



## Original Contribution

# Socioeconomic Position and the Tracking of Physical Activity and Cardiorespiratory Fitness From Childhood to Adulthood

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Initially submitted March 4, 2009; accepted for publication June 11, 2009.

This study examined the influence of childhood socioeconomic position (SEP) and social mobility on activity and fitness tracking from childhood into adulthood. In a prospective cohort of 2,185 Australian adults (aged 26–36 years), first examined in 1985 (at ages 7–15 years), self-reported physical activity and cardiorespiratory fitness (subsample only) were measured. SEP measures included retrospectively reported parental education (baseline) and own education (follow-up). There was little evidence of a relation between childhood SEP and activity tracking, but high childhood SEP (maternal education) was associated with a 59% increased likelihood of persistent fitness, and medium childhood SEP (paternal and parental education) was associated with a 33%–36% decreased likelihood of persistent fitness. Upward social mobility was associated with a greater likelihood of increasing activity (38%–49%) and fitness (90%), and persistently high SEP was associated with a greater likelihood of increasing activity (males: 58%) and fitness (males and females combined: 89%). In conclusion, persistently high SEP and upward social mobility were associated with increases in activity and fitness from childhood to adulthood. Findings highlight socioeconomic differentials in activity and fitness patterns and suggest that improvements in education may represent a pathway through which physical activity levels can be increased and health benefits achieved.

adult; child; motor activity; physical fitness; prospective studies; social class; social mobility

Abbreviation: SEP, socioeconomic position.

**Editor's note:** An invited commentary on this article appears on page 000, and the authors' response is published on page 000.

Despite well-documented benefits of physical activity (1), many people fail to meet physical activity recommendations (2, 3). Understanding influences on physical activity is therefore an important public health priority. Childhood physical activity has been examined as a predictor of activity in adulthood. These investigations are referred to as “tracking” studies, and they examine the maintenance of relative rank or position within a group over time. While physical activity tends to be relatively stable in the short term (4), tracking weakens with increasing length of follow-up (5). Tracking of physical activity from childhood to adulthood is generally weak ( $r = 0.05$ – $0.54$ ), whereas car-

diorespiratory fitness tracking is stronger ( $r = 0.30$ – $0.46$ ) (6). Difficulties in measuring physical activity, particularly in childhood (7), may partly explain the weak associations observed (8).

Participation in physical activity is unevenly distributed across population groups. Adults of lower socioeconomic position (SEP) are commonly found to be less active in their leisure time than adults of higher SEP (9). Although some socioeconomic disparities in children's physical activity behavior have been documented (10–12), evidence is equivocal (13), and the few studies using objective measures of physical activity or longitudinal study designs have failed to find an association (14, 15), suggesting that socioeconomic differentials may not become evident until late adolescence or early adulthood.

Few studies have examined socioeconomic inequalities in physical activity and cardiorespiratory fitness longitudinally.

The European Youth Heart Study found no differences in tracking of low cardiorespiratory fitness across different SEP strata but that the prevalence of low cardiorespiratory fitness was higher in lower-SEP groups (16), highlighting the socioeconomic gradient in physical activity. Although some studies have examined social mobility (i.e., changes in SEP over time) in relation to obesity risk (17–19), no published reports are known to have examined whether social mobility is associated with the tracking of physical activity and fitness from childhood into adulthood. Very little is known about the lasting contribution of childhood SEP to adult physical activity and fitness and about whether improvements in socioeconomic circumstances over time may lead to increases in physical activity and fitness. Understanding the association of social mobility with physical activity and fitness may provide important insights into the pathways through which socioeconomic inequalities lead to poorer health. This prospective study examined the relation of SEP and social mobility with tracking of physical activity and cardiorespiratory fitness from childhood into adulthood.

## MATERIALS AND METHODS

### Participants

At baseline, 8,498 children and adolescents participated in the 1985 Australian Schools Health and Fitness Survey, a nationally representative study of youth aged 7–15 years in Australia (20, 21). A 2-stage probability sampling process was used, which involved selecting schools (government, Catholic, and independent) with a probability proportional to size ( $n = 109$ , 90.1% response rate), then using simple random sampling to select 10 boys and girls from each age strata within schools ( $n = 8,498$ , 67.5% response rate).

