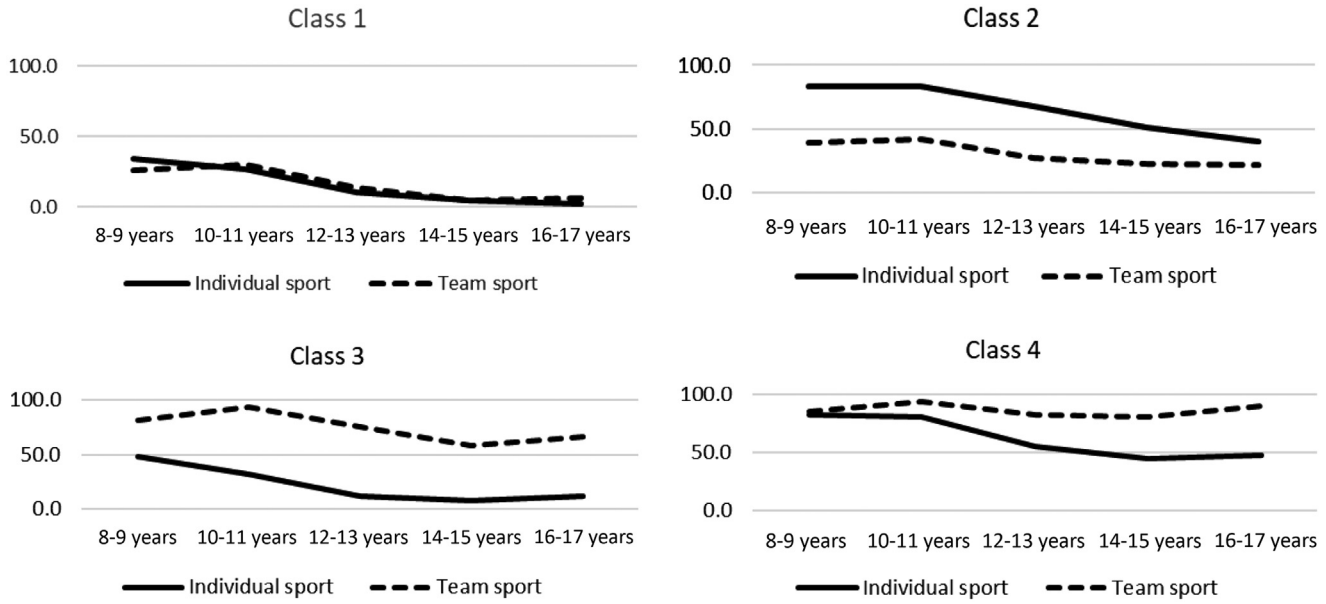

Figure 2 — Probabilities of participating in team and individual sport across ages for class 1 (nonparticipants), class 2 (individual sport participants), class 3 (team sport participants), and class 4 (both sport participants).

Compared with children who did not participation in sport (ie, nonparticipants), demographic characteristics associated with increased risk of dropping out of sport included being male (mOR = 1.75; 95% CIs, 1.44 to 2.14), speaking English at home (mOR = 1.74; 95% CIs, 1.28 to 2.35), high maternal education (university level mOR = 2.27; 95% CIs, 1.65 to 3.13), and living in the least disadvantaged areas (mOR = 2.05; 95% CIs, 1.26 to 3.35).

Sport Participation Latent Class as Predictors of Educational Outcomes

During school years, continued sport participation was associated with lower odds of being absent from school without permission (OR = 0.44; 95% CIs, 0.26 to 0.74; Table 2). Continued sport participation was also associated with better performance on attention and working memory ($B = -0.010$; 95% CIs, –0.019 to –0.002; $B = -0.013$; 95% CIs, –0.023 to –0.003, respectively), and higher numeracy and literacy NAPLAN scores ($B = 20.21$; 95% CIs, 14.56 to 25.86; $B = 9.42$; 95% CIs, 2.82 to 16.02, respectively).

