Middle Childhood Sport Participation Predicts Timely Long-Term Chances of Academic Success in Boys and Girls by Late Adolescence

LINDA S. PAGANI[1,2,3], KIANOUSH HARANDIAN[1], BENOIT GAUTHIER[4], LAURIE-ANNE KOSAK[1], BEATRICE NECSA[1], and MARK S. TREMBLAY[5,6]

[1]School of Psycho-Education, Université de Montréal, Montreal, CANADA; [2]Sainte-Justine's Pediatric Hospital Research Center, Université de Montréal, Montreal, CANADA; [3]School Environment Research Group, Université de Montréal, Montreal, CANADA; [4]Art and Sciences Faculty, Applied Human Sciences Program, Université de Montréal, Montreal, CANADA; [5]Department of Pediatrics, University of Ottawa, Ottawa, CANADA; and [6]CHEO Research Institute, Ottawa, CANADA

ABSTRACT

PAGANI, L. S., K. HARANDIAN, B. GAUTHIER, L.-A. KOSAK, B. NECSA, and M. S. TREMBLAY. Middle Childhood Sport Participation Predicts Timely Long-Term Chances of Academic Success in Boys and Girls by Late Adolescence. *Med. Sci. Sports Exerc.*, Vol. 56, No. 11, pp. 2184–2194, 2024. **Introduction:** School-aged children experience successive academic demands that increase over time. Extracurricular sport develops skills that involve physical movement, social rules, formal practice, and rational competition. This may facilitate success. **Purpose:** Using a prospective-longitudinal birth cohort of 746 girls/721 boys, we examined prospective associations between middle childhood sport participation with subsequent indicators of academic success in adolescence. We hypothesized that persistent participation would promote long-term achievement indicators. **Methods:** Mothers reported on whether the child participated in sporting activities with a coach/instructor from ages 6 to 10 yr. Developmental trajectories of participation were generated using longitudinal latent class analysis and then used to predict outcomes. From ages 12 to 17 yr, youth self-reported on academic indicators of success over the last 6 months. These were linearly regressed on trajectories of participation in sport, while controlling for preexisting and concurrent child/family confounds. **Results:** Children's sport participation from kindergarten to fourth grade predicted long-term chances of academic success in boys and girls, above and beyond individual/family confounders. Consistent participation predicted increments indicators of future success and reductions in academic failure and dropout risk through to the senior year of secondary school, ranging from 9.1% to 21.3% for girls and 11.7% to 22.9% for boys. **Conclusions:** We provide compelling and timely evidence of long-term associations between children's sport participation and subsequent indicators of academic success in typically developing boys and girls by late adolescence. Persistent sport involvement in sport increased educational prospects by late adolescence, potentially improving opportunities for success in emerging adulthood. **Key Words:** EXTRACURRICULAR SPORT, PHYSICAL ACTIVITY, SPORT, ACADEMIC ACHIEVEMENT, CHILD DEVELOPMENT, EDUCATION, HUMAN CAPITAL

Society has become increasingly concerned about how children spend their discretionary time while growing up (1). Considering global concerns about a more effortless and sedentary human existence, sport is now viewed as a typical childhood activity and not just for elite performers or more affluent social classes (2). Organized and directed by adults/youth leaders in communities, children's sport offers extracurricular experiences that involve physical movement, social rules, formal practice, and rational competition (2). Parents believe that sport involvement hones the effects of child-rearing environments (1,2). In fact, a qualitative socioecological study on parental insights reports benefits that include more optimal perceptions of self and better opportunities for creating friendships, learning teamwork and cooperation, and developing motor skills (3). Such beliefs are supported by observational data (4). Both parents and policymakers believe that youth sport experiences shape optimal perseverance, especially with developmental tasks like schoolwork and relationships, over the long term (1,3). Remarkably, there remains a dearth of evidence on the unique contribution of childhood sport to later indicators of achievement despite substantial investments by children, parents, and communities.

There are some studies that support parental aspirations regarding children and sport. Correlational longitudinal designs, which serve as natural experiments, indicate a relationship between sport and cognitive development and achievement (4). Such findings are replicated with studies of physical activity, movement, and fitness (5–7). Although they do not directly address sport, links with academic achievement have been examined using experimental designs on physical activity as an intervention. As a comprehensive example, a meta-analytic

review of causal research by Haverkamp et al. (8) found positive effects of short- and long-term physical activity interventions on executive functions from ages 12 to 30 yr. This review also suggests that more time-intensive interventions predict more pronounced and longer impacts, particularly for boys. Therefore, regular or consistent participation is important.

Parental aspirations are also backed by theory. Decisions to enroll children in sport are propelled by hopes that their sons and daughters will develop skills that correlate with later mental and physical flourishment (1,9). Aligned with the *exercise is medicine* movement, parents opt for childhood sport to promote healthy growth and development through cardiorespiratory, muscular, skeletal, and cerebral fitness (1,10–12). Through contact with peers and supportive coaches or instructors, sport offers a favorable and fair context that inspires productive and engaged attitudes (13). Its environments and activities foster self-regulation because participants must successfully follow rules and hold back on their own wants and needs (14). Sport involvement also inspires behavioral corrections that are meant to ensure a better person–environment fit, which maximizes chances of school success (3,11,12). Therefore, in theory, sport should reinforce favorable dispositions toward achievement and give the necessary endurance for thriving in the face of difficulty (1,13).

Substantiating such convictions remains a methodological challenge. First, experimental studies provide evidence of the positive impact on cognitive development; however, they are on physical activity. Manipulated interventions are also difficult to replicate in everyday life. Nonexperimental studies are mostly cross-sectional and typically address correlates of sport (fitness, movement, etc.). They might suffer from confounding from preexisting factors or selection bias. When studies on sport are longitudinal, they do not always offer extensive control of preexisting individual and family factors that could serve as competing explanations (13,15). Second, the literature has treated sex as a control variable, as though life is gender neutral regarding social expectations. Considering biological and contextual influences, boys and girls experience risk and protective factors in unique ways (16,17). There are sex differences in mental health disorder risk (18). Boys and girls have distinct experiences with sport, sedentariness, and physical activity as well (19). Examining prospective-longitudinal associations between extended childhood sport involvement in boys and girls during primary school would thus provide compelling evidence of its extracurricular value in charting a developmental course toward future academic achievement.

Using a longitudinal population-based birth cohort design, this study prospectively examines associations between sport participation from kindergarten to fourth grade and subsequent academic benefits through the end of secondary school. Specifically, we aim to verify whether partaking in extracurricular sport between ages 6 and 10 yr, according to parent reports, predicts indicators of academic achievement from ages 12 to 17 yr in typically developing millennial boys and girls. We expect that consistent participation during early primary school, beyond typical childhood venues of school gym classes and physical play (outdoor amusement, going to park, shopping, neighborhood biking), would be associated with later academic achievement in adolescence, above and beyond baseline individual and family factors.