At follow-up, on average 19.6 (standard deviation, 0.6) years later (Web Figure 1; this supplemental figure is posted on the *Journal's* website (<http://aje.oupjournals.org/>)), 6,840 participants (80%) were traced from current and historical electoral rolls, electronic telephone directories, and contact with classmates as part of the Childhood Determinants of Adult Health study (22–24). Participants were sent invitation letters and were followed up via telephone if a contact number was available. Of those individuals found, 5,170 agreed to participate in follow-up (61% of the baseline sample), and physical activity or cardiorespiratory fitness data were collected from 2,905 (34% of the baseline sample; mean age, 31.9 (standard deviation, 2.1) years).

### Measures

**Physical activity.** At baseline, participants aged 9–15 years ( $n = 6,559$ ) self-reported past-week duration and frequency of active commuting to and from school and school physical education, school sport, and nonorganized physical activity outside of school hours, providing an estimate of past-week, mostly discretionary (59%) physical activity (25). This survey instrument demonstrated similar positive associations with cardiorespiratory fitness ( $r = 0.2$ ) observed for other self-report measures among children (26). At follow-up, 2,679 participants completed the long version

of the International Physical Activity Questionnaire (27). Weekly minutes of leisure-time physical activity were used in this study to indicate discretionary physical activity because, conceptually, it most closely matched the childhood activity measure and was correlated with cardiorespiratory fitness ( $r = 0.33$ – $0.34$ ,  $P < 0.001$ ) (28).

**Fitness.** At baseline, participants aged 9, 12, and 15 years ( $n = 2,595$ ) completed a bicycle ergometer test of cardiorespiratory fitness from physical working capacity at a heart rate of 170 beats per minute following a standardized procedure (29). At follow-up, 2,032 participants completed a bicycle ergometer test of physical working capacity at a heart rate of 170 beats per minute on a Monark bicycle ergometer (model 828E; Monark Exercise AB, Vansbro, Sweden). Physical working capacity at a heart rate of 170 beats per minute at both times was divided by lean body mass (Watts/kilogram of lean body mass) estimated from the sum of 4 skinfolds by using standard equations (30–32).

**SEP.** Baseline (childhood) SEP was retrospectively reported by participants in adulthood. For each parent separately, participants reported the highest level of education completed by their father/mother (or other male/female who lived with them and was like a father/mother to them) for most of the time until they were 12 years of age, similar to measures used in several other epidemiologic studies (33–37). Three variables were used for this analysis: highest level of maternal education, highest level of paternal education, and highest level of either parent's education (low = school only, medium = trade/vocational certificate, high = university). Follow-up (adult) SEP was classified similarly by self-reported highest level of education.

To classify change or stability in SEP, a social mobility variable was created in terms of movement between parental SEP and own SEP, similar to that used elsewhere (17, 18). Highest level of parental education at baseline and highest level of own education at follow-up were used to classify social mobility as persistently low (low SEP at baseline and follow-up), persistently medium (medium SEP at baseline and follow-up), persistently high (high SEP at baseline and follow-up), upwardly mobile (moving from low SEP at baseline to medium or high SEP at follow-up or from medium SEP at baseline to high SEP at follow-up), and downwardly mobile (moving from high SEP at baseline to medium or low SEP at follow-up or from medium SEP at baseline to low SEP at follow-up).

### Ethics

At baseline, the directors of education in each state granted ethical approval, and consent was obtained from children and parents. At follow-up, ethical clearance was obtained from the Southern Tasmanian Health and Medical Human Research Ethics Committee (H0008152), and participants provided written informed consent.

### Analysis

Baseline questionnaires from 147 participants were deemed invalid because of large quantities of missing physical activity data ( $\geq 30$  missing values from the physical

activity questionnaire), resulting in valid data for 6,412 children. Only those participants who were not pregnant ( $n = 82$  pregnant) at follow-up and who had completed either 1) both baseline and follow-up physical activity questionnaires ( $n = 2,047$ ) or 2) both baseline and follow-up cardiorespiratory fitness tests ( $n = 645$ ) were included in analyses (in total,  $n = 2,122$  participants eligible for analyses). Because of the skewed nature of the physical activity and fitness data, age-adjusted partial correlation coefficients were calculated by using ranked data. In general, correlation coefficients between 2 variables are classified as follows: low ( $<0.30$ ), moderate ( $0.30$ – $0.59$ ), and high ( $\geq 0.60$ ) (38).

