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ABSTRACT

Introduction

Physical fitness is an important indicator of current and future health status. This analysis examines the relationships among child-parent dyads in physical fitness measures.

Methods

The analysis is based on biological child-parent dyads from three cycles of the Canadian Health Measures Survey (Cycle 1: 2007 to 2009, Cycle 2: 2009 to 2011, and Cycle 5: 2016 to 2017). Physical fitness components—cardiorespiratory (CRF) (n = 615), muscular strength (n = 1,319) and flexibility (n = 1,295)—were measured at mobile examination centres using standardized fitness tests. Descriptive, correlation and regression analyses were used to examine relationships among child-parent dyads.

Results

CRF (R = 0.12), muscular strength (R = 0.23) and flexibility (R = 0.22) measures were weakly correlated among child-parent dyads. Modest increases in the physical fitness levels of children were observed with increases in the fitness rating scores of their parents. According to unadjusted and adjusted regression models, CRF ($p < 0.05$), muscular strength ($p < 0.001$) and flexibility ($p < 0.001$) were positively associated among child-parent dyads. When examined by sex of parent and child, CRF was significantly associated in mother-son dyads only, grip strength was associated in all dyad types except father-son pairings, and flexibility was associated in mother-son and father-son pairings only.

Interpretation

A significant and positive association was evident in measured physical fitness among parents and children. Some variation in the presence and strength of associations existed according to child and parent sex.

Keywords

dyad, health, cardiorespiratory, muscular strength, flexibility

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What is already known on this subject?

- Physical fitness is an important indicator of health status.
- Physical fitness declined in Canadian children from 1980 to 2007, but remained relatively stable from 2007 to 2017.
- Children's body weight status is associated with that of their biological parents. Children who have a parent with obesity are at increased risk of being overweight or obese.
- Children's physical activity and sedentary behaviour are associated with that of their biological parents.

What does this study add?

- Measures of physical fitness are significantly associated among child-parent dyads.
- Associations differ according to different child-sex and parent-sex combinations.
- Findings support the importance of parents as an influence on the physical fitness of their children.

The physical fitness (i.e., the ability to perform physical activity) of Canadian children declined from 1980 to 2007,[1] and then remained relatively stable from 2007 to 2017.[2] High physical fitness is associated with many health benefits[3-5] and is an important indicator of future health status among children.[6-9] The interrelationships among fitness, obesity, physical activity and health are well established, [10-12] and are sensitive to a myriad of socioeconomic influences.[13] The health status and lifestyle habits of parents have been proposed as important sources of influence.[14-16]

Family-based research[17,18] and twin studies[19-21] indicate that a large proportion of the variance in physical fitness is explained by genetics. The HERITAGE Family Study provides evidence of familial aggregation in cardiorespiratory fitness (CRF), both in untrained individuals[22] and in response to training.[23] More recent studies have reported significant relationships among child-parent dyads in both CRF[24] and muscular strength.[25] Findings from obesity and physical activity research tell a similar story.[15] Obesity aggregates within families because of common genetics, health behaviours and environments.[26,27] The body weight status of children is associated with that of their parents[28,29], and having a parent with obesity increases the risk of a child being overweight or obese.[30] Parents influence their child's physical activity habits through role modelling (e.g., adopting physical activity themselves), material support (e.g., financial, logistical), encouragement (e.g., cheering at games), and co-participation (e.g., parent and child being active together).[15,16,31-33] This body of research has highlighted the importance of the family environment in shaping health behaviours and future health status among children.

Differences are evident in the influence of mothers versus fathers on the health and lifestyle habits of their children, but findings tell an inconsistent story.[34] Some research has reported stronger associations among same-sex child-parent dyads[35,36], while other studies have noted that mothers have a stronger effect than fathers[24,37,38], or that there are stronger associations among parent-son dyads compared with parent-daughter dyads.[34] Two previous studies using Canadian Health Measures Survey (CHMS) data found that the sex of both the parent and child were important to consider in child-parent dyad research.[30,39] Considering the sex of both the child and parent in these types of analyses provides important insights that may inform the design of intervention strategies.