METHODS

Study Design and Participants

Participants from this Institutional Review Board–approved investigation are from the Quebec Longitudinal Study of Child Development (QLSCD) birth cohort, coordinated by the *Institut de la Statistique du Québec*. The QLSCD was designed to advance knowledge of child development in typically developing children. The original sampling, launched to track the growth of typically developing children, comprised 2837 randomly selected infants born between 1997 and 1998 from all administrative regions of Quebec, Canada. Because the aim of the study was to study representative Canadian children, 614 infants were deemed ineligible for one of the following reasons: being a twin, having First Nation status, being untraceable at the time, having incorrect contact details, and refusing to participate. Consequently, 2223 infants were selected for initial follow-up from age 5 months onward (http://www.iamillbe.stat. gouv.qc.ca/default_an.htm). Annual follow-ups occurred until children reached age 8 yr, and biennial follow-ups occurred onward. For each data collection wave, informed consent was obtained from parents. Child assent and consent (after age 14 yr) was also obtained. During the school-aged phase, teachers also gave consent. For the study reported here, a subsample of 1467 children (49% boys) with sport participation data from ages 6 to 10 yr was retained (20). This study included outcomes at each time point between ages 12 and 17 yr. Measures were selected based on the most reliable and valid measures that would stand the test of time and be amenable to long-term data collection.

Measures: Sport Participation Predictor (Ages 6, 7, 8, and 10 yr)

Extracurricular sport participation was measured at four time points, from spring of kindergarten to spring of fourth grade. Mothers reported on two items regarding child participation in sport at ages 6, 7, and 8 yr: "In the last 12 months, outside of school hours, how often has your child: (a) Taken part in sports with a coach or instructor (except dance or gymnastics)? and (b) taken lessons or instruction in other organized physical activities with a coach or instructor such as dance, gymnastics, martial arts or circus arts?" (0 = never, 1 = roughly once a month, 2 = roughly once a week, 3 = several times a week, 4 = roughly every day, 5 = 1 session, 6 = 2 sessions). At age 10 yr, mothers completed three items: "How many times a week has your child participated: (a) In organized sport or physical activity with a coach last summer?" (b) "in organized sport or physical activity with a coach at school since last September, outside of physical education classes?" and (c) "in organized sport or physical activity with a coach outside of school since last September?"

EPIDEMIOLOGY

(0 = never, 1 = less than once a week, 2 = once a week, 3 = twice a week, 4 = three times a week, 5 = four times a week, 6 = five times a week or more). For all five items, past-year participation in sporting activity was computed as 0 = never participated or 1 = participated.

Using longitudinal latent class analyses, two typical trajectories of participation in sporting activities, structured by a coach/instructor were established in Brière et al., using the same five items: 0 = *low-inconsistent participation* (39%) for children who did not participate or participated only for a year or two from ages 6 to 10 yr and 1 = *consistent participation* (61%) for children with significant probability of regular participation during that period (20,21).

Measures: Indicators of Academic Outcomes (Ages 12, 13, 15, and 17 yr)

Average grade in languages was obtained using youth self-reported average in language arts class at all ages (22).

Importance given to academic performance was assessed through one question. Youth were asked: "How important is it for you to get good marks?" (0 = not important at all, 1 = somewhat important, 2 = important, 3 = very important).

Intrinsic motivation was measured using the Marsh/Shavelson model of academic self-concept (23). Youth were asked about reading and writing (three items): "I like my languages class," "My languages class interests me," and "I practice languages even when it is not mandatory." A mean of the answers, ranging from "always yes" to "always no" on a five-point Likert scale, was calculated and converted to a scale from 1 to 10 ($\alpha_{12yr\text{-}reading}$ = 0.86, $\alpha_{12yr\text{-}writing}$ = 0.81; α_{13yr} = 0.63; α_{15yr} = 0.69; α_{17yr} = 0.75).

Attachment to school was measured using a five-item self-report scale: "I am proud to study at this school," "I am happy to study at this school," "I feel safe in my school," "On most days, I feel like going to school," and "I like my school" (α_{12yr} = 0.86; α_{13yr} = 0.86; α_{15yr} = 0.87; α_{17yr} = 0.88 (24)). An average score was calculated and brought to a scale ranging from 0 to 10.

Academic aspiration was measured by one self-reported item: "What is the highest level of schooling that you would like to achieve?" (1 = before the end of secondary school, 2 = secondary school diploma, 3 = diploma of vocational studies, 4 = diploma in college studies, 5 = university diploma).

Grade retention was assessed by asking participants if they had been held back in school in the past (0 = no; 1 = yes, 1 yr; 2 = yes, 2 yr; 3 = yes, 3 or more years).

Dropout risk was calculated as a probability ranging from 0 to 1, where a score closer to 1 represents a higher risk for dropping out. Using the Dropout Prediction Index, at ages 12 and 13 yr, youth self-reported the following: their average grade in language arts and math, if they experienced grade retention, if they like school, how their marks compare to those of the other students, if having good marks is important to them, and what they aspired to as their highest level of schooling (25). At ages 15 and 17 yr, the same questions were asked, in addition to the importance of having good grades in language arts and in math. To create the index, answers were coded as 1 if they scored 1 SD above the mean (or below the mean if positively scored) on each of the risk components and 0 if above/below that cutoff (25).

Thought of dropping out was assessed at ages 13, 15, and 17 yr. Youth were asked, "Have you ever seriously thought about giving up on school?" (yes = 1 or no = 0).

Measures: Baseline Childhood Individual and Family Control Variables (Ages 5 months to 6 yr)

Individual. Child temperament problems were parent-reported at age 1.5 yr, using 20 items from the Infant Characteristics Questionnaire (0 = below the median, 1 = above the median (26)). Literacy stimulation was reported at age 1.5 yr. Parents were asked how often they: looked through books with their children, read books with their children, and played with crayons with their children. Responses for each question were categorized as 0 = once a week or less and 1 = a few times a week or every day. The sum of the three items was reverse-coded and reported the different types of stimulation at home (0 = all types of stimulation, 1 = 2 types of stimulation, 2 = 1 type of stimulation, 3 = no type of stimulation). Neurocognitive skills were evaluated at age 2 yr by research assistants using the Imitation Sorting Task, where a higher score indicates a better performance (scores ranging from 0 to 3, (27)). Receptive vocabulary knowledge and skills were measured by a trained examiner at age 6 yr with a French adaptation of the Peabody Picture Vocabulary Test (28).

Family. Parent antisocial behavior was measured at 5 months using the National Institute of Mental Health–Diagnostic Interview Schedule (12 items; 0 = below the median, 1 = above the median (29)). Maternal education was measured at age 5 months (0 = finished secondary school, 1 = did not finish secondary school). Maternal depressive symptoms were self-reported when the child was 5 months old using an abridged 13-question version of the Diagnostic Interview Schedule, where a higher score represents a higher level of depressive symptoms (0 = below the median and 1 = above the median (30)). Family dysfunction was reported by parents at age 6 yr using seven items from the McMaster Family Assessment Device, with a lower score indicating a more functional family (0 = below the median, 1 = above the median (31)). At age 6 yr, we also included family configuration (0 = intact, 1 = non-intact) and family income (0 = sufficient income, 1 = insufficient income as defined by the Canadian low-income cutoff of that year provided by Statistics Canada).

Data Analytic Strategies

Analyses. Using Growth Mixture Modeling generated natural groupings of individuals with similar extracurricular sport participation during childhood. Latent classes of overall participation between ages 6 and 10 yr were established by Brière et al. (20). Descriptive statistics were obtained using SPSS (v. 26). Estimations predicted the outcomes children in the high-consistent trajectory, compared with their same-sex counterparts from the

TABLE 1. Descriptive statistics for study variables.