To examine physical activity tracking, a categorical variable was created, as in other tracking studies (39): persistently inactive (bottom third of physical activity at baseline and follow-up), decreasing activity (moved from the top third to the middle or bottom third or from the middle third to the bottom third), increasing activity (moved from the bottom third to the middle or top third or from the middle third to the top third), and persistently active (top third of physical activity at baseline and follow-up or middle third of physical activity at baseline and follow-up). A corresponding variable was created for fitness (persistently unfit, decreasing fitness, increasing fitness, persistently fit). Thirds were age specific and sex specific at baseline and were sex specific at follow-up (because no age differences were detected at follow-up) (Web Table 1; this supplemental table is posted on the *Journal's* website (<http://aje.oupjournals.org/>)).

Pearson chi-squared tests examined sex differences in changes in SEP, physical activity, and cardiorespiratory fitness. Log multinomial regression was used to calculate the relative risks and 95% confidence intervals of decreasing activity/fitness, increasing activity/fitness, and persistently active/fit, compared with persistently inactive/unfit, across categories of each of the childhood SEP and social mobility variables. Estimates for childhood SEP influences on physical activity were calculated by adjusting for age and were stratified by sex. Because of the smaller number of participants with cardiorespiratory fitness data, estimates for childhood SEP influences on fitness were adjusted for age and sex. To determine whether the relation between childhood SEP and changes in physical activity and fitness were attenuated by adult SEP, a second model contained an adjustment for participants' own highest level of education.

## RESULTS

### Loss to follow-up

There were no significant differences in childhood (1985) physical activity (432 vs. 437 minutes/week,  $P = 0.62$ ), cardiorespiratory fitness (2.7 vs. 2.8 W/kg of lean body mass,  $P = 0.17$ ), or body mass index (18.8 vs. 18.6 kg/m<sup>2</sup>,  $P = 0.05$ ) between those who did and did not participate in follow-up. Differences in parental education at baseline were unable to be assessed because these data were reported retrospectively by only those who participated at follow-up. We found few significant differences between those who did and did not participate in follow-up according to school

**Table 1.** Physical Activity, Cardiorespiratory Fitness, and SEP Patterns From Childhood (Ages 9–15 Years) Into Adulthood (Ages 26–36 Years) in the Childhood Determinants of Adult Health Follow-up Study (1985–2004/2006), by Sex

	Male		Female		P Value <sup>a</sup>
	No.	%	No.	%	
Physical activity					
Persistently low	110	11.7	117	10.6	0.33
Decreased	289	30.8	380	34.3	
Increased	290	30.9	342	30.8	
Persistently high	249	26.6	270	24.4	
Fitness					
Persistently low	46	13.8	51	16.4	0.71
Decreased	107	32.0	89	28.6	
Increased	96	28.7	91	29.3	
Persistently high	85	25.5	80	25.7	
SEP					
Low, low	171	16.7	214	18.2	0.06
Middle, middle	158	15.4	136	11.5	
High, high	155	15.2	207	17.6	
Downward	177	17.3	215	18.2	
Upward	362	35.4	407	34.5	

Abbreviation: SEP, socioeconomic position.

<sup>a</sup> From Pearson chi-squared test for differences between males and females.

attended at baseline, except that a significantly ( $P < 0.001$ ) higher proportion of primary-school-aged boys who participated in follow-up attended Catholic (22% vs. 18%) or independent (8% vs. 4%) schools, and a lower proportion attended government schools (69% vs. 78%), compared with those who did not participate in follow-up. A marginally higher proportion of females compared with males (52% vs. 48%) participated in follow-up.

In the restricted sample of participants with fitness data at both time points, no significant differences were found between those with and without these data according to sex (51.8% vs. 51.5% male,  $P = 0.88$ ), baseline age (11.9 vs. 11.9 years,  $P = 0.83$ ), follow-up age (31.8 vs. 31.9 years,  $P = 0.25$ ), baseline physical activity (434 vs. 430 minutes/week,  $P = 0.88$ ), follow-up physical activity (162 vs. 158 minutes/week,  $P = 0.69$ ), baseline prevalence of overweight (7.8% vs. 10.3%,  $P = 0.08$ ) or obesity (1.2% vs. 1.6%,  $P = 0.08$ ), or follow-up prevalence of overweight (35.4% vs. 35.8%,  $P = 0.78$ ) or obesity (14.9% vs. 16.2%,  $P = 0.78$ ). Furthermore, these participants were similar to the general population in terms of the proportion achieving sufficient physical activity (male: 42.4% vs. 44.1%; female: 42.9% vs. 49.0%) (40) and those overweight or obese (male: 62.0% vs. 61.1%; female: 38.7% vs. 42.1%) (41).

