Predisposing, reinforcing and enabling factors for physical activity in boys and girls from socially disadvantaged communities

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Abstract

Objective: This study investigated relative associations between physical activity and selected predisposing, reinforcing, and enabling factors among 9-10 year-old children from socially disadvantaged communities, and examined the extent to which associations varied by sex.
Design: Cross-sectional design
Setting: Ten public primary schools in Liverpool, England.
Methods: One hundred-ninety-four children (107 girls) completed measures of stature, body mass, waist circumference and cardiorespiratory fitness. Physical activity, physical activity self-efficacy, perceived physical competence, and parental physical activity support were self-reported. Sex-specific associations were examined by multiple linear regression and mediator analyses using bootstrapping method.
Results: Boys' physical activity was positively associated with parental physical activity support and perceived physical competence ($p<0.01$), whereas girls' physical activity was positively associated with parental physical activity support and physical activity self-efficacy ($p<0.01$). Sex-specific mediation analyses revealed that perceived physical competence and physical activity self-efficacy partially mediated the association between parental physical activity support and boys' and girls' physical activity, respectively.
Conclusion: As parents influence child physical activity directly and indirectly their involvement in future child physical activity intervention programmes is essential. Formative research with parents living in socially disadvantaged communities is warranted to explore the range and *interaction* of challenges they face to support different modes of physical activity participation for their children.

Keywords: physical activity; parent support; physical competence; self-efficacy, social disadvantage.

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Introduction

Children living in areas of high social disadvantage are at greatest risk of poor health including obesity and low cardiorespiratory fitness (Marmot, 2010; Noonan et al., 2016a). Physical activity is a modifiable component of obesity (Guinhouya, 2012) and cardiorespiratory fitness (Boddy et al., 2014). In the UK and other developed countries, children are recommended to engage in at least 60 minutes of moderate-to-vigorous-intensity physical activity to achieve and maintain health (Department of Health, 2011; World Health Organization, 2010). Surveillance data shows that many children in the UK fail to achieve these physical activity guidelines and activity levels are lowest among children from socially disadvantaged communities (Public Health England, 2017). As such, children living in socially disadvantaged communities represent an important target group for physical activity and health promoting programmes and interventions.

To promote and support physical activity among children living in socially disadvantaged communities, it is important to understand its individual and socio-environmental underpinnings. The Youth Physical Activity Promotion Model (Welk, 1999) provides a socio-ecological conceptual framework to understand factors that may predispose (e.g., self-efficacy and perceived physical competence), reinforce (e.g., parental physical activity support) or enable child physical activity (e.g., aerobic fitness and weight status). Sex and social disadvantage (i.e., demographic factors) have a direct effect on how predisposing (Telford et al. 2016a), reinforcing (Solomon-Moore et al. 2018) and enabling factors influence child physical activity (Keller, 2008), and thus, are positioned at the base of the model (Welk, 1999).

Children who are healthy weight and aerobically fit are more likely to engage in higher levels of physical activity than overweight and aerobically unfit children (Voss, Ogunleye and Sandercock, 2013). However, among children living in socially disadvantaged communities, other factors that are predictive of child physical activity such as parental physical activity support and motivation (Sterdt, Liersch and Walter, 2014) may provide more important targets for physical activity intervention programmes.

While school-based physical activity opportunities (e.g., physical education and recess play) may be available to many children, out-of-school physical activity opportunities are directly influenced by parental encouragement (e.g., positive verbal reinforcement) and support (e.g., payment of club subscriptions, transport to and from provision (Noonan et al., 2016b), and constraints on children's individual choice (e.g., access to garden/yard (Noonan et al., 2016a). Various studies have shown that children who receive a high level of parental physical activity support are more likely to engage in more physical activity than children who receive limited parental physical activity support (Beets, Cardinal and Alderman, 2010). Parents may also support their child's physical activity indirectly, by influencing predisposing factors for physical activity such as physical activity self-efficacy and perceived physical competence (Seabra et al., 2013). Perceived physical competence contributes to a child's self-esteem, which reflects their evaluation of the worth inherent in their self-description (Whitehead, 1995), and self-esteem is interlinked with motivation (Whitehead and Corbin, 1997). In the context of competence motivation theory (Harter, 1982), children who perceive themselves to be competent will be motivated to engage in physical activities. On this basis, self-