	Boys			Girls		
	M (SD)	Categorical variables (%)	Range	M (SD)	Categorical variables (%)	Range
Predictor (6–10 yr)						
Extracurricular sport						
0 = Low-inconsistent		37.9			34.7	
1 = High-consistent		62.1			65.3	
Outcomes (12 yr)						
Average grade in languages	75.96 (11.42)		0.00–100.00	81.07 (9.43)		0.00–100.00
Importance given to academic performance						
0 = Not important at all		1.1			0.6	
1 = Somewhat important		14.8			12.4	
2 = Important		34.0			31.8	
3 = Very important		50.2			55.2	
Intrinsic motivation	5.73 (1.89)		0.00–10.00	7.28 (1.72)		0.00–10.00
Attachment to school	7.13 (2.10)		0.00–10.00	7.87 (1.84)		0.00–10.00
Academic aspirations						
1 = Before the end of high school		3.6			1.7	
2 = High school diploma		10.3			6.6	
3 = DVS		10.7			6.8	
4 = DCS		16.9			10.4	
5 = University diploma		58.6			74.5	
Grade retention						
0 = No		91.3			94.1	
1 = Yes, 1 yr		7.5			4.9	
2 = Yes, 2 yr		1.1			0.8	
3 = Yes, 3 or more years		0.2			0.2	
Dropout risk	0.20 (0.22)		0.00–1.00	0.15 (0.18)		0.00–1.00
Outcomes (13 yr)						
Average grade in languages	74.13 (11.26)		0.00–100.00	78.03 (10.35)		0.00–100.00
Importance given to academic performance						
0 = Not important at all		1.4			0.8	
1 = Somewhat important		13.1			10.7	
2 = Important		39.0			36.7	
3 = Very important		46.4			51.8	
Intrinsic motivation	5.31 (2.42)		0.00–10.00	6.19 (2.16)		0.00–10.00
Attachment to school	7.11 (2.03)		0.00–10.00	7.76 (1.75)		0.00–10.00
Academic aspirations						
1 = Before the end of high school		2.0			1.4	
2 = High school diploma		7.1			4.2	
3 = DVS		13.4			6.3	
4 = DCS		18.5			12.7	
5 = University diploma		58.9			75.5	
Grade retention						
0 = No		88.2			92.5	
1 = Yes, 1 yr		10.2			7.2	
2 = Yes, 2 yr		1.0			0.2	
3 = Yes, 3 or more years		0.0			0.2	
Dropout risk	0.21 (0.22)		0.00–1.00	0.17 (0.18)		0.00–1.00
Thought of dropping out						
0 = No		91.2			94.6	
1 = Yes		8.8			5.4	
Outcomes (15 yr)						
Average grade in languages	72.27 (11.17)		0.00–100.00	77.55 (10.35)		0.00–100.00
Importance given to academic performance						
0 = Not important at all		4.0			0.8	
1 = Somewhat important		21.9			15.1	
2 = Important		49.8			43.0	
3 = Very important		24.3			41.1	
Intrinsic motivation	5.06 (2.55)		0.00–10.00	6.27 (2.36)		0.00–10.00
Attachment to school	6.76 (2.05)		0.00–10.00	6.98 (2.11)		0.00–10.00
Academic aspirations						
1 = Before the end of high school		1.8			0.9	
2 = High school diploma		3.9			3.7	
3 = DVS		18.1			5.6	
4 = DCS		19.3			13.5	
5 = University diploma		56.9			76.3	
Grade retention						
0 = No		82.5			87.3	
1 = Yes, 1 yr		13.5			10.7	
2 = Yes, 2 yr		3.3			1.4	
3 = Yes, 3 or more years		0.7			0.6	
Dropout risk	0.30 (0.28)		0.00–10.00	0.22 (0.24)		0.00–10.00
Thought of dropping out						
0 = No		91.0			92.4	
1 = Yes		9.0			7.6	

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TABLE 1. *(Continued)*

	Boys			Girls		
	M (SD)	Categorical variables (%)	Range	M (SD)	Categorical variables (%)	Range
Outcomes (17 yr)						
Average grade in languages	71.87 (10.53)		0.00–100.00	78.16 (10.80)		0.00–100.00
Importance given to academic performance						
0 = Not important at all		7.1			1.1	
1 = Somewhat important		26.8			13.0	
2 = Important		45.2			42.7	
3 = Very important		20.9			43.2	
Intrinsic motivation	4.90 (2.60)		0.00–10.00	6.24 (2.52)		0.00–10.00
Attachment to school	6.61 (2.13)		0.00–10.00	6.93 (2.04)		0.00–10.00
Academic aspirations						
0 = Does not know, does not matter						
1 = Before the end of high school		1.4			0.7	
2 = High school diploma		4.0			2.6	
3 = DVS		20.7			6.5	
4 = DCS		17.9			16.0	
5 = University diploma		56.0			74.2	
Grade retention						
0 = No		80.7			87.2	
1 = Yes, 1 yr		14.0			8.2	
2 = Yes, 2 yr		4.4			3.7	
3 = Yes, 3 or more years		0.9			0.9	
Dropout risk	0.31 (0.27)		0.00–10.00	0.20 (0.23)		0.00–10.00
Thought of dropping out						
0 = No		88.1			89.6	
1 = Yes		11.9			10.4	
Control variables						
Parent antisocial behavior (5 mo)						
1 = Above the median		49.4			46.9	
Maternal education (5 mo)						
1 = Did not finish high school		12.6			15.3	
Maternal depressive symptoms (5 mo)						
1 = Above the median		47.1			42.7	
Literacy stimulation (1.5 yr)						
0 = Three types		9.1			4.7	
1 = Two type		15.1			14.1	
2 = One types		32.8			28.9	
3 = No stimulation		43.0			52.3	
Child temperament problems (1.5 yr)						
1 = Above the median		49.0			49.7	
Neurocognitive skills (2 yr)						
0 = Score of 3		3.2			6.1	
1 = Score of 2		22.8			22.4	
2 = Score of 1		52.4			52.7	
3 = Score of 0		21.6			18.8	
Family configuration (6 yr)						
1 = Non-intact		29.6			30.1	
Family income (6 yr)						
1 = Insufficient		16.6			16.6	
Family dysfunction (6 yr)						
1 = Above the median		43.0			44.2	
Vocabulary skills (6 yr)	115.14 (17.00)		0.00–160.00	115.18 (17.50)		0.00–160.00

Data were compiled from the final master file of the QLSCD (1998–2015), ©*Gouvernement du Québec, Institut de la statistique du Québec*.
DCS, diploma in college studies; DVS, diploma of vocational studies.

low-inconsistent trajectory. Long-term prospective associations were estimated using ordinary least squares multiple regression using Mplus (v. 8.0), stratified by sex (32). Regressions were operated independently at every outcome time point. Specific indicators of academic achievement (at ages 12, 13, 15, and 17 yr) were adjusted and linearly regressed on middle childhood sport participation trajectories measured (at ages 6, 7, 8, and 10 yr). Adjustments for possible omitted variable bias were accounted for by including preexisting and concurrent child and family characteristics that were either statistically or substantively linked to the predictor or outcomes. For each achievement outcome, the predictor and confound controls were entered simultaneously. Specific baseline variables (Peabody Picture Vocabulary Test) were also added to further bootstrap confound control. Our results bear upon the adjusted model, where "a" and "e" represent the intercept and stochastic error, respectively:

$$\text{ACH}_{\text{iages12–17 yr}} = a_1 + \beta_1 \, \text{SP}_{\text{iages6–10 yr}} + \gamma_1 \, \text{CHILD}_{\text{iages1.5–6 yr}} + \gamma_2 \, \text{FAMIILY}_{\text{iages5 mo–6 yr}} + e_i$$

Indicators of achievement ($\text{ACH}_{\text{iages12–17yr}}$, represented by the outcome measures) from ages 12 to 17 yr are regressed on sport participation from ages 6 to 10 yr ($\text{SP}_{\text{iages6–10yr}}$) for each individual child while simultaneously controlling for concurrent and preexisting individual ($\text{CHILD}_{\text{iages1.5–6yr}}$) and family ($\text{FAMILY}_{\text{i5months–6yr}}$) characteristics that are statistically and/or substantively correlated with our predictor and outcome variables.