The CHMS is a comprehensive and ongoing direct health measures survey that is conducted by Statistics Canada in partnership with Health Canada and the Public Health Agency of Canada.[40] The CHMS samples a second person from households where the first person selected was between the ages of 3 and 12 years, thus creating a subset of data on pairs of respondents living in the same household. In the majority of cases, the second person sampled is a biological parent. This creates a unique subsample dataset that allows researchers to examine interrelationships between parents and children across the range of health data collected in the CHMS. Previous research using this dataset observed significant associations between parents and children in obesity[30], physical activity and sedentary behaviour.[39,41] The purpose of this current study is to examine associations between biological child-parent dyads in measures of physical fitness (i.e., CRF, muscular strength and flexibility). In addition, the present study examines whether the associations varied according to the different sex combinations of the child-parent dyads, and whether associations remained when adjusted for child, parent and household characteristics.

Methods

Data source

The CHMS is an ongoing cross-sectional survey conducted by Statistics Canada. It collects directly measured and self-reported health information from a nationally representative sample of the Canadian household-dwelling population aged 3 to 79 years. To collect this data, mobile examination centres travel to

Table 1
Child, parent and household characteristics of the dyad sample, household population, Canada excluding territories, 2007 to 2017

	All			Males			Females		
		95% confidence interval			95% confidence interval			95% confidence interval	
	Mean or %	from	to	Mean or %	from	to	Mean or %	from	to
Child characteristics									
Age (years)	**8.4**	8.3	8.6	**8.4**	8.2	8.6	**8.5**	8.3	8.7
Body mass index (kg/m^2)	**17.4**	17.2	17.7	**17.6**	17.2	18.0	**17.2**	16.9	17.6
Percent overweight or obese (%)	**29.3**	25.8	33.0	**32.1**	27.7	36.9	**26.0**	21.3	31.3
Average daily MVPA (min/d)	**61.2**	56.9	65.6	**68.8**	63.6	74.0	**52.5** ***	48.3	56.8
Cardiorespiratory fitness (ml/kg/min) (8-to-11-year-olds only)	**50.6**	50.2	51.1	**51.1**	50.4	51.8	**50.1**	49.5	50.8
Muscular strength: grip strength (kg)	**25.6**	24.8	26.3	**26.4**	25.2	27.6	**24.6** *	23.7	25.5
Muscular strength: grip strength (kg per kg body weight)	**0.8**	0.8	0.8	**0.8**	0.8	0.8	**0.8** *	0.8	0.8
Flexibility: sit-and-reach (cm)	**27.0**	26.3	27.7	**24.5**	23.5	25.5	**29.9** ***	29.2	30.6
Parent Characteristics									
Age (years)	**39.3**	38.7	40.0	**40.7**	39.7	41.6	**38.4** ***	37.7	39.0
Body mass index (kg/m^2)	**27.2**	26.8	27.6	**27.9**	27.3	28.5	**26.7** *	26.1	27.3
Percent overweight or obese (%)	**60.3**	56.2	64.2	**74.1**	67.6	79.7	**50.6** ***	44.0	57.3
Average daily MVPA (min/d)	**23.4**	21.0	25.7	**27.0**	23.7	30.3	**20.9** *	17.9	23.8
Cardiorespiratory fitness (ml/kg/min)	**36.6**	36.0	37.1	**39.3**	38.2	40.4	**34.9** ***	34.2	35.5
Muscular strength: grip strength (kg)	**72.9**	71.1	74.6	**95.0**	92.1	98.0	**57.5** ***	56.3	58.8
Muscular strength: grip strength (kg per kg body weight)	**0.9**	0.9	1.0	**1.1**	1.1	1.1	**0.8** ***	0.8	0.9
Flexibility: sit-and-reach (cm)	**27.7**	26.9	28.6	**23.6**	22.4	24.7	**30.6** ***	29.8	31.3
Household characteristics (presented by sex of the parent)									
Marital status of parent									
Married or living common-law (%)	**85.0**	81.2	88.2	**94.9**	90.6	97.3	**78.2** ***	72.5	83.0
Single, divorced or widowed (%)	**15.0**	11.8	18.8	**5.1**	2.7	9.4	**21.8** ***	17.0	27.5
Highest education of parent									
Secondary school graduation or less (%)	**20.0**	16.5	24.1	**24.7**	19.3	30.9	**16.8**	13.1	21.3
Postsecondary below bachelor's degree (%)	**43.0**	39.2	46.9	**40.1**	34.7	45.7	**45.0**	40.1	50.0
Bachelor's degree or more (%)	**37.0**	31.8	42.5	**35.2**	28.6	42.4	**38.2**	31.9	44.9
Number of children in household									
More than one child in household (%)	**82.6**	78.6	85.9	**86.7**	82.2	90.1	**79.8** *	74.4	84.2
One child in household (%)	**17.4**	14.1	21.4	**13.3**	9.9	17.8	**20.2** *	15.8	25.6
Household income (adjusted for household size)									
Quintile 1 (%)	**14.4**	11.9	17.3	**8.0**	5.5	11.5	**18.8**	14.7	23.9
Quintile 2 (%)	**16.6**	13.8	19.9	**15.6**	11.8	20.2	**17.4**	13.8	21.6
Quintile 3 (%)	**20.5**	16.5	25.1	**21.2**	14.5	30.0	**19.9**	15.5	25.2
Quintile 4 (%)	**21.6**	18.0	25.5	**24.1**	19.3	29.5	**19.8**	15.9	24.4
Quintile 5 (%)	**27.0**	22.8	31.6	**31.2**	24.0	39.4	**24.1**	19.6	29.2