perceptions are deemed as strong predictors of child physical activity (Babic et al., 2014). Cognitive theories of intrinsic motivation also emphasise the importance of choice and autonomy (Sebire et al., 2013). As children residing in socially disadvantaged communities are likely to experience few organised physical activity opportunities and gardens/yards to play in (Noonan et al., 2016a), these children may be dependent on encouragement from their parents to play outdoors in the community (i.e., independent mobility).

Research on child physical activity typically draws on motivational theories alone to explain behaviour (e.g., self-determination theory; Deci and Ryan, 1985). However, motivational factors alone (e.g., perceived competence and self-efficacy), do not tackle important barriers to child physical activity (e.g., accessing physical activity provision and financing physical activity opportunities). To date, no study has examined the *combined* influence of predisposing, enabling, reinforcing and demographic factors on physical activity among children from socially disadvantaged communities. Moreover, whilst a few studies have examined the effect of parental physical activity support on children's physical activity through children's predisposing factors (Seabra et al., 2013), these were not among children living in socially disadvantaged communities or stratified by sex. Physical activity levels among children living in socially disadvantaged communities are known to differ by sex (Breslin et al., 2017), but whether physical activity predictors among children living in socially disadvantaged communities are sex specific remains unknown. Therefore, the aims of this study were to 1) investigate relative associations between physical activity and selected predisposing, reinforcing, and enabling factors among 9-10-year-old children from socially disadvantaged communities, and 2) examine the extent to which associations vary by sex. In particular, it is hypothesised that children who report high levels of physical activity would score high on parental physical activity support, perceived physical competence, and physical activity self-efficacy, and have lower waist circumference and higher cardiorespiratory fitness than children who report low levels of physical activity, but the strength of these relationships would differ by sex. Secondly, it is hypothesised that parental physical activity support would be the strongest predictor of child physical activity and would be mediated by predisposing factors to physical activity.

Materials and Methods

Participants

Study participants were 9–10 year-old children recruited from ten primary schools in Liverpool, England. The ten primary schools were located across a range of socially disadvantaged areas based on the English Indices of Multiple Deprivation (social diadvantage mean score=41.1; range=8.50-72.3). Schools were approached as convenience samples and agreed to participate. Liverpool is ranked as one of the most socially disadvantaged cities in England (Department for Communities and Local Government, 2015) with around 32% (24, 900) of children living in low income families. All children in participating schools were eligible to take part in the study (*n*=549). Each child received a participant recruitment pack containing parent and child information sheets, consent and assent forms, and a medical screening form. Written informed consent and assent were received from parents and their children, respectively, before children could participate in the study. Completed informed parental consent and child assent were obtained for 217 children (39.5% response rate).

Liverpool John Moores University Ethics Committee approved the study (13/SPS/048) and data collection took place between January and April 2014.

Measures

Researchers visited schools to conduct anthropometric measurements, fitness assessments and administer questionnaires to children in classrooms. The children were informed that the questionnaires were not tests, and were asked to answer all questions as honestly as possible, not to confer with others, and to ask a researcher if they were unsure about any of the questions.

Self-Reported physical activity

Physical activity was assessed using the Physical Activity Questionnaire for Older Children (Kowalski, Crocker and Donen, 2004). The Physical Activity Questionnaire for Older Children is a valid and reliable measure of general physical activity levels (Crocker et al., 1997; Kowalski, Crocker and Faulkner, 1997), and is considered a suitable tool for physical activity surveillance in young people (Biddle et al., 2011). The questionnaire comprises nine items assessing physical activity at various times of the week. Each statement is scored on a five-point scale ranging from low (1) to very high levels of activity (5), with the overall Physical Activity Questionnaire for Older Children score calculated as the mean of the nine physical activity items (Kowalski, Crocker and Donen, 2004). The alpha coefficient inter-item reliability was 0.8.