TABLE 2. Unstandardized regression coefficients (standard error) reflecting the adjusted relationship between baseline and concurrent child and family characteristics ages between 5 months and 6 yr and extracurricular sport from ages 6 to 10 yr.

	Extracurricular Sport (6–10 yr)	
Sex	0.03 (0.03)	
	Boys	**Girls**
Parent antisocial behavior (5 mo)	−0.06 (0.17)	−0.09 (0.17)
Maternal education (5 mo)	−1.27 (0.27)***	−0.99 (0.24)***
Maternal depressive symptoms (5 mo)	−0.37 (0.17)*	−0.34 (0.17)*
Literacy stimulation (1.5 yr)	−0.19 (0.09)*	−0.09 (0.10)
Child temperament problems (1.5 yr)	0.04 (0.19)	−0.04 (0.19)
Neurocognitive skills (2 yr)	−0.01 (0.12)	−0.27 (0.11)**
Family configuration (6 yr)	−0.27 (0.20)	−0.32 (0.19)
Family income (6 yr)	−0.49 (0.25)*	−0.77 (0.23)***
Family dysfunction (6 yr)	−0.38 (0.17)*	−0.24 (0.17)
Vocabulary skills (6 yr)	0.02 (0.01)**	0.00 (0.01)
R^2	0.160***	0.149***

Analyses corrected for attrition bias. Data were compiled from the final master file of the QLSCD (1998–2015), ©Gouvernement du Québec, Institut de la statistique du Québec.
*$P \leq 0.05$.
**$P \leq 0.01$.
***$P \leq 0.001$.

Missing data treatment. This study required data from various sources and waves. As expected from a longitudinal study, some participants had incomplete data. We used the full-maximum likelihood procedure in Mplus 8.0 to conduct the analyses and correct any bias introduced by attrition (32).

RESULTS

Descriptive statistics. Table 1 reports descriptive statistics for all study variables between ages 5 months and 17 yr. Approximately two-thirds of boys and girls were classified in the high-consistent trajectory of sport participation. By

age 17 yr, 19.3% of boys and 12.8% of girls had been held back at least 1 yr in school. Table 2 reports adjusted unstandardized regression coefficients reflecting the relationship between baseline and concurrent individual and family characteristics and sport participation from ages 6 to 10 yr. Maternal education made the largest contributions to predicting sport participation, followed by family income.

Inferential Analyses: Middle childhood sport from ages 6 to 10 yr and academic achievement indicators

Table 3 reports the adjusted relationship between middle childhood sport participation and academic achievement indicators at age 12 yr. Compared with girls with low-inconsistent participation, girls with high-consistent participation had a 10.5% unit increase in average grades in language ($P \leq 0.05$, 95% confidence interval (CI): 0.42 to 3.68), 10.1% unit increase in the importance given to academic performance ($P \leq 0.05$, 95% CI: 0.06 to 0.72), 18.4% unit increase in academic aspirations ($P \leq 0.001$, 95% CI: 0.34 to 1.14), and 12.1% unit decrease in dropout risk ($P \leq 0.01$, 95% CI: −0.08 to −0.01). Compared with boys with low-inconsistent participation, boys with high-consistent participation had a 12.5% unit increase in average grades in language ($P \leq 0.01$, 95% CI: 0.86 to 4.96), 11.7% unit increase in the importance given to academic performance ($P \leq 0.01$, 95% CI: 0.11 to 0.78), 22.9% unit increase in academic aspirations ($P \leq 0.001$, 95% CI: 0.53 to 1.34), 18.6% unit decrease in chances of being held back in school ($P \leq 0.05$, 95% CI: −1.38 to −0.08), and 13.9% unit decrease in dropout risk ($P \leq 0.01$, 95% CI: −0.10 to −0.02).

Table 4 documents the adjusted relationship between childhood sport participation and academic achievement indicators

TABLE 3. Unstandardized regression coefficients (standard error) reflecting the adjusted relationship between extracurricular sport from ages 6 to 10 yr and academic achievement at age 12 yr.

		Age 12 yr						
		Average Grade in Languages	Importance Given to Academic Performance	Intrinsic Motivation	Attachment to School	Academic Aspirations	Grade Retention	Dropout Risk
Boys	Extracurricular sport (6–10 yr)	2.91 (1.05)**	0.45 (0.17)**	0.15 (0.18)	0.36 (0.20)	0.93 (0.21)***	−0.73 (0.33)*	−0.06 (0.02)**
	Parent antisocial behavior (5 mo)	−2.76 (0.94)**	0.10 (0.17)	−0.03 (0.16)	−0.18 (0.18)	0.06 (0.19)	0.14 (0.32)	0.03 (0.02)
	Maternal education (5 mo)	−7.01 (1.97)***	−0.09 (0.29)	−0.32 (0.28)	−0.38 (0.31)	−1.46 (0.31)***	0.94 (0.43)*	0.11 (0.04)**
	Maternal depressive symptoms (5 mo)	−0.48 (0.96)	0.06 (0.17)	0.10 (0.16)	−0.42 (0.18)*	0.22 (0.19)	0.04 (0.30)	001 (0.02)
	Literacy stimulation (1.5 yr)	−0.09 (0.54)	0.03 (0.09)	0.03 (0.09)	−0.12 (0.10)	−0.16 (0.10)	0.24 (0.17)	0.01 (0.01)
	Child temperament problems (1.5 yr)	0.82 (1.02)	0.01 (0.18)	−0.12 (0.18)	0.30 (0.19)	−0.43 (0.21)*	0.10 (0.33)	−0.01 (0.02)
	Neurocognitive skills (2 yr)	−1.08 (0.58)	−0.03 (0.12)	−0.19 (0.12)	−0.22 (0.13)	−0.30 (0.14)*	0.11 (0.20)	0.03 (0.01)*
	Family configuration (6 yr)	−1.96 (1.11)	0.21 (0.20)	0.32 (0.19)	−0.10 (0.22)	0.23 (0.24)	0.15 (0.37)	0.03 (0.02)
	Family income (6 yr)	1.12 (1.37)	−0.26 (0.24)	−0.23 (0.25)	0.31 (0.28)	−0.15 (0.29)	−0.37 (0.47)	0.03 (0.03)
	Family dysfunction (6 yr)	0.81 (0.94)	0.06 (0.17)	0.03 (0.16)	−0.12 (0.18)	−0.07 (0.19)	0.17 (0.32)	−0.01 (0.02)
	Vocabulary skills (6 yr)	0.07 (0.04)	−0.02 (0.01)**	−0.01 (0.01)	—	—	—	—
	R^2	0.111***	0.042*	0.018	0.043**	0.155***	0.091**	0.093***
Girls	Extracurricular sport (6–10 yr)	2.05 (0.83)**	0.39 (0.17)*	0.15 (0.15)	0.14 (0.18)	0.74 (0.20)***	−0.54 (0.40)	−0.05 (0.02)**
	Parent antisocial behavior (5 mo)	−1.86 (0.72)**	−0.05 (0.16)	−0.26 (0.14)	−0.14 (0.15)	−0.65 (0.21)**	0.31 (0.35)	0.04 (0.01)**
	Maternal education (5 mo)	−4.45 (1.12)***	0.08 (0.25)	−0.08 (0.21)	−0.44 (0.25)	−0.59 (0.28)*	1.12 (0.41)**	0.11 (0.03)***
	Maternal depressive symptoms (5 mo)	−1.03 (0.74)	−0.24 (0.16)	−0.27 (0.15)	−0.36 (0.15)*	−0.31 (0.21)	−0.07 (0.35)	0.01 (0.02)
	Literacy stimulation (1.5 yr)	−0.31 (0.41)	−0.06 (0.09)	−0.06 (0.08)	−0.24 (0.09)**	−0.08 (0.12)	0.15 (0.21)	0.01 (0.01)
	Child temperament problems (1.5 yr)	−0.74 (0.77)	0.19 (0.17)	−0.12 (0.15)	0.10 (0.16)	−0.07 (0.23)	0.39 (0.38)	0.00 (0.02)
	Neurocognitive skills (2 yr)	−0.47 (0.45)	0.01 (0.11)	−0.08 (0.09)	−0.07 (0.10)	−0.23 (0.14)	0.37 (0.26)	0.01 (0.01)
	Family configuration (6 yr)	−1.00 (0.81)	0.10 (0.18)	0.15 (0.15)	0.02 (0.17)	−0.02 (0.23)	0.36 (0.39)	0.01 (0.02)
	Family income (6 yr)	−0.43 (1.09)	−0.07 (0.27)	−0.25 (0.23)	−0.10 (0.22)	−0.02 (0.32)	0.83 (0.42)*	0.06 (0.03)*
	Family dysfunction (6 yr)	0.55 (0.74)	−0.10 (0.16)	0.20 (0.14)	0.03 (0.14)	−0.24 (0.20)	−0.21 (0.36)	0.01 (0.01)
	Vocabulary skills (6 yr)	0.12 (0.02)***	0.00 (0.01)	0.00 (0.01)	—	—	—	—
	R^2	0.156***	0.019	0.029*	0.046**	0.112***	0.176***	0.137***