* significantly different to males, $p < 0.05$

*** significantly different to males, ($p < 0.001$)

Note: MVPA refers to moderate-to-vigorous intensity physical activity.

Source: Canadian Health Measures Survey, 2007 to 2009, 2009 to 2011 and 2016 to 2017.

multiple sites across the country. The design and procedures of the CHMS are described elsewhere.[40] Ethics approval to conduct the survey was obtained from Health Canada's Research Ethics Board.[42] Respondents provided consent to participate and children less than 14 years of age provided assent and parental consent.

This analysis used measured physical fitness data from 3 separate cross-sectional cycles of the CHMS: cycle 1 (2007 to 2009), cycle 2 (2009 to 2011) and cycle 5 (2016 to 2017). The dataset included children aged 6 to 11 years for whom complete physical fitness and covariate data on one biological parent living in the same household was also available. The sample size of child-parent dyads varied between fitness measures: CRF had a sample size of 615 (for children, only those aged 8 to 11 years were measured); muscular strength had a sample of 1,319; and flexibility had a sample of 1,295.

Following a household interview, CHMS respondents visited the mobile examination centre where they underwent biological and physical measures and participated in fitness tests. The fitness tests were conducted by Certified Exercise Physiologists and Certified Personal Trainers. Before undergoing any fitness tests, parent respondents were asked about their and their child's physical health conditions and medication use. A Physical Activity Readiness Questionnaire, the standard approach at the time these data were collected, was completed and signed by all respondents (and by the guardian if the respondent was younger than 14 years). Respondents were screened out of certain tests according to their answers to the screening questions (e.g., a respondent was screened out if

they had asthma and forgot to bring their puffer to a clinic visit). Respondents were requested to adhere to pre-testing guidelines regarding food, alcohol, caffeine, nicotine, exercise and blood donations.[43-45]

Physical fitness measures

CRF was measured in children aged 8 to 11 and youth and adults aged 12 to 79 years using the modified Canadian Aerobic Fitness Test (mCAFT), a progressive step test where respondents complete one or more three-minute stages at a cadence predetermined based on their age and sex.[46] Respondents' heart rates were recorded after each stage, and their test was completed when their heart rate reached 85% of their age-predicted maximum heart rate (220 minus age) at the end of the stepping stage. Predicted maximal CRF (mL/kg/min) was calculated for all respondents using an equation developed for people aged 15 to 69 years.[47] This equation was also applied to children aged 8 to 11 years in this analysis as mCAFT equations have not been developed for this age group.