### Tracking of physical activity, cardiorespiratory fitness, and SEP

Overall, age-adjusted physical activity demonstrated low tracking (males:  $r = 0.07$ ,  $P < 0.05$ ; females:  $r = 0.04$ ,

**Table 2.** Relative Risks and 95% Confidence Intervals of Physical Activity Patterns From Childhood (Ages 9–15 Years) Into Adulthood (Ages 26–36 Years)<sup>a</sup> According to the Childhood SEP of Males in the Childhood Determinants of Adult Health Follow-up Study (1985–2004/2006)

Measure of Childhood SEP	Decreasingly Active				Increasingly Active				Persistently Active			
	No.	%	Adjusted RR <sup>b</sup>	95% CI	No.	%	Adjusted RR <sup>b</sup>	95% CI	No.	%	Adjusted RR <sup>b</sup>	95% CI
Parental education												
Low ( <i>n</i> = 364)	114	31.3	1.0 (ref)		114	31.3	1.0 (ref)		86	23.6	1.0 (ref)	
Medium ( <i>n</i> = 305)	103	33.8	1.09	0.89, 1.33	96	31.5	1.00	0.80, 1.24	77	25.3	1.05	0.81, 1.36
High ( <i>n</i> = 241)	68	28.2	1.13	0.88, 1.45	73	30.3	0.86	0.66, 1.11	74	30.7	1.09	0.81, 1.45
<i>P</i> <sub>trend</sub>			0.24				0.28				0.66	
Maternal education												
Low ( <i>n</i> = 588)	191	32.5	1.0 (ref)		182	31.0	1.0 (ref)		142	24.2	1.0 (ref)	
Medium ( <i>n</i> = 146)	44	30.1	1.03	0.80, 1.32	47	32.2	0.99	0.76, 1.29	41	28.1	1.08	0.81, 1.44
High ( <i>n</i> = 158)	46	29.1	1.16	0.89, 1.52	46	29.1	0.84	0.63, 1.13	51	32.3	1.12	0.83, 1.50
<i>P</i> <sub>trend</sub>			0.28				0.29				0.47	
Paternal education												
Low ( <i>n</i> = 403)	120	29.8	1.0 (ref)		128	31.8	1.0 (ref)		104	25.8	1.0 (ref)	
Medium ( <i>n</i> = 285)	101	35.4	1.16	0.95, 1.42	86	30.2	0.96	0.77, 1.20	71	24.9	0.99	0.77, 1.27
High ( <i>n</i> = 183)	47	25.7	1.04	0.78, 1.39	59	32.2	0.94	0.72, 1.22	54	29.5	0.95	0.72, 1.25
<i>P</i> <sub>trend</sub>			0.33				0.56				0.62	

Abbreviations: CI, confidence interval; ref, referent; RR, relative risk; SEP, socioeconomic position.

<sup>a</sup> Persistently inactive is the reference group.

<sup>b</sup> Adjusted for age and own highest level of education.

$P = 0.16$ ), whereas age-adjusted cardiorespiratory fitness tracked more strongly (males:  $r = 0.20$ ,  $P < 0.01$ ; females:  $r = 0.26$ ,  $P < 0.01$ ). Parental education was correlated with own education in adulthood for females and males (both  $r = 0.30$ ,  $P < 0.01$ ). Two-thirds of the sample demonstrated changes in physical activity or fitness (Table 1). One-third of participants were upwardly mobile, with the remainder relatively evenly distributed across the other 4 categories. There were no significant sex differences in activity or fitness patterns or in SEP.

#### Childhood SEP and tracking of physical activity and cardiorespiratory fitness

We found no significant differences in the tracking of physical activity from childhood into adulthood across SEP categories among males or females (Tables 2 and 3). For the combined parental education indicator, those of medium SEP at baseline, compared with those of low SEP at baseline, were 36% more likely to decrease their fitness and 33% less likely to be persistently fit than persistently unfit (Table 4). For the maternal education indicator, those of high baseline SEP had a 59% greater likelihood of being persistently fit than persistently unfit when compared with those of low SEP.