Analyses corrected for attrition bias. Data were compiled from the final master file of the QLSCD (1998–2015), ©Gouvernement du Québec, Institut de la statistique du Québec.
*$P \leq 0.05$.
**$P \leq 0.01$.
***$P \leq 0.001$.

at age 13 yr. Compared with girls with low-inconsistent participation, girls with high-consistent participation had a 10.8% unit increase in the importance given to academic performance ($P \leq 0.05$, 95% CI: 0.07 to 0.76), 12.2% unit increase in intrinsic motivation ($P \leq 0.01$, 95% CI: 0.15 to 0.96), 12.9% unit increase in academic aspirations ($P \leq 0.05$, 95% CI: 0.09 to 0.94), and 11.4% unit decrease in dropout risk ($P \leq 0.05$, 95% CI: −0.08 to −0.01). Compared with boys with low-inconsistent participation, boys with high-consistent participation had a 15.5% unit decrease in chances of being held back in school ($P \leq 0.05$, 95% CI: −1.25 to 0.00).

Table 5 reports the adjusted relationship between childhood sport participation and academic achievement indicators at age 15 yr. Compared with girls with low-inconsistent participation, girls with high-consistent participation had a 9.1% unit increase in average grades in language ($P \leq 0.05$, 95% CI: 0.19 to 3.73), 11.1% unit increase in academic aspirations ($P \leq 0.05$, 95% CI: 0.00 to 0.91), 12.1% unit decrease in dropout risk ($P \leq 0.01$, 95% CI: −0.11 to −0.02), and 20.9% unit decrease in chances of being held back in school ($P \leq 0.001$, 95% CI: −1.43 to −0.36). Compared with boys with low-inconsistent participation, boys with high-consistent participation had a 16.6% unit increase in intrinsic motivation ($P \leq 0.001$, 95% CI: 0.42 to 1.33), 14.0% unit increase in attachment to school ($P \leq 0.001$, 95% CI: 0.23 to 0.95), 21.2% unit increase in academic aspirations ($P \leq 0.001$, 95% CI: 0.48 to 1.24), 20.6% unit decrease in chances of being held back in school ($P \leq 0.001$, 95% CI: −1.33 to −0.37), 16.6% unit decrease in dropout risk ($P \leq 0.001$, 95%

CI: −0.15 to −0.04), and 15.7% unit decrease in having thoughts of dropping out ($P \leq 0.05$, 95% CI: −1.22 to −0.02).

Table 6 documents the adjusted relationship between childhood sport participation and indicators of academic achievement indicators at age 17 yr. Compared with girls with low-inconsistent participation, girls with high-consistent participation had a 20.3% unit increase in academic aspirations ($P \leq 0.001$, 95% CI: 0.41 to 1.28), 21.3% unit decrease in chances of being held back in school ($P \leq 0.01$, 95% CI: −1.57 to −0.34), and 19% unit decrease in having thoughts of dropping out ($P \leq 0.05$, 95% CI: −1.47 to −0.16). Compared with boys with low-inconsistent participation, boys with high-consistent participation had a 18.3% unit increase in academic aspirations ($P \leq 0.001$, 95% CI: 0.31 to 1.12), 16.6% unit decrease in chances of being held back in school ($P \leq 0.01$, 95% CI: −1.21 to −0.16), and 16.1% unit decrease in dropout risk ($P \leq 0.01$, 95% CI: −0.15 to −0.03).

DISCUSSION

This investigation provides compelling and timely evidence of long-term associations between sport participation and subsequent indicators of academic success in typically developing boys and girls by late adolescence. Middle childhood is characterized by formal entry into grade school with successive academic demands, which require perseverance such as learning to read and reading to learn, arithmetic, and attention skills (17). These are important for academic success as the demands

TABLE 4. Unstandardized regression coefficients (standard error) reflecting the adjusted relationship between extracurricular sport from ages 6 to 10 yr and academic achievement at age 13 yr.