Muscular strength was assessed by measuring isometric hand grip strength in kilograms with a Smedley III analog hand grip dynamometer (Takei Scientific Instruments, Tokyo, Japan) following standardized procedures.[46] Two attempts were performed for each hand, alternating. The maximum results for each hand were combined.

Flexibility was assessed using the sit-and-reach test, in centimetres, after a brief warm-up (a 20-second modified hurdler stretch, twice per leg). Respondents sat on the floor with their legs extended against a flexometer (Fit Systems Inc., Calgary, Canada) and stretched as far forward as possible, trying to touch their toes without bending their knees. Two attempts were performed and the better of two attempts was used in the analyses.[46] A toe touch was equivalent to 26 cm. Values above 26 cm represent a stretch with fingers extended beyond a respondent's toes.

Covariates

Average daily minutes of moderate-to-vigorous physical activity (MVPA) was included as a covariate in analyses for both parents and children, and was directly measured using accelerometer data. Respondents were asked to wear an Actical accelerometer (Phillips Respironics, Oregon, United States) over their right hip on an elasticized belt during waking hours for seven consecutive days. The Actical accelerometer measures and records time-stamped acceleration in all directions, providing an index of movement intensity via a count value for each minute (data were collected in 60-second epochs). A day was defined as valid if an accelerometer had 10 or more hours of wear time, and a respondent was defined as valid if they completed a minimum of four valid days.[48] Wear time was determined by subtracting non-wear time per day from 24 hours. Non-wear time was defined as at least 60 consecutive minutes of no counts, with allowance for one to two minutes of counts between 0 and 100. More details are available in previous publications.[48]

Height was measured to the nearest 0.1 centimetre using a ProScale M150 digital stadiometer (Accurate Technology Inc., Fletcher, United States), and weight to the nearest 0.1 kilogram was measured with a Mettler Toledo VLC terminal scale with Panther Plus (Mettler Toledo Canada, Mississauga, Canada). Body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared (kg/m^2). BMI *z*-scores were determined using the World Health Organization's BMI-for-age child growth standards. Respondents were classified as being overweight or obese if their BMI *z*-score was more than 1 standard deviation above the mean.[43-45]

Statistical Analysis

Descriptive analyses were used to present the physical fitness characteristics of the children and parents included in the sample, as well as the sociodemographic characteristics of the household. Pearson correlation analysis was used to assess the unadjusted relationship between child and parent fitness measures overall, and by the sex of the child, the parent sex, and both the parent and the child. To visually depict the relationship among child-parent dyads, the child fitness values for CRF, grip strength and flexibility were presented according to the parent's corresponding fitness rating (excellent, very good, good, fair and poor). Linear regression modelling was used to assess the association of physical fitness among child-parent dyads (dependant variable: child fitness; independent variable: parent fitness). Five separate models were used to assess how adjustment for covariates and stratification by the sex of parents and children affected the associations: (1) overall model, unadjusted; (2) overall model, adjusted for sex, age, BMI and MVPA of both the child and parent plus household income, parental education, single child status, marital status; (3) models stratified by child sex and adjusted for parent sex and age, BMI, and the MVPA of both the child and parent; (4) models stratified by parent sex and adjusted for child sex and age, BMI, and the MVPA of both the child and parent; (5) models stratified by the sex of the child and the parent and adjusted for age, BMI and the MVPA of both the child and parent.

CHMS combined survey weights were applied to make the results representative of the Canadian population living in the provinces. Bootstrap weights were used to calculate variance (95% confidence intervals). Statistical significance was set a priori at $p < 0.05$ and $p < 0.001$. Correlations were considered weak if they were less than 0.3, moderate if they were equal to or greater than 0.3 and strong if they were equal to or greater than 0.6.[49] All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, North Carolina, United States) and SUDAAN version 11.0.3 (RTI International, Research Triangle Park, United States) using denominator degrees of freedom set to 35 in the SUDAAN procedure statements.