#### Social mobility and tracking of physical activity and cardiorespiratory fitness

In general, those of persistently high SEP or upward social mobility, compared with those of persistently low SEP, tended to have a lower likelihood of decreasing their physical activity and fitness and a higher likelihood of increasing

their physical activity and fitness (Table 5). For example, males of persistently high SEP and upward mobility were 33%–43% less likely to decrease their activity and 49%–58% more likely to increase their activity than to remain persistently inactive. Upwardly mobile females were 38% more likely to increase their physical activity, compared with females of persistently low SEP. Similarly, those of persistently high SEP or upward mobility were, respectively, 89% and 90% more likely to increase their fitness than remain persistently unfit, compared with those of persistently low SEP. Findings were similar when maternal or paternal education was used as the baseline SEP indicator of social mobility (data not shown).

#### DISCUSSION

This study examined socioeconomic influences on physical activity and cardiorespiratory fitness tracking from childhood into adulthood. This longitudinal study is one of the first to report on the influence of social mobility on physical activity and fitness trajectories over these life stages. Findings suggest that improvements in SEP, indicated by educational level, are associated with increases in physical activity and cardiorespiratory fitness from childhood to adulthood. They also suggest no lasting impact of childhood socioeconomic circumstances on physical activity, independently of adult SEP. Combined, this study demonstrates that the influence of poorer childhood socioeconomic circumstances on physical activity and fitness may be amenable to change, and it supports the idea that improvements in education represent a key potential strategy through which improvements in physical activity (and hence associated health benefits (24)) may be achieved (42).



**Table 3.** Relative Risks and 95% Confidence Intervals of Physical Activity Patterns From Childhood (Ages 9–15 Years) Into Adulthood (Ages 26–36 Years)<sup>a</sup> According to the Childhood SEP of Females in the Childhood Determinants of Adult Health Follow-up Study (1985–2004/2006)

Measure of Childhood SEP	Decreasingly Active				Increasingly Active				Persistently Active			
	No.	%	Adjusted RR <sup>b</sup>	95% CI	No.	%	Adjusted RR <sup>b</sup>	95% CI	No.	%	Adjusted RR <sup>b</sup>	95% CI
Parental education												
Low ( <i>n</i> = 452)	153	33.9	1.0 (ref)		145	32.1	1.0 (ref)		98	21.7	1.0 (ref)	
Medium ( <i>n</i> = 367)	122	33.2	1.01	0.83, 1.23	108	29.4	0.87	0.71, 1.07	95	25.9	1.19	0.93, 1.52
High ( <i>n</i> = 284)	98	34.5	1.09	0.88, 1.34	90	31.7	0.89	0.71, 1.11	71	25.0	1.11	0.84, 1.45
<i>P</i> <sub>trend</sub>			0.55				0.32				0.31	
Maternal education												
Low ( <i>n</i> = 709)	245	34.6	1.0 (ref)		227	32.0	1.0 (ref)		156	22.0	1.0 (ref)	
Medium ( <i>n</i> = 211)	69	32.7	0.97	0.78, 1.20	56	26.5	0.77	0.60, 1.00	57	27.0	1.23	0.95, 1.60
High ( <i>n</i> = 163)	52	31.9	0.96	0.74, 1.25	53	32.5	0.92	0.71, 1.20	47	28.8	1.23	0.91, 1.64
<i>P</i> <sub>trend</sub>			0.58				0.26				0.06	
Paternal education												
Low ( <i>n</i> = 505)	174	34.5	1.0 (ref)		163	32.3	1.0 (ref)		112	22.2	1.0 (ref)	
Medium ( <i>n</i> = 328)	106	32.3	0.95	0.78, 1.16	97	29.6	0.91	0.75, 1.12	90	27.4	1.24	0.98, 1.56
High ( <i>n</i> = 215)	73	34.0	1.03	0.82, 1.30	69	32.1	0.92	0.72, 1.18	52	24.2	1.05	0.78, 1.40
<i>P</i> <sub>trend</sub>			0.85				0.54				0.42	

Abbreviations: CI, confidence interval; ref, referent; RR, relative risk; SEP, socioeconomic position.