		Average Grade in Languages	Importance Given to Academic Performance	Intrinsic Motivation	Attachment to School	Academic Aspirations	Grade Retention	Dropout Risk	Thought of Dropping Out
					Age 13 yr				
Boys	Extracurricular sport (6–10 yr)	1.78 (1.13)	0.00 (0.19)	0.21 (0.24)	0.22 (0.21)	0.37 (0.19)	−0.63 (0.32)*	−0.04 (0.02)	−0.18 (0.35)
	Parent antisocial behavior (5 mo)	−2.59 (1.01)**	−0.13 (0.18)	−0.25 (0.22)	−0.36 (0.18)*	0.17 (0.19)	0.22 (0.31)	0.04 (0.02)*	0.08 (0.32)
	Maternal education (5 mo)	−1.77 (2.04)	−0.43 (0.31)	−0.33 (0.35)	−0.61 (0.39)	−0.98 (0.32)**	1.71 (0.40)***	0.11 (0.05)	0.41 (0.42)
	Maternal depressive symptoms (5 mo)	−0.68 (1.03)	0.07 (0.18)	0.13 (0.23)	−0.20 (0.18)	−0.07 (0.19)	0.13 (0.30)	0.00 (0.02)	0.03 (0.35)
	Literacy stimulation (1.5 yr)	−0.83 (0.56)	0.17 (0.10)	−0.05 (0.12)	−0.15 (0.11)	−0.02 (0.10)	0.02 (0.17)	−0.00 (0.01)	0.27 (0.16)
	Child temperament problems (1.5 yr)	−1.18 (1.24)	−0.11 (0.19)	−0.15 (0.24)	0.22 (0.20)	0.16 (0.21)	0.21 (0.34)	0.01 (0.02)	0.43 (0.37)
	Neurocognitive skills (2 yr)	−0.46 (0.72)	−0.04 (0.12)	−0.21 (0.15)	−0.24 (0.11)*	−0.08 (0.12)	0.00 (0.19)	0.02 (0.01)	0.28 (0.20)
	Family configuration (6 yr)	−1.48 (1.17)	−0.16 (0.21)	−0.04 (0.28)	0.18 (0.22)	−0.31 (0.22)	0.28 (0.34)	0.04 (0.03)	0.39 (0.34)
	Family income (6 yr)	−1.17 (1.68)	−0.67 (0.26)**	−0.40 (0.37)	−0.24 (0.32)	−0.40 (0.28)	0.21 (0.39)	0.09 (0.04)**	1.15 (0.39)**
	Family dysfunction (6 yr)	0.96 (1.00)	0.04 (0.18)	−0.10 (0.23)	−0.20 (0.18)	−0.28 (0.19)	0.07 (0.32)	0.01 (0.02)	−0.11 (0.33)
	Vocabulary skills (6 yr)	0.14 (0.05)**	−0.01 (0.01)	−0.01 (0.01)	—	—	—	—	—
	R^2	0.101**	0.046*	0.020	0.052*	0.081**	0.141***	0.114**	0.140**
Girls	Extracurricular sport (6–10 yr)	1.39 (0.97)	0.42 (0.18)*	0.56 (0.20)**	0.23 (0.17)	0.51 (0.22)*	−0.32 (0.38)	−0.04 (0.02)*	−0.15 (0.43)
	Parent antisocial behavior (5 mo)	−2.33 (0.80)**	0.07 (0.17)	−0.34 (0.18)	−0.30 (0.14)*	−0.13 (0.20)	0.52 (0.36)	0.04 (0.02)*	−0.25 (0.40)
	Maternal education (5 mo)	−2.96 (1.35)*	0.12 (0.23)	−0.45 (0.29)	−0.10 (0.21)	−0.51 (0.30)	1.32 (0.37)***	0.06 (0.03)*	0.59 (0.51)
	Maternal depressive symptoms (5 mo)	−1.08 (0.85)	−0.30 (0.17)	−0.09 (0.19)	−0.26 (0.15)	−0.31 (0.21)	0.06 (0.35)	0.01 (0.02)	0.74 (0.41)
	Literacy stimulation (1.5 yr)	−0.82 (0.46)	−0.12 (0.09)	0.01 (0.10)	−0.13 (0.08)	−0.16 (0.11)	0.16 (0.18)	0.02 (0.01)*	0.11 (0.18)
	Child temperament problems (1.5 yr)	−1.64 (0.89)	0.08 (0.17)	−0.28 (0.20)	−0.14 (0.16)	0.03 (0.22)	−0.07 (0.38)	0.01 (0.02)	0.45 (0.43)
	Neurocognitive skills (2 yr)	−1.10 (0.52)*	0.01 (0.12)	−0.10 (0.12)	0.01 (0.09)	−0.23 (0.14)	0.42 (0.24)	0.02 (0.01)*	0.49 (0.27)
	Family configuration (6 yr)	−3.34 (0.96)***	0.00 (0.19)	−0.24 (0.20)	−0.41 (0.16)**	−0.12 (0.23)	0.55 (0.36)	0.07 (0.02)***	0.32 (0.45)
	Family income (6 yr)	−2.47 (1.27)*	0.49 (0.24)*	0.78 (0.27)**	0.23 (0.21)	−0.18 (0.30)	0.79 (0.41)*	0.05 (0.02)	−0.69 (0.66)
	Family dysfunction (6 yr)	0.17 (0.80)	−0.27 (0.17)	0.06 (0.18)	0.12 (0.14)	−0.24 (0.20)	−0.21 (0.35)	0.00 (0.01)	−0.04 (0.37)
	Vocabulary skills (6 yr)	0.10 (0.03)***	0.00 (0.01)	0.00 (0.01)	—	—	—	—	—
	R^2	0.170***	0.036*	0.043**	0.040**	0.072**	0.215***	0.135***	0.122

Analyses corrected for attrition bias. Data were compiled from the final master file of the QLSCD (1998–2015), ©*Gouvernement du Québec, Institut de la statistique du Québec.*
* $P \leq 0.05$.
** $P \leq 0.01$.
*** $P \leq 0.001$.

TABLE 5. Unstandardized regression coefficients (standard error) reflecting the adjusted relationship between extracurricular sport from ages 6 to 10 yr and academic achievement at age 15 yr.