Enabling factors

Anthropometrics. Stature and sitting stature were measured to the nearest 0.1 cm using a portable stadiometer (Leicester Height Measure, Seca, Birmingham, UK). Leg length was calculated by subtracting sitting stature from stature. Body mass was measured to the nearest 0.1 kg using calibrated scales (Seca, Birmingham, UK). Body mass index (BMI) was calculated from stature and body mass as a proxy measure of body composition (kg/m²), and BMI z-scores were assigned to each child (Cole, Freeman and Preece, 1995). Age and sex-specific BMI cut-points were used to classify children as normal weight or overweight/obese (Cole et al., 2000). Waist circumference was measured at the midpoint between the bottom rib and the iliac crest to the nearest 0.1 cm using a non-elastic measuring tape (Seca, Birmingham, UK). Sex-specific regression equations were used to predict children's age from peak height velocity (Mirwald et al., 2002). This calculation was used as a proxy measure of biological maturation.

Cardiorespiratory fitness. Cardiorespiratory fitness was assessed using the Sports Coach UK 20 m multistage shuttle run test (Leger et al., 1988). Children completed 20m shuttle runs keeping in time with an audible 'bleep' signal. The time between bleeps progressively decreases, increasing the intensity of the test. Children were encouraged to run to exhaustion, and the number of completed shuttles was recorded for each participant and retained for analysis.

Predisposing factors

Perceived physical competence. Perceived physical competence was assessed using a scale from The Physical Self Perceptions and Self-Esteem Questionnaire (Whitehead, 1995). The perceived physical competence scale is measured on a 1–4 scale (1=low self-perception, 4=high self-perception) by six items that use a structured alternative format to reduce socially desirable responses. The mean score of the six items is used to represent the value for the scale with higher scores representing higher perceived physical competence. The perceived physical competence scale was administered to children during curriculum time by the first author who provided verbal and visual examples of how and where to respond to items on the scale. The alpha coefficient inter-item reliability was 0.8.

Physical activity self-efficacy. Physical activity self–efficacy was assessed using the physical activity self-efficacy scale (Motl et al., 2000). The physical activity self-efficacy scale includes 8 items and responses are recorded on a 5-point scale ranging from extremely often (1) to not very often (5). Items include; 'I can be physically active during my free time on most days', 'I have the coordination I need to be physically active during my free time on most days', etc. The mean score of the eight items was used to represent the value for the scale with higher scores representing higher physical activity self-efficacy. The alpha coefficient inter-item reliability was 0.8.

Reinforcing factors

Parental physical activity support. Parental physical activity support was assessed using the sum of responses to five questions on how often during a typical week do parents provide direct (e.g., transport child to areas to do physical activity) and indirect support (e.g., praise child for doing well in physical activity) for their children's physical activity. Frequency of parent physical activity support was rated on a 5-point Likert scale ranging from never (0) to every day (4). Total scores range from 0 to 20 (Prochaska, Rodgers and Sallis, 2002). The alpha coefficient inter-item reliability was 0.8.

Demographic factors

Social disadvantage. Social disadvantage was calculated using the 2015 English Indices of Multiple Deprivation (Department for Communities and Local Government, 2015). The Indices of Multiple Deprivation is a UK Government produced measure comprising 7 areas of deprivation (i.e., income, employment, health, education, housing, environment, and crime). Parent reported home postcodes were imported into the GeoConvert (http://geoconvert.mimas.ac.uk/) application to generate social disadvantage scores. Higher social disadvantage was represented by higher deprivation scores.