<sup>a</sup> Persistently inactive is the reference group.<sup>b</sup> Adjusted for age and own highest level of education.

To our knowledge, no previous research has investigated the longitudinal influence of childhood SEP and social mobility on physical activity and cardiorespiratory fitness pat-

terns from childhood into adulthood. Given the major contribution of physical inactivity to the burden of chronic disease (43), socioeconomic disparities in physical activity

**Table 4.** Relative Risks and 95% Confidence Intervals of Fitness Patterns From Childhood (Ages 9–15 Years) Into Adulthood (Ages 26–36 Years)<sup>a</sup> According to the Childhood SEP of Males and Females Combined in the Childhood Determinants of Adult Health Follow-up Study (1985–2004/2006)

Measure of Childhood SEP	Decreasingly Fit				Increasingly Fit				Persistently Fit			
	No.	%	Adjusted RR <sup>b</sup>	95% CI	No.	%	Adjusted RR <sup>b</sup>	95% CI	No.	%	Adjusted RR <sup>b</sup>	95% CI
Parental education												
Low ( <i>n</i> = 238)	68	28.6	1.0 (ref)		62	26.1	1.0 (ref)		69	29.0	1.0 (ref)	
Medium ( <i>n</i> = 204)	75	36.8	1.36*	1.04, 1.79	67	32.8	1.23	0.92, 1.66	38	18.6	0.67*	0.46, 0.97
High ( <i>n</i> = 168)	41	24.4	0.96	0.69, 1.33	51	30.4	1.01	0.74, 1.38	52	31.0	1.11	0.81, 1.52
<i>P</i> <sub>trend</sub>			0.97				0.88				0.64	
Maternal education												
Low ( <i>n</i> = 397)	123	31.0	1.0 (ref)		119	30.0	1.0 (ref)		94	23.7	1.0 (ref)	
Medium ( <i>n</i> = 100)	34	34.0	1.26	0.92, 1.71	28	28.0	0.77	0.55, 1.07	27	27.0	1.26	0.86, 1.85
High ( <i>n</i> = 99)	20	20.2	0.73	0.49, 1.11	31	31.3	0.90	0.67, 1.22	36	36.4	1.59*	1.17, 2.16
<i>P</i> <sub>trend</sub>			0.31				0.40				<0.01	
Paternal education												
Low ( <i>n</i> = 251)	71	28.3	1.0 (ref)		70	27.9	1.0 (ref)		66	26.3	1.0 (ref)	
Medium ( <i>n</i> = 190)	68	35.8	1.26	0.96, 1.65	33	17.4	1.36	1.02, 1.80	65	34.2	0.64*	0.44, 0.94
High ( <i>n</i> = 141)	35	24.8	0.92	0.65, 1.29	44	31.2	1.08	0.79, 1.48	45	31.9	1.21	0.87, 1.68
<i>P</i> <sub>trend</sub>			0.92				0.42				0.59	

Abbreviations: CI, confidence interval; ref, referent; RR, relative risk; SEP, socioeconomic position.

\* *P* < 0.05.<sup>a</sup> Persistently unfit is the reference group.<sup>b</sup> Adjusted for age and own highest level of education.

**Table 5.** Relative Risks and 95% Confidence Intervals of Physical Activity (by Sex) and Fitness (Males and Females Combined) Patterns From Childhood (Ages 9–15 Years) Into Adulthood (Ages 26–36 Years)<sup>a</sup> According to Social Mobility in the Childhood Determinants of Adult Health Follow-up Study (1985–2004/2006)