Results

Descriptive statistics on characteristics of the child, parent and household are presented overall and by sex in Table 1. There

was no difference in mean child age between sons and daughters; however, mothers were younger than fathers, on average. There were more mothers than fathers in the sample. Mothers were less likely to be married or common law compared with fathers, and there were more single mothers in the sample than single fathers. The majority of dyads were part

Figure 1
Fitness of children presented by level of parental fitness

Figure 1a. Cardiorespiratory fitness of boys and girls, by health benefit rating of parental cardiorespiratory fitness

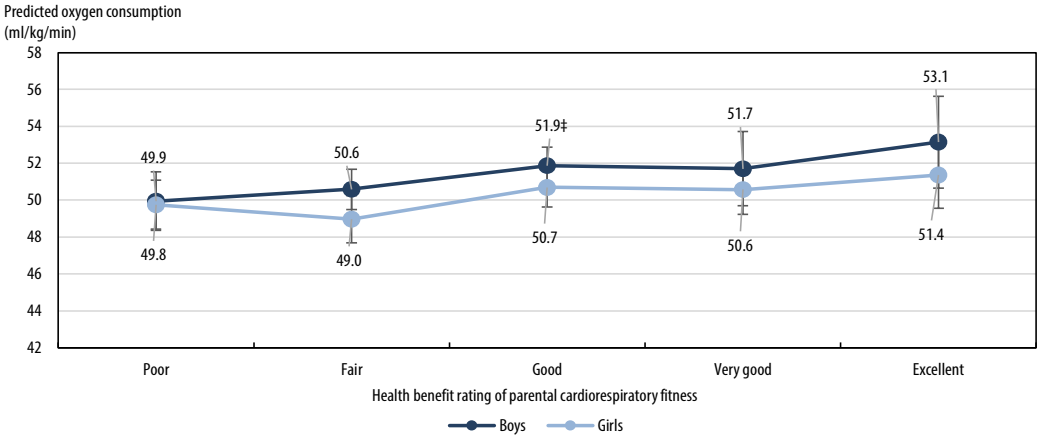


Figure 1b. Grip strength of children, by health benefit rating of parental grip strength

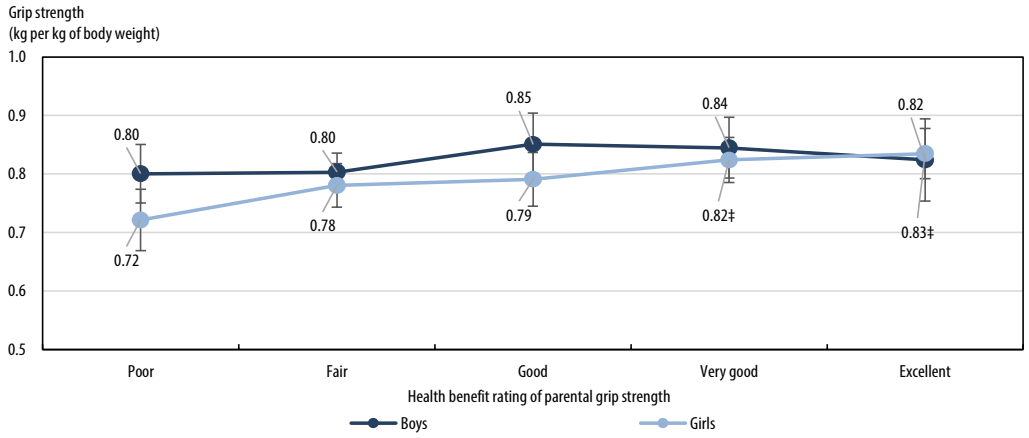
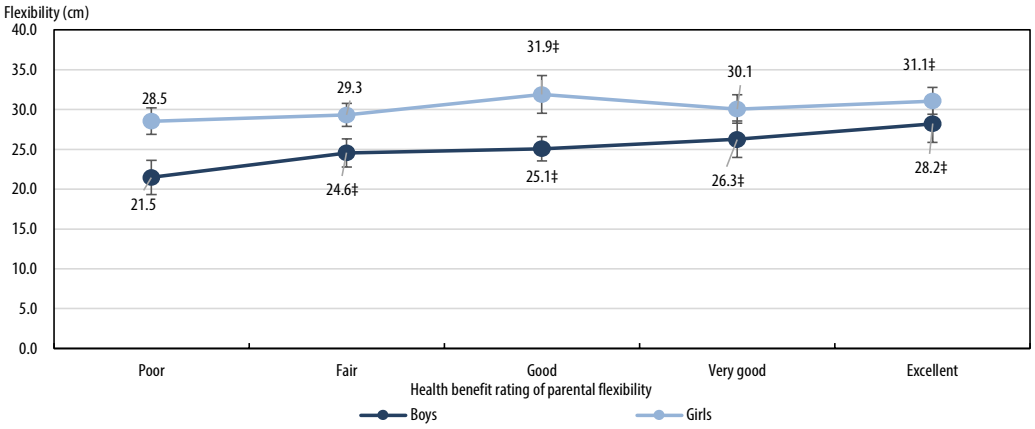