Continued sport participation was not associated with being awarded the HSC/equivalent (OR = 1.47; 95% CIs, 0.93 to 2.34) but was associated with higher academic performance at the end of school scores (ATAR; $B = 3.28$; 95% CIs, 1.47 to 5.09) and higher odds of studying at university (OR = 1.78; 95% CIs, 1.32 to 2.40).

Table 1 Multivariate Multinomial Logistic Regression Predicting Latent Class Membership Using Baseline Characteristics

	Children who continued sport participation mOR (95% CIs)	Children who drop out from sport participation mOR (95% CIs)
Sex		
Female	Reference	Reference
Male	2.20 (1.86–2.60)	1.75 (1.44–2.14)
Language		
Other	Reference	Reference
English	2.10 (1.61–2.75)	1.74 (1.28–2.35)
Aboriginal and/or Torres Strait Islander		
Yes	Reference	Reference
No	1.87 (1.08–3.24)	0.91 (0.49–1.70)
Disability status		
Yes	Reference	Reference
No	1.56 (1.26–1.92)	1.27 (0.99–1.63)
Maternal education		
Did not complete secondary school	Reference	Reference
Secondary education	1.84 (1.38–2.46)	1.49 (1.1–2.02)
Certificate	1.55 (1.21–1.99)	1.36 (1.04–1.79)
Advanced diploma/diploma	2.42 (1.71–3.42)	1.36 (0.91–2.03)
University	4.09 (3.08–5.43)	2.27 (1.65–3.13)
Area-based socioeconomic status quintiles		
First (most disadvantaged)	Reference	Reference
Second	1.28 (0.91–1.78)	1.54 (1.02–2.32)
Third	1.44 (1.02–2.02)	1.35 (0.91–2.02)
Fourth	1.81 (1.27–2.56)	1.72 (1.07–2.76)
Fifth (least disadvantaged)	2.68 (1.84–3.89)	2.05 (1.26–3.35)
Remoteness		
Major cities	Reference	Reference
Regional	1.28 (1.06–1.54)	1.12 (0.91–1.39)
Remote	1.49 (0.83–2.66)	1.68 (0.86–3.29)

Abbreviations: CI, confidence interval; mOR, multinomial odds ratio. Note: Reference = children who did not participation in sport (ie, nonparticipants).

Team Versus Individual Sport Participation Latent Class as Predictors of Educational Outcomes

During school years, only team sport participation was associated with lower odds of being absent from school without permission (OR = 0.54; 95% CIs, 0.30 to 0.99; Table 3). Participation in team sport and both sports was associated with better performance on attention ($B = -0.010$; 95% CIs, −0.018 to −0.002) and working memory ($B = -0.010$; 95% CIs, −0.019 to −0.001), respectively. Participation in individual, team, and both sports was associated with higher numeracy NAPLAN scores ($B = 17.53$; 95% CIs, 10.24 to 24.81; $B = 11.87$; 95% CIs, 6.34 to 17.41; and $B = 26.04$; 95% CIs, 19.22 to 32.86, respectively). However, only participation in individual and both sports was associated with higher NAPLAN literacy scores ($B = 13.61$; 95% CIs, 5.01 to 22.2; $B = 8.62$; 95% CIs, 1.10 to 16.13, respectively).

Only team sport participation was associated with being awarded the HSC/equivalent (OR = 1.54; 95% CIs, 1.03 to 2.30), but participation in individual sport and both sports was associated with higher academic performance at the end of school scores (ATAR; $B = 2.64$; 95% CIs, 0.61 to 4.68; $B = 3.38$; 95% CIs, 1.50 to 5.26, respectively). Individual (OR = 1.88; 95% CIs, 1.31 to 2.72), team (OR = 1.32; 95% CIs, 1.01 to 1.73), and participation in both sports (OR = 2.08; 95% CIs, 1.41 to 3.05) was associated with higher odds of studying at university).