Data Management and Analysis

All analyses were conducted using SPSS v. 23 (SPSS Inc; Chicago, IL) and statistical significance was set at *p*<0.05. Kolmogorov–Smirnov and Levene's tests were used to assess data distribution and variance, respectively. Descriptive statistics were calculated for all measured variables. Sex differences were examined by independent samples t-tests and chi-square tests (χ2). Cohen's d values were calculated as a measure of effect size for t-tests and χ2 tests. Sex-

specific hierarchical multiple regression was used to examine associations between predisposing, reinforcing, and enabling factors and physical activity. Sex-specific associations between each predictor variable and physical activity were first explored using correlations, and variables that were significantly associated with physical activity ($p<0.05$) were then retained for inclusion in the sex-specific hierarchical multiple regression analysis. Predictor variables were then entered into the regression models in separate blocks based on their known theoretical association with the outcome variable guided by the Youth Physical Activity Promotion Model (Welk, 1999). Predictor variables were entered in the following order: Demographic factors: social disadvantage (i.e., Indices of Multiple Deprivation score); Predisposing factors: perceived physical competence, physical activity self-efficacy; Reinforcing factors: parental physical activity support; enabling factors, cardiorespiratory fitness, waist circumference. Physical Activity Questionnaire for Older Children score was the outcome variable.

Sex-specific mediation was assessed through regression analyses using the PROCESS macro for SPSS (http://www.processmacro.org/index.html; Hayes, 2013). Because of the small sample size and multiple mediators, nonparametric bootstrapping analysis (Hayes, 2013) was used to estimate direct and indirect effects in models. Bootstrapping is a non-parametric resampling method that uses confidence internals to estimate the size of indirect effects. The bootstrapping approach makes no assumption about the shape of the sampling distribution of the indirect effect, and has been shown to enhance statistical power and Type I error control compared to other techniques (Baron and Kenny, 1986; Hayes, 2009). Keeping in line with recommendations (Hayes, 2009), 95% bias corrected and accelerated confidence intervals were employed, and 5000 bootstrapping re-samples were run. Mediation is evident when zero is not included within the lower and upper bound confidence intervals.

Results

Nineteen participants had incomplete data and were excluded from analyses, resulting in a final sample of 198 (109 girls). Preliminary analyses confirmed that the data were normally distributed. There were no differences in measured variables between participants included and excluded from analyses. Descriptive characteristics of the participants are presented in Table 1. The mean Indices of Multiple Deprivation score for the sample was above the national average (36.8 vs 23.6; Department for Communities and Local Government, 2015). Twenty-one percent of boys were classified as overweight compared to 28% of girls. Boys were taller ($p<0.05$) and aerobically fitter than girls who were significantly closer to peak height velocity than boys ($p<0.001$). Boys and girls reported comparable levels of physical activity self-efficacy, parental physical activity support and perceived physical competence but boys reported higher levels of physical activity compared to girls ($p=0.02$).

[TABLE 1 NEAR HERE]

Results of the hierarchical regression analyses for boys and girls are shown in Table 2. Among boys, demographic variables alone were not significantly related to physical activity [$F(1, 80)=1.69$; $p=0.20$]. With the addition of perceived physical competence and PA self-efficacy in model two, the explained variance in physical activity increased by 33% [$F(3, 78)=15.06$; $p<0.001$]. In model three, parental support was added as a reinforcing factor, and the model's

ability to predict physical activity increased by a further 4% [$F(4, 77)=13.52$; $p<0.001$]. In the final model for boys, only physical activity parental physical activity support and perceived physical competence were significant predictors of physical activity ($p<0.01$). Waist circumference was marginally associated with physical activity ($p=0.07$). The final model was significantly associated with physical activity [$F(6, 75)=10.00$; $p<0.001$] and accounted for 40% of the variance in physical activity among boys. Similar to boys, the first model for girls with social disadvantage alone was not significantly associated with physical activity [$F(1, 103)=3.66$; $p=0.06$]. When perceived physical competence and physical activity self-efficacy were entered in the second model, the model was significantly associated with physical activity [$F(3, 101)=12.21$; $p<0.001$]. The addition of parental physical activity support in model three explained an additional 17% of variance in physical activity [$F(4, 100)=19.35$; $p<0.001$], which was greater than that observed for boys. When all variables were included in the final model for girls, only parental physical activity support and physical activity self-efficacy were significant predictors of physical activity ($p<0.01$). Cardiorespiratory fitness was marginally associated with physical activity ($p=0.08$). The final model was significantly associated with physical activity [$F(6, 98)=13.85$ $p<0.001$] and accounted for 43% of the variance in physical activity among girls.