Figure 1c. Flexibilty of children by health benefit rating of parental flexibility



‡ significantly different to poor fitness rating
Source: Canadian Health Measures Survey, 2007 to 2009, 2009 to 2011 and 2016 to 2017.

Table 2
Pearson correlations among child-parent dyads for measures of physical fitness, household population, Canada excluding territories, 2007 to 2017

	Cardiorespiratory fitness (ml/kg/min)		Muscular strength (kg per kg body mass)		Flexibility (cm)	
	Pearson correlation co-efficient (R)	Significance (p-value)	Pearson correlation co-efficient (R)	Significance (p-value)	Pearson correlation co-efficient (R)	Significance (p-value)
Parent-child	0.12	0.0042	0.23	<0.0001	0.22	<0.0001
Parent-son	0.15	0.0089	0.19	<0.0001	0.31	<0.0001
Parent-daughter	0.11	0.0433	0.29	<0.0001	0.12	0.0027
Father-child	0.15	0.0202	0.26	<0.0001	0.32	<0.0001
Mother-child	0.12	0.0230	0.31	<0.0001	0.20	<0.0001
Mother-daughter	0.06	0.4336	0.31	<0.0001	0.12	0.0227
Father-son	0.15	0.1212	0.19	0.0019	0.40	<0.0001
Mother-son	0.18	0.0145	0.30	<0.0001	0.32	<0.0001
Father-daughter	0.25	0.0065	0.35	<0.0001	0.17	0.0044

Source: Canadian Health Measures Survey, 2007 to 2009, 2009 to 2011 and 2016 to 2017.

of a two-parent household where parents were married or common law (85%), and where there was more than one child in the household (83%). Boys had higher average daily minutes of MVPA and muscular strength than girls. Men had higher average daily minutes of MVPA, BMI, CRF and grip strength than women. Girls and women both had higher flexibility compared with their male counterparts.

An upward trend in children's CRF was observed across the fitness ratings of CRF among parents (Figure 1a). Boys who had a parent with a "good" fitness rating had a higher CRF level than those whose parent had a "poor" rating. The grip strength of girls was higher when the grip strength of their parent was "very good" or "excellent" compared with "poor" (Figure 1b). The flexibility of girls was higher when the flexibility of their parent was "good" or "excellent" compared with "poor," while the flexibility of boys was higher when the flexibility of their parent was at any level higher than "poor" (Figure 1c).

The overall correlation between parents and children was weak but significant for CRF (R = 0.12), muscular strength (R = 0.23) and flexibility (R = 0.22) (Table 2). Correlations remained significant when examined separately by parent sex (i.e., mother-child and father-child) or child sex (i.e., parent-daughter and parent-son). In correlations stratified by the sex of both parents and children, all were significant with the exception of CRF in same-sex dyads (i.e., mother-daughter and father-son).