Sensitivity Analyses

Results of the sensitivity analyses were generally consistent with the main analyses. The effect sizes in the adjusted models were attenuated compared with the unadjusted models (Supplementary Table S4 [available online]). The results were similar when removing children living with a disability (Supplementary Table S5 [available online]), separating boys (Supplementary Table S6 [available online]) and girls (Supplementary Table S7 [available online]), and removing children who attended a private school (Supplementary Table S8 [available online]). When controlling for previous academic performance, continued sport participation was still associated with better performance on attention and working memory ($B = -0.009$; 95% CIs, −0.017 to −0.0005; $B = -0.012$;

Table 2 The Relationship Between Sport Participation and Educational Outcomes

	Executive function—attention	Executive function—working memory	Executive function—error monitoring	Numeracy performance during school (NAPLAN)	Literacy performance during school (NAPLAN)	Absent days without permission	Awarded the HSC/equivalent	Academic performance at end of schooling (ATAR)	Studying at university
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	N (%)	N (%)	Mean (SD)	N (%)
	2.74 (0.05)	2.91 (0.05)	53.2 (11.04)	599.89 (39.12)	587.68 (42.64)	98 (3.9%)	2310 (91.8%)	0.38 (19.06)	1784 (70.9%)
Sport	***B* (95% CIs)**	***B* (95% CIs)**	***B* (95% CIs)**	***B* (95% CIs)**	***B* (95% CIs)**	**OR (95% CIs)**	**OR (95% CIs)**	***B* (95% CIs)**	**OR (95% CIs)**
Nonparticipants	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Dropouts	–0.007 (–0.016 to 0.001)	–0.006 (–0.016 to 0.004)	–0.43 (–2.28 to 1.42)	10.56 (4.7 to 16.41)	7.92 (0.93 to 14.91)	0.54 (0.28 to 1.06)	1.37 (0.77 to 2.41)	1.16 (–0.96 to 3.28)	1.2 (0.79 to 1.83)
Continued participants	–0.010 (–0.019 to –0.002)	–0.013 (–0.023 to –0.003)	–0.39 (–2.29 to 1.51)	20.21 (14.56 to 25.86)	9.42 (2.82 to 16.02)	0.44 (0.26 to 0.74)	1.47 (0.93 to 2.34)	3.28 (1.47 to 5.09)	1.78 (1.32 to 2.4)

Abbreviations: ATAR, Australian Tertiary Admission Ranks; CI, confidence interval; HSC, Higher School Certificate; NAPLAN, National Assessment Program—Literacy and Numeracy; OR, odds ratio. Note: Models adjust for sex, language spoken at home, aboriginal status, disability status, maternal education, area-level Relative Socioeconomic Disadvantage, and remoteness. Executive function, NAPLAN, and absent days without permission were measured in wave 7; awarded the HSC and ATAR were measured in wave 8; and studying at university was measured in wave 9.

Table 3 The Relationship Between Team and Individual Sport Participation and Educational Outcomes

Sport class	Executive function—attention *B* (95% CIs)	Executive function—working memory *B* (95% CIs)	Executive function—error monitoring *B* (95% CIs)	Numeracy performance during school (NAPLAN)	Literacy performance during school (NAPLAN)	Absent days without permission OR (95% CIs)	Awarded the HSC/equivalent OR (95% CIs)	Academic performance at the end of school scores, ATAR *B* (95% CIs)	Studying at university OR (95% CIs)
No participation (1)	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Individual sport (2)	0.000 (–0.01 to 0.011)	–0.006 (–0.018 to 0.006)	0.18 (–2.24 to 2.61)	17.53 (10.24 to 24.81)	13.61 (5.01 to 22.2)	0.88 (0.41 to 1.89)	1.10 (0.58 to 2.10)	2.64 (0.61 to 4.68)	1.88 (1.31 to 2.72)
Team sport (3)	–0.01 (–0.018 to –0.002)	–0.010 (–0.019 to –0.001)	0.02 (–1.84 to 1.89)	11.87 (6.34 to 17.41)	–0.82 (–7.16 to 5.53)	0.54 (0.30 to 0.99)	1.54 (1.03 to 2.30)	1.29 (–0.35 to 2.93)	1.32 (1.01 to 1.73)
Both sports (4)	–0.010 (–0.02 to –0.001)	–0.014 (–0.024 to –0.004)	–0.03 (–2.17 to 2.11)	26.04 (19.22 to 32.86)	8.62 (1.10 to 16.13)	0.50 (0.07 to 3.42)	1.16 (0.61 to 2.23)	3.38 (1.50 to 5.26)	2.08 (1.41 to 3.05)