		Average Grade in Languages	Importance Given to Academic Performance	Intrinsic Motivation	Attachment to School	Academic Aspirations	Grade Retention	Dropout Risk	Thought of Dropping out
					Age 15 yr				
Boys	Extracurricular sport (6–10 yr)	1.85 (1.07)	0.22 (0.19)	0.88 (0.23)***	0.59 (0.19)**	0.86 (0.20)***	−0.85 (0.25)***	−0.10 (0.03)***	−0.62 (0.31)*
	Parent antisocial behavior (5 mo)	−0.15 (0.95)	0.02 (0.16)	−0.23 (0.21)	−0.32 (0.17)	−0.08 (0.19)	0.39 (0.24)	0.04 (0.02)	−0.21 (0.30)
	Maternal education (5 mo)	−5.35 (1.67)***	−0.33 (0.29)	−0.53 (0.34)	−0.41 (0.32)	−1.59 (0.34)***	1.32 (0.32)***	0.16 (0.05)***	0.53 (0.38)
	Maternal depressive symptoms (5 mo)	−1.01 (0.99)	−0.12 (0.17)	0.18 (0.22)	−0.27 (0.17)	−0.44 (0.19)*	−0.10 (0.24)	0.03 (0.02)	0.68 (0.31)*
	Literacy stimulation (1.5 yr)	0.14 (0.49)	0.06 (0.09)	0.10 (0.11)	0.14 (0.09)	0.00 (0.10)	0.10 (0.13)	0.00 (0.01)	0.07 (0.17)
	Child temperament problems (1.5 yr)	0.22 (1.05)	−0.14 (0.18)	−0.37 (0.23)	0.26 (0.19)	−0.12 (0.21)	−0.04 (0.28)	−0.03 (0.03)	−0.01 (0.38)
	Neurocognitive skills (2 yr)	−0.20 (0.66)	−0.15 (0.11)	−0.28 (0.15)	0.00 (0.13)	−0.11 (0.13)	0.18 (0.17)	0.02 (0.02)	0.04 (0.20)
	Family configuration (6 yr)	−0.35 (1.17)	0.01 (0.20)	0.54 (0.24)*	−0.25 (0.21)	−0.16 (0.22)	0.32 (0.25)	0.04 (0.03)	0.68 (0.32)*
	Family income (6 yr)	−0.84 (1.62)	−0.18 (0.25)	0.37 (0.33)	0.14 (0.25)	0.01 (0.31)	0.76 (0.29)**	0.07 (0.04)	0.11 (0.38)
	Family dysfunction (6 yr)	0.69 (0.96)	−0.15 (0.17)	−0.14 (0.22)	−0.06 (0.18)	−0.01 (0.18)	0.28 (0.24)	−0.02 (0.02)	−0.10 (0.31)
	Vocabulary skills (6 yr)	0.02 (0.04)	−0.01 (0.01)*	−0.01 (0.01)	—	—	—	—	—
	R^2	0.045**	0.026	0.060**	0.046**	0.146***	0.176***	0.113***	0.111**
Girls	Extracurricular sport (6–10 yr)	1.96 (0.90)*	0.27 (0.17)	0.20 (0.21)	0.16 (0.18)	0.45 (0.23)*	−0.90 (0.27)***	−0.06 (0.02)**	−0.51 (0.35)
	Parent antisocial behavior (5 mo)	−20.3 (0.80)**	−0.15 (0.16)	−0.21 (0.19)	−0.50 (0.17)**	−0.79 (0.21)***	0.33 (0.27)	0.07 (0.02)***	0.54 (0.35)
	Maternal education (5 mo)	−3.36 (1.36)**	0.20 (0.25)	−0.1 (0.29)	−0.22 (0.27)	−0.53 (0.33)	0.95 (0.32)**	0.14 (0.04)***	0.68 (0.39)
	Maternal depressive symptoms (5 mo)	−1.08 (0.82)	0.10 (0.16)	0.10 (0.20)	−0.02 (0.18)	−0.08 (0.21)	0.10 (0.28)	0.01 (0.02)	0.29 (0.34)
	Literacy stimulation (1.5 yr)	−1.26 (0.47)**	−0.17 (0.09)*	−0.24 (0.11)*	−0.14 (0.10)	−0.21 (0.12)	0.11 (0.15)	0.02 (0.01)*	−0.05 (0.19)
	Child temperament problems (1.5 yr)	−0.30 (0.87)	−0.24 (0.17)	−0.18 (0.20)	−0.08 (0.19)	−0.18 (0.22)	0.06 (0.31)	0.01 (0.02)	−0.01 (0.37)
	Neurocognitive skills (2 yr)	−1.01 (0.47)*	−0.21 (0.10)*	−0.14 (0.13)	−0.16 (0.11)	−0.26 (0.13)*	0.41 (0.20)*	0.03 (0.01)**	0.05 (0.22)
	Family configuration (6 yr)	−1.88 (0.87)*	−0.14 (0.18)	0.02 (0.21)	−0.29 (0.19)	−0.09 (0.24)	0.64 (0.29)*	0.07 (0.02)**	0.80 (0.34)*
	Family income (6 yr)	−2.25 (1.15)*	−0.21 (0.24)	0.23 (0.30)	−0.06 (0.27)	−0.67 (0.32)*	0.83 (0.33)**	0.08 (0.03)*	0.17 (0.43)
	Family dysfunction (6 yr)	−0.19 (0.77)	−0.30 (0.15)*	0.23 (0.19)	−0.10 (0.17)	−0.15 (0.23)	0.04 (0.27)	0.02 (0.02)	0.17 (0.31)
	Vocabulary skills (6 yr)	0.10 (0.03)***	0.00 (0.01)	0.01 (0.01)	—	—	—	—	—
	R^2	0.153***	0.039**	0.022*	0.036**	0.138***	0.212***	0.188***	0.128**

Analyses corrected for attrition bias. Data were compiled from the final master file of the QLSCD (1998–2015), ©*Gouvernement du Québec, Institut de la statistique du Québec.*

*$P \leq 0.05$.
**$P \leq 0.01$.
***$P \leq 0.001$.

of schooling increase (22). Knowing that achievement in school and in sport requires perseverance (or grit) in the face of difficulty (33,34), parents invest in sport with hopes that their sons and daughters will acquire competencies, assets, values, and life skills that will help them flourish and thrive in the face of adversity (1). There is a belief that developing positive perceptions of self and social skills for teamwork, responsibility, and relationships will somehow translate into better outcomes in emerging adulthood (3). Our findings suggest that childhood involvement in sport makes unique contributions to improvements in educational prospects for both boys and girls, potentially improving opportunities for economic and personal success in adulthood.

By the end of sixth grade, more consistent participation in sport forecasted improvements in achievement for boys and girls, compared with less consistent participation in their same-sex counterparts. Middle childhood sport participation persistently forecasted greater academic aspirations, less grade retention, and lower dropout risk toward the end senior year for both sexes. These findings align with past literature using similar populational techniques. In a 12-month longitudinal study, Gil-Espinosa et al. (5) found that cardiorespiratory fitness and muscular strength were associated with higher academic achievement in adolescents. Syväoja et al. (6) found similar longitudinal associations between muscular fitness and subsequent grades in middle childhood and adolescence. Girls, being considered more at risk for emotional disorders (anxiety and depression) (18), distinctly reported important academic advantages of consistently partaking in childhood sport. This was especially remarked for achievement in language arts.

The transition from primary to secondary school represents a critical period when students disengage, especially boys (33). This disengagement may reflect variations in brain growth and development that might not yet match the requirements of the academic curriculum and other school demands (17). Puberty triggers maturation by evoking accelerated cortical thinning, which leads to better deductive reasoning and abstract thinking in adolescence (35). Girls show such cortical thinning 1 to 2 yr earlier than boys (35). Boys start puberty and cortical maturation, on average, 2 yr later than girls (36). Thus, boys are expectedly maturing less slowly on the cortical front and are more at risk of disengaging from achievement-related behaviors and values during their academic journey than girls. Boys are also more at risk of neurodevelopmental disorders like attention-deficit/hyperactivity disorder than girls (18). By seventh grade, the associated benefits for boys were not only for improved achievement but also for importance given to school, academic motivation, and positive attitudes about learning. There were reductions in grade retention and dropout risk through to their senior year of secondary school. We thus observed salutary associations for boys through to age 17 yr, which corresponds to the end of their senior year in French Canada (37).

Sport participation is thus generally predictive of more success-oriented behavior (1,13). Past research reveals two characteristics of children's sport participation that might

TABLE 6. Unstandardized regression coefficients (standard error) reflecting the adjusted relationship between extracurricular sport from ages 6 to 10 yr and academic achievement at age 17 yr.