Unadjusted and adjusted regression models showed a significant association among child-parent dyads for all three types of physical fitness (Table 3, models 1 and 2). Stratified models indicated that the association in CRF among child-parent dyads was driven by the mother-son dyad (Table 3, models 3, 4 and 5). Muscular strength was significantly associated among mother-son, mother-daughter and father-daughter dyads, while flexibility was significantly associated among father-son and mother-son dyads only.

Discussion

Using a representative sample of Canadian children aged 6 to 11 years, this analysis demonstrates that the fitness of parents was associated with the fitness of their biological children. The presence of significant associations among child-parent dyads varied when models were stratified by the sex of the child and parent. Significant associations in unadjusted correlation analyses did not always remain in models that were adjusted for child and parent age, BMI and MVPA.

Two previous studies used paired biological child-parent dyad data from the CHMS to show that a school-aged child's body weight status and objectively measured physical activity are associated with those of their parents.[30,39] A more recent study examined the association in physical activity and sedentary behaviour among preschool-aged children and their biological parents. It also found a significant, albeit slightly weaker, association.[41] The current study is a continuation of these studies: it used the same unique dyad dataset to examine whether an association exists between biological parents and their children in terms of physical fitness. Across the CHMS dyad studies on school-aged children, the strength of correlation (R-value) was slightly higher for accelerometer-measured MVPA (R=0.28),[39] BMI (R=0.24)[30] and sedentary time (R=0.19)[39] than for physical fitness (range: R=0.12 to 0.23). The correlation strength observed in the present study for muscular strength (R=0.23) is consistent with that observed by Barbosa et al. in Brazilian child-parent dyads.[25] Like Foraita et al.,[24] the present study found that BMI and MVPA were significant in the adjusted regression models between child and parent CRF (data not shown). Despite much of the variance in child fitness being explained by these related variables, the association between child and parent physical fitness remained significant overall; however, significance was lost in some of the adjusted models that were segregated by the sex of the child and parent. Collectively, these CHMS dyad papers highlight the

Table 3
Association between children and parents in cardiorespiratory fitness, muscular strength and flexibility, household population, Canada excluding territories, 2007 to 2017

	Cardiorespiratory fitness				Muscular strength				Flexibility			
Model, model adjustment and segregation	Beta	Standard error	p-value	Model R^2	Beta	Standard error	p-value	Model R^2	Beta	Standard error	p-value	Model R^2
Model 1: Unadjusted	0.08	0.03	0.0200	0.01	0.19	0.03	0.0000	0.05	0.18	0.03	0.0000	0.05
Model 2: Adjusted for characteristics of child, parent and household	0.14	0.05	0.0087	0.36	0.22	0.06	0.0003	0.33	0.21	0.03	0.0000	0.23
Model 3: Adjusted for characteristics of child and parent												
Boys	0.19	0.07	0.0137	0.34	0.19	0.08	0.0276	0.32	0.30	0.05	0.0000	0.21
Girls	0.11	0.06	0.0513	0.33	0.29	0.05	0.0000	0.27	0.11	0.04	0.0087	0.05
Model 4: Adjusted for characteristics of child and parent												
Fathers	0.10	0.07	0.1807	0.40	0.21	0.08	0.0085	0.30	0.25	0.05	0.0000	0.25
Mothers	0.23	0.07	0.0013	0.30	0.28	0.07	0.0002	0.31	0.19	0.04	0.0000	0.20
Model 5: Adjusted for characteristics of child and parent												
Mother-daughter	0.15	0.09	0.1020	0.30	0.24	0.09	0.0087	0.25	0.10	0.05	0.0502	0.03
Father-son	0.11	0.11	0.3211	0.45	0.12	0.10	0.2653	0.32	0.36	0.07	0.0000	0.25
Mother-son	0.32	0.12	0.0112	0.31	0.32	0.11	0.0056	0.37	0.26	0.07	0.0005	0.22
Father-daughter	0.04	0.06	0.5183	0.46	0.34	0.07	0.0000	0.33	0.12	0.07	0.0888	0.08

Notes: MVPA refers to moderate-to-vigorous intensity physical activity. BMI refers to Body mass index. Model 1 is unadjusted. Model 2 is adjusted for sex, age, BMI, MVPA of both the child and parent plus household income, parental education, single child status and marital status. Model 3 is adjusted for parent sex and age, BMI, MVPA of both the child and parent. Model 4 is adjusted for child sex and age, BMI, MVPA of both child and parent. Model 5 is adjusted for age, BMI and MVPA of both child and parent.