Social Mobility	No.	Decreasingly Active/Fit				Increasingly Active/Fit				Persistently Active/Fit			
		No.	%	RR	95% CI	No.	%	RR	95% CI	No.	%	RR	95% CI
Activity, males <sup>b</sup>													
Persistently low	138	53	38.4	1.0 (ref)		32	23.2	1.0 (ref)		36	26.1	1.0 (ref)	
Persistently medium	138	51	37.0	0.94	0.70, 1.26	44	31.9	1.38	0.94, 2.04	26	18.8	0.73	0.47, 1.14
Persistently high	141	30	21.3	0.57*	0.39, 0.82	52	36.9	1.58*	1.08, 2.29	44	31.2	1.18	0.81, 1.71
Upwardly mobile	334	92	27.5	0.67*	0.51, 0.88	113	33.8	1.49*	1.06, 2.09	90	27.0	1.07	0.76, 1.49
Downwardly mobile	157	58	36.9	0.94	0.71, 1.26	41	26.1	1.13	0.76, 1.69	41	26.1	1.01	0.69, 1.48
Activity, females <sup>b</sup>													
Persistently low	192	70	36.5	1.0 (ref)		48	25.0	1.0 (ref)		41	21.4	1.0 (ref)	
Persistently medium	129	42	32.6	0.89	0.65, 1.22	43	33.3	1.31	0.93, 1.86	34	26.4	1.24	0.83, 1.85
Persistently high	197	71	36.0	0.99	0.76, 1.29	58	29.4	1.17	0.84, 1.62	55	27.9	1.31	0.92, 1.86
Upwardly mobile	381	121	31.8	0.87	0.69, 1.11	131	34.4	1.38*	1.04, 1.83	94	24.7	1.15	0.84, 1.59
Downwardly mobile	185	69	37.3	1.02	0.79, 1.33	51	27.6	1.10	0.79, 1.54	40	21.6	1.01	0.69, 1.49
Fitness <sup>c</sup>													
Persistently low	90	26	28.9	1.0 (ref)		17	18.9	1.0 (ref)		29	32.2	1.0 (ref)	
Persistently medium	82	38	46.3	1.59*	1.07, 2.37	21	25.6	1.36	0.77, 2.39	11	13.4	0.41*	0.22, 0.77
Persistently high	112	28	25.0	0.85	0.54, 1.35	40	35.7	1.89*	1.14, 3.11	32	28.6	0.90	0.59, 1.38
Upwardly mobile	213	54	25.4	0.85	0.57, 1.28	75	35.2	1.90*	1.18, 3.05	55	25.8	0.76	0.52, 1.13
Downwardly mobile	112	38	33.9	1.15	0.76, 1.75	26	23.2	1.23	0.71, 2.13	32	28.6	0.89	0.58, 1.35

Abbreviations: CI, confidence interval; ref, referent; RR, relative risk.

\*  $P < 0.05$ .<sup>a</sup> Persistently inactive/unfit is the reference group.<sup>b</sup> Relative risks were adjusted for age.<sup>c</sup> Relative risks were adjusted for age and sex.

participation may represent a key pathway by which socioeconomic disadvantage, operationalized here as low levels of education, leads to poor health. Understanding associations among childhood SEP, social mobility, and physical activity and fitness is important to best target and tailor interventions to promote health. For example, policies and programs that support further education, as well as improving socioeconomic circumstances, may additionally benefit health through increasing participation in physical activity. Further research is required to confirm this hypothesis and to determine the mechanisms through which increases in socioeconomic circumstances across the lifespan might operate to promote increased physical activity.

Two cross-sectional studies have attempted to disentangle these associations. The Whitehall II Study (19) and the West of Scotland Collaborative Study (17) found that adult SEP was more important than childhood SEP in predicting physical activity behaviors. The consistency of findings from these and our current study appears despite many methodological differences. For instance, both of these British studies were cross-sectional, used samples that consisted solely of employees, and investigated different age cohorts. Both British studies classified SEP according to father's occupational status, whereas the current study used highest level of maternal, paternal, and parental educational indicators. Although the literature concerning classification of SEP is

contentious (44), there is a clear need to examine SEP more broadly than in terms of father's occupation in contemporary cohorts, for a number of reasons. Notably, women's workforce participation in Australia increased from 37% to 55% from 1971 to 2001 (45), and there is some evidence that influence of maternal characteristics on the health behaviors of children may be more important than that of paternal characteristics (46–48). Additionally, different measures of physical activity were used across studies, although the current study had the added strength of examining changes in objectively measured cardiorespiratory fitness, a significant advantage over previous studies that relied upon self-reported physical activity. Findings for fitness were generally stronger than those observed for physical activity, suggesting that physical activity measurement error may lead to an underestimation of effects.

Some limitations of this study should be considered. Approximately two-thirds of the baseline sample did not participate in follow-up, although no differences in baseline physical activity, fitness, or body mass index were detected between those who did and did not participate, even though a marginally higher proportion of females compared with males participated in follow-up. It is possible that differential loss to follow-up according to changes in SEP may have occurred; that is, those who were persistently of low SEP or were downwardly mobile may have been less likely to

participate in follow-up than those of higher SEP. However, these groups were well represented in the analyses, and no significant differences were evident in the proportion of participants classified as of low, medium, or high physical activity or fitness at baseline among those who did and did not participate in follow-up.