Abbreviations: ATAR, Australian Tertiary Admission Ranks; CI, confidence interval; HSC, Higher School Certificate; NAPLAN, National Assessment Program—Literacy and Numeracy; OR, odds ratio. Note: Models adjust for sex, language spoken at home, aboriginal status, disability status, maternal education, area-level Relative Socioeconomic Disadvantage, and remoteness. Executive function, NAPLAN, and absent days without permission were measured in wave 7; awarded the HSC and ATAR were measured in wave 8; and studying at university was measured in wave 9.

95% CIs, −0.022 to −0.003, respectively), and higher numeracy NAPLAN scores ($B = 4.69$; 95% CIs, 0.60 to 8.78), but not literacy NAPLAN scores ($B = 3.46$; 95% CIs, −1.76 to 8.68; Supplementary Table S9 [available online]).

Discussion

The study aimed to examine how trajectories of sport participation from childhood to adolescence were associated with a broad range of academic outcomes across a 12-year span. Children who continued sport participation were less likely to be absent from school without permission, had better executive function, and higher standardized test scores (NAPLAN) during their school education. Children who continued sport participation also had higher standardized test scores (ATAR) at the end of school and were more likely to study at university. These findings remained robust when accounting for a range of individual- and area-level confounders and in several sensitivity analysis.

These findings echo existing findings,[6] but extended the evidence base by applying a longitudinal design, considering long-term patterns of sport participation over 13 years, and examining participation in team versus individual sport. For outcomes where it was possible (ie, executive function and NAPLAN scores), we controlled for previous executive function and NAPLAN scores and found that continued sport participation was still positively associated with better performance on attention, working memory, and numeracy NAPLAN scores, but not literacy NAPLAN scores. This suggests that continued sport participation may improve executive function and numeracy NAPLAN scores.

The finding that sport participation may positively affect numeracy NAPLAN scores, but not literacy NAPLAN scores is consistent with the recent meta-analytic findings[6] that found sport participation was most beneficial for mathematics and science grades, compared with English and language grades. It is possible that skills developed through sport, such as problem solving and perseverance, can be transferred to classroom learning, and possibly more so to mathematics where problem solving and perseverance are commonly used.[34] These findings suggest that sport participation could be used to promote academic performance in mathematics, which is a core Science, Technology, Engineering, and Mathematics subject that provides children with the critical skills they need for informed decision making and effective community, national, and global citizenship.[35]

Our findings indicate that individual and team sport may be beneficial for different aspects of academic performance. While the overall benefit of sport for academic performance is likely due to being physically active,[36] there were differences across academic outcomes for individual and team sports. Children who participated in team sport had better performance on attention and working memory, fewer absent days without permission, and were more likely to be awarded the HSC/equivalent. Previous studies have shown that participation in team sport has high cognitive requirements including foresight, visual search, pattern recognition, situational awareness, attention distribution, reaction speed, and hand–eye coordination.[37] When participating in team sport, children have to process an overflow of information in a short amount of time and under psychological pressure, and make decisions, which need to be fast and accurate, depending on the demands of the sport.[38] These tasks are cognitively demanding and could explain why team sport appear to be more beneficial to cognitive functions (ie, attention and working memory) compared with individual sport. It is also possible that children are more physically active in team sports compared with individual sports, resulting in additional cognitive benefits. For example, Kudlacek[39] found that children who participated in team sports had higher levels of overall physical activity and were more likely to meet physical activity guidelines. Future research should examine whether the dose and intensity of physical activity during sport participation moderate the relationship between sport participation and academic performance.