Source: Canadian Health Measures Survey, 2007 to 2009, 2009 to 2011 and 2016 to 2017.

interconnectedness in lifestyle behaviours (i.e., physical activity and sedentary time) and physical states (i.e., obesity and fitness level).

Much of the child-parent dyad research has been focused on physical activity and obesity. This body of work provides a point of comparison when trying to understand the influence of child and parent sex in the observed associations. In the present study, a significant relationship was observed among mother-son dyads, both in unadjusted correlation analyses and adjusted regression models. For the remaining three dyad types, a consistent pattern in how the sex of children and their parents affected their association in physical fitness was not evident across the types of fitness. The stronger relationship among same-sex child-parent dyads that has been observed by others for measures of fitness[35] and physical activity[34,36,38] was not evident in the present study. According to the adjusted models, a significant association was evident only for muscular strength in mother-daughter dyads and for flexibility in father-son dyads. Several previous studies have reported a stronger association among mother-child dyads compared with father-child dyads in physical activity[37,38,50] and CRF.[24] This is somewhat consistent with the present study, which found that mother-child associations were significant for all types of fitness, while associations among father-child dyads were significant for muscular strength and flexibility only. Conversely, significant associations were observed in the present study for all types of fitness measures for boys, but for only two types among girls. This is consistent with a finding reported in a meta-analysis that shows a significant moderating effect of parent sex on the physical activity of children among parent-son dyads, but not parent-daughter dyads.[34] Although the role that the sex of parents and children plays in understanding their association in lifestyle habits and health states appears to be inconsistent between studies[34], it is clear that the sex of both the child and parent is an important variable to consider in this area of research. Considering how lifestyle habits vary by child-sex and parent-sex combinations may help to tailor intervention and messaging strategies to encourage both parents to get involved in modelling and supporting healthy behaviours.[36] Ultimately, the results of the present study and others support the idea that the family environment is important in shaping the health behaviours of children. Given that health behaviours and physical fitness predict adult health status[7,8], this information is important to understand and highlight.

Strengths and limitations

A strength of this analysis is the large sample of biological child-parent dyads on whom measured physical fitness data were collected. The sample is representative of children aged 6 to 11 years and their biological parents in Canada. The sample used standardized physical fitness measurement techniques. Models were adjusted for several potential confounders, including the age, sex, BMI and accelerometer-measured MVPA of both the child and the parent, as well as a range of household characteristics including education, income and marital status.

Nonetheless, caution is warranted in the interpretation of the results. The test used to estimate CRF has been validated only for adults; more research is needed to understand whether it is an appropriate test to estimate CRF among children.[51,52] Because of the strict guidelines for who can complete CRF testing, it is likely that the present sample represents a slightly healthier subset of the Canadian population of children aged 6 to 11 years. It is also important to note that a test of bias analysis on the CHMS dyad dataset revealed that compared with children in the file without a respondent birth parent, children with a respondent birth parent were more likely to have a younger parent, be from a smaller household size, live in two-parent or single-child household, have a respondent parent who has completed a Bachelor's degree or more as the highest level of household education and be from a household with income more than $100,000. Despite these sources of bias, it is important to note that the second member of the household was selected at random and the weighting strategy is designed to adjust for non-response bias.

Conclusion

The present study adds to a body of work from the CHMS dyad dataset that illustrates important relationships among child-parent dyads in health status and health-related behaviours. Similar to observations for obesity, physical activity and sedentary behaviour, the present study found a significant and positive association among child-parent dyads in measured physical fitness. It also found evidence of variation in the strength of association depending on the sex of the child and parent. As highlighted in the recently published 2020 ParticipACTION Report Card[15,16], families play a crucial role in shaping the lifestyle habits and health outcomes of children.

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