The limitations of self-reported measures of physical activity are well documented (49, 50). It is possible that measurement error in the self-reported physical activity questionnaires at either time point may explain why few significant associations were observed. A further potential limitation of this study is the different measures of physical activity used at baseline and follow-up. However, assessing adults' physical activity with a survey designed for children would have been inappropriate, and we assessed change in rank rather than absolute physical activity. The consistency of findings for physical activity and objectively measured cardiorespiratory fitness is reassuring. The smaller number of participants with fitness data at both time points did not permit analyses to be stratified by sex; nevertheless, there was no evidence of confounding or effect modification in the relation between childhood SEP or social mobility and fitness by sex. Furthermore, we found no significant differences in fitness (baseline), physical activity, sex, age, overweight, or obesity at baseline or at follow-up between those with and those without fitness data at both time points.

The childhood SEP measures were retrospectively reported, although evidence suggests that recall is valid and does not differ according to SEP (34), with this data collection technique being commonly used (17, 19, 34–37), and most participants (95%) provided this information. The findings from our study may have differed had we used an alternate indicator of SEP, such as occupation, employment status, or income. Although the influence of using alternate indicators of SEP on physical activity has not been assessed comprehensively in the literature, studies of diet demonstrate that occupation and education appear to have independent effects on behavior (51). Income is typically poorly reported so that information was not collected in this study, and the validity of retrospectively reported parental income is unknown. Larger changes in SEP (e.g., moving 2 SEP categories from a low to a high educational category) may have had a greater influence on physical activity and fitness than smaller changes in SEP (e.g., moving from a low to a medium category). The small cell sizes prevented these analyses in this study, but these associations warrant more detailed investigation in future studies.

Despite the study's longitudinal design, collection of data at 2 time points does not enable the temporal nature of associations to be determined with certainty and limits conclusions about causality. It is plausible that increases in physical activity lead to improvements in SEP through mechanisms such as enhanced physical or emotional health conferred by physical activity (1, 52), leading to improvements in SEP through improved educational and occupational opportunities. Given the socioeconomic gradients typically observed in physical activity (9), it seems more plausible that improvements in socioeconomic circumstances lead to increases in physical activity. This possibility likely occurs through a number of potential mechanisms, such as improved socioeco-

nom circumstances leading to greater social or economic support for physical activity (e.g., through more flexible work hours or higher discretionary income) or relocation to more affluent neighborhoods that tend to provide physical environments more supportive of physical activity (e.g., better walking tracks, greater access to facilities) (53). Further research is needed to better understand this relation.

This study is one of the first to examine the influence of social mobility on physical activity and cardiorespiratory fitness trajectories from childhood to adulthood. Its key strengths are its prospective study design, large sample size, long period of follow-up, and consideration of 2 distinct life stages. Inclusion of both self-reported measures of physical activity and objective measures of cardiorespiratory fitness, as well as an indicator of maternal SEP, adds strength to the findings.

In conclusion, this study found socioeconomic differences in physical activity and cardiorespiratory fitness tracking from childhood into adulthood. Upward social mobility and persistently high SEP, measured by educational level, were associated with increases in physical activity and fitness, but there was little evidence of a lasting impact of childhood SEP on physical activity tracking. Findings suggest that improvements in educational levels, and as a consequence SEP, may lead to increases in physical activity and fitness and therefore to better health from childhood into adulthood. By examining the influence of changes in SEP on physical activity and fitness tracking, this study provides important insights into potential pathways through which poorer socioeconomic conditions may lead to poorer health outcomes.

## ACKNOWLEDGMENTS

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This work was supported by grants from the Australian National Health and Medical Research Council (211316), the National Heart Foundation (GOOH 0578), and the Tasmanian Community Fund (D0013808).

V. C. is supported by a National Health and Medical Research Council Public Health Postdoctoral Fellowship. K. B. is supported by a National Health and Medical Research Council Senior Research Fellowship.

The authors gratefully acknowledge the contributions of the Childhood Determinants of Adult Health study's project manager Marita Dalton and all other project staff.

Conflict of interest: none declared.

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