Children who continued participation in team sport were less likely to have absent days from school without permission. Team sport facilitates the development of important social and mental skills in children and adolescents,[40] and provides an opportunity for children and adolescents to learn to work together and effectively contribute to a group, leading to a sense of support and belonging.[41] Previous research has found that students who feel a sense of belonging have fewer absences from school.[42] It is possible that participating in team sport, especially at school, fosters a sense of belonging, which increases motivation to attend school. This is especially important as school absences have been linked to children being more likely to discontinue schooling,[43] social isolation,[44] poorer mental health,[45] and increased likelihood of criminal activity.[46]

Children who continued participation in individual sport reported higher NAPLAN literacy results and had higher academic performance at the end of school (ATAR) scores compared with children who participated in team sport. Individual sport usually involves training alone, which has been shown to improve concentration and mental strength.[47] Individual sport also tends to encourage responsibility, self-reliance, goal setting, and a higher level of preparation as their success relies completely on their own training and skills.[47] These skills are important psychological skills that could carry over into preparation for school exams and may explain why children who continued participation in individual sport had higher literacy results during school and academic performance at the end of school.[48,49]

We found that continued sport participation was beneficial for academic performance in socioeconomically disadvantaged children. However, these children were less likely to continue sport participation, consistent with extensive previous research.[50] The World Health Organization's Global Action Plan on Physical Activity emphasizes the need to prioritize disparities and reduce inequalities in physical activity to achieve the proposed 15% reduction in physical inactivity in adolescents (and adults) by 2030.[51] Given that socioeconomically disadvantaged children participate in lower levels of sport and achieve poorer across academic outcomes,[52] sport provides the potential to increase physical activity and health outcomes, while simultaneously reducing the gap in academic outcomes.

Strengths and Limitations

To our knowledge, this is the first study to identify long-term patterns of sport participation from childhood into adolescence and explore the effect of these patterns on educational outcomes. This study utilized longitudinal data from a large representative cohort of Australian children (n = 4241) from 4 to 21 years of age (with high retention rates at each wave). Further, we examined a broad range of academic outcomes throughout adolescence (eg, executive function when the adolescent was 12–13 y through to university enrollment at 20–21 y), providing a comprehensive understanding of how sport participation affects different academic outcomes.

There are also limitations to note. First, while this was a longitudinal cohort study, we could not infer a causal relationship between sport participation and academic performance. It is possible that insufficiently measured confounders (eg, socioeconomic status) and unmeasured confounders (eg, mental health) could have at least partially explained the positive relationships between continued sport participation and academic outcomes. For example, it is possible that the children who continue participating in sport have certain personality characteristics and motivations (eg, high levels of self-regulation and self-efficacy) which also lead to higher educational achievements. Second, sport participation was assessed using 2 self-report items, which could be subject to self-report bias. While these items allowed us to distinguish between team and individual sport, we did not have data on the specific type (eg, dance vs swimming), frequency, and duration of sport participation. These are important factors that could influence the relationship between sport participation and academic outcomes and should be examined in future studies.

Conclusions

Children who continued sport participation into adolescence had higher academic performance across a broad range of academic outcomes. Individual and team sport appear to be beneficial for different aspects of academic performance. Children who participated in team sport had better performance on attention and working memory, fewer absent days without permission, and were more likely to be awarded the HSC/equivalent. Whereas children who participated in individual sport reported higher NAPLAN literacy results and had a higher academic performance at the end of school (ATAR). Given the decline in sport participation during adolescence, these findings highlight the need to develop or modify educational policies to establish an environment that fosters and promotes sport participation, which in turn could improve academic outcomes.

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