		Age 17 yr							
		Average Grade in Languages	Importance Given to Academic Performance	Intrinsic Motivation	Attachment to School	Academic Aspirations	Grade Retention	Dropout Risk	Thought of Dropping out
Boys	Extracurricular sport (6–10 yr)	2.21 (1.16)	0.30 (0.20)	0.36 (0.29)	0.32 (0.22)	0.71 (0.21)***	−0.69 (0.27)**	−0.09 (0.03)**	−0.44 (0.32)
	Parent antisocial behavior (5 mo)	−0.90 (1.05)	−0.06 (0.19)	−0.19 (0.25)	−0.01 (0.20)	−0.21 (0.20)	0.38 (0.27)	0.03 (0.03)	0.18 (0.33)
	Maternal education (5 mo)	−1.64 (1.98)	0.16 (0.36)	0.37 (0.48)	−0.56 (0.40)	−0.67 (0.33)*	0.93 (0.41)*	0.17 (0.06)**	1.09 (0.47)*
	Maternal depressive symptoms (5 mo)	−1.44 (1.11)	−0.31 (0.20)	−0.45 (0.26)	−0.33 (0.20)	−0.28 (0.21)	0.59 (0.27)*	0.06 (0.03)*	0.97 (0.33)**
	Literacy stimulation (1.5 yr)	−0.01 (0.52)	0.03 (0.10)	0.11 (0.13)	−0.04 (0.11)	−0.15 (0.10)	0.15 (0.15)	0.02 (0.01)	−0.15 (0.21)
	Child temperament problems (1.5 yr)	0.73 (1.07)	0.05 (0.20)	0.17 (0.27)	0.18 (0.22)	0.05 (0.21)	−0.63 (0.29)*	−0.06 (0.03)*	−0.12 (0.36)
	Neurocognitive skills (2 yr)	−1.02 (0.79)	0.02 (0.14)	−0.24 (0.19)	0.04 (0.15)	0.00 (0.14)	0.20 (0.20)	0.02 (0.02)	0.29 (0.24)
	Family configuration (6 yr)	−0.33 (1.14)	0.35 (0.22)	0.26 (0.29)	−0.16 (0.22)	0.02 (0.22)	0.47 (0.28)	0.02 (0.03)	0.19 (0.32)
	Family income (6 yr)	−2.50 (1.91)	0.10 (0.31)	0.94 (0.37)**	0.26 (0.27)	−0.41 (0.29)	0.35 (0.38)	0.05 (0.04)	−0.27 (0.45)
	Family dysfunction (6 yr)	0.04 (1.08)	0.08 (0.20)	−0.29 (0.25)	−0.03 (0.20)	0.06 (0.20)	0.42 (0.27)	0.03 (0.03)	0.21 (0.32)
	Vocabulary skills (6 yr)	0.03 (0.04)	0.01 (0.01)	−0.02 (0.01)**	—	—	—	—	—
	R^2	0.049*	0.025	0.067**	0.023	0.081***	0.183***	0.150***	0.139**
Girls	Extracurricular sport (6–10 yr)	1.86 (1.03)	0.26 (0.20)	0.25 (0.24)	0.05 (0.19)	0.85 (0.22)***	−0.96 (0.31)**	−0.04 (0.02)	−0.81 (0.33)**
	Parent antisocial behavior (5 mo)	−3.50 (0.87)***	−0.08 (0.17)	−0.42 (0.22)	−0.27 (0.17)	−0.80 (0.21)***	0.55 (0.33)	0.07 (0.02)***	0.54 (0.33)
	Maternal education (5 mo)	−4.20 (1.47)**	−0.10 (0.26)	0.27 (0.33)	−0.35 (0.27)	−0.88 (0.32)**	1.53 (0.35)***	0.17 (0.04)***	1.22 (0.38)***
	Maternal depressive symptoms (5 mo)	−1.71 (0.88)*	0.01 (0.18)	0.03 (0.23)	−0.22 (0.18)	0.06 (0.23)	−0.14 (0.34)	0.01 (0.02)	0.32 (0.34)
	Literacy stimulation (1.5 yr)	−1.12 (0.47)*	−0.14 (0.10)	−0.25 (0.13)*	−0.02 (0.09)	−0.11 (0.11)	−0.14 (0.16)	0.02 (0.01)*	−0.07 (0.19)
	Child temperament problems (1.5 yr)	−0.27 (0.92)	0.02 (0.18)	−0.19 (0.24)	−0.11 (0.18)	0.15 (0.24)	0.00 (0.38)	0.01 (0.02)	−0.20 (0.34)
	Neurocognitive skills (2 yr)	−1.11 (0.47)*	0.04 (0.11)	−0.20 (0.14)	0.05 (0.11)	−0.20 (0.14)	0.04 (0.19)	0.01 (0.01)	−0.28 (0.18)
	Family configuration (6 yr)	−2.20 (1.13)*	0.02 (0.20)	−0.42 (0.26)	−0.71 (0.20)***	−0.54 (0.24)*	0.90 (0.35)**	0.07 (0.03)**	1.09 (0.33)***
	Family income (6 yr)	−2.27 (1.45)	−0.08 (0.28)	0.74 (0.35)*	−0.32 (0.26)	−0.13 (0.34)	1.10 (0.39)**	0.09 (0.04)**	−0.08 (0.42)
	Family dysfunction (6 yr)	0.74 (0.90)	−0.15 (0.17)	0.01 (0.22)	−0.02 (0.17)	−0.14 (0.21)	−0.05 (0.29)	0.02 (0.02)	0.06 (0.31)
	R^2	0.227***	0.012	0.053**	0.060**	0.162***	0.279***	0.225***	0.203***

Analyses corrected for attrition bias. Data were compiled from the final master file of the QLSCD (1998–2015), ©*Gouvernement du Québec, Institut de la statistique du Québec.*

*$P \leq 0.05$.
**$P \leq 0.01$.
***$P \leq 0.001$.

explain our findings. First, physical exercise triggers an upregulation of neurotransmitters associated with positive mood and neurotrophic factors that protect and support neuronal vitality. Neurotrophic factors promote cellular and synaptic proliferation, which, in turn, enhance executive functions, regional brain volume, and connectivity (38). Sustained participation in physical activity increases chances of epigenetic upregulation of brain-derived neurotrophic factor synthesis, thus promoting brain health throughout the life course (39). Although physical activity in sport is variable, sport participation does correlate with increases in fitness, which likely explain improvements in executive functions, regional brain volume, and connectivity (4,33,35). Second, given that interpersonal interactions have salutary associations with brain development, sport directed by a coach or instructor provides a challenging shared environment with stimulating social transactions, which likely propels neural systems toward brain plasticity and thus flourishment (40,41).

This study is not without limitations. First, although it is observational, our data on participation are by parental proxy. Second, our observations are longitudinal; yet they remain correlational. This precludes causal references. Finally, because this investigation treated existing longitudinal data, standardized achievement data were unavailable. Nevertheless, self-report data on academic achievement and positive learning behaviors are strongly correlated with more objective tests (42,43).

The chief strengths of this study are its longitudinal tracking of prolonged childhood participation, large array of academic achievement indicators, prospective nature, and comprehensive confound control. Its focus on the sexes as two heterogeneous populations with distinct interests, motivations, and contextual experiences also represents an ideal design option. Typical gender experiences, even if by parental proxy, remain insightful.

Childhood represents a critical period orchestrated by genetic and environmental processes that unfold in response to vulnerability (risks) and opportunity (resources) (44). This investigation finds that middle childhood sport represents an influential factor against academic hardship and maladjustment in adolescence. Early experiences foretell subsequent adult lifestyle habits (13,40). A healthy lifestyle involving physical social effortful play (such as sport) currently represents the best prevention and intervention strategy for mental and physical health (45). Our findings extend beneficial associations to indicators of academic achievement, which have the potential to become intergenerational protective factors (46).

Most children are not meeting the daily recommendations for physical activity (1,10). School-aged youth accumulate an average of 8 $h \cdot d^{-1}$ of sedentary time (47). This exceeds the 24-h movement guidelines of limiting sitting for extended periods and no more than 2 $h \cdot d^{-1}$ of screen time (48,49). Participating in afterschool sports represents both a strategy to reduce sedentary screen time and a contributor to physical activity (50).

Given the significant crisis in mental and physical health associated with screen media, sport as an after-hours adjunct to child-rearing has become undeniable (51). Access and economic barriers to extracurricular sport, especially cost, should be reconsidered. Sport in childhood should be treated as a population health investment for the future.

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