[TABLE 2 NEAR HERE]

Figure 1 displays unstandardised regression coefficients for the sex-specific mediation models. In both models, parental physical activity support was the independent variable and physical activity the dependent variable. Perceived physical competence and physical activity self-efficacy were parallel mediators (panel A and B). Results of the indirect effects for boys and girls are presented in Table 3.

Figure 1 shows that parental physical activity support was related to perceived physical competence and physical activity self-efficacy for boys ($β=0.10$, $p<0.001$; $β=0.08$, $p<0.001$) and girls ($β=0.09$, $p<0.001$; $β=0.08$, $p<0.001$), respectively. However, only perceived physical competence was related to boys physical activity ($β=0.52$, $p<0.001$), and physical activity self-efficacy to girls physical activity ($β=0.25$, $p<0.01$). In the model for boys (Figure 1, panel A), the bootstrap procedure revealed that the total effect of parental physical activity support on physical activity was significant ($β=0.10$, $p<0.001$). When the mediators were included in the model, the direct effect of parental physical activity support on boys physical activity reduced but remained significant, suggesting partial mediation ($β=0.05$, $p<0.01$). Only perceived physical competence displayed an indirect effect, $β=0.04$; 95% CI=0.02-0.08; $p=0.002$ (Table 3). Therefore, the effect of parental physical activity support on boys' physical activity was partially mediated by perceived physical competence. In the model for girls (Figure 1, panel B), the bootstrap procedure revealed that the total effect of parental physical activity support on physical activity was significant ($β=0.15$, $p<0.001$). When the mediators were included in the model, the direct effect of parental physical activity support on girls' physical activity reduced but remained significant, suggesting partial mediation ($β=0.12$, $p<0.001$). Only physical activity self-efficacy displayed an indirect effect, $β=0.02$; 95% CI=0.01-0.05; $p=0.03$ (Table 3). Therefore, the effect of parental physical activity support on girls physical activity was partially mediated by physical activity self-efficacy.

[FIGURE 1 NEAR HERE]

[TABLE 3 NEAR HERE]

Discussion

This is the first study to report on predisposing, reinforcing and enabling factors for physical activity among 9-10-year-old children living in socially disadvantaged communities. From the range of correlates assessed, parental physical activity support was the strongest and most consistent predictor of physical activity in boys and girls. We found that boys' physical activity was associated with parental physical activity support, perceived physical competence, and waist circumference, whereas girls' physical activity was associated with parental physical activity support and physical activity self-efficacy. Moreover, sex-specific mediation analyses revealed that perceived physical competence and physical activity self-efficacy partially mediated the association between parental physical activity support and boys' and girls' physical activity, respectively.

The results of this study extend beyond previous research in more heterogeneous samples by highlighting the predictive nature of sex on cardiorespiratory fitness (Boddy et al., 2014) and physical activity (Voss, Ogunleye and Sandercock, 2013; Breslin et al., 2017) with boys recording higher cardiorespiratory fitness and physical activity than girls. Differences in physical activity levels between boys and girls may reflect sex differences in modes of physical activity. For example, girls are known to participate in less structured sport compared to boys (Hebert et al., 2015). This discrepancy is likely to have contributed to the observed differences in cardiorespiratory fitness between boys and girls in this study given that organised sport participation is linked with higher levels of physical activity and cardiorespiratory fitness in children (Marques, Ekelund and Sardinha, 2016; Telford et al., 2016b).

In this study, children with smaller waists and those that were aerobically fitter reported higher levels of physical activity. However, when these enabling factors (i.e., waist circumference and cardiorespiratory fitness) were included in the regression model alongside predisposing and reinforcing factors for physical activity, their influence became minimal. In the final regression model for boys, waist circumference was partially associated with physical activity. Previous UK research has also reported lower physical activity among overweight and obese boys compared with leaner peers (Stone, Rowlands and Eston, 2009). The relative energy cost and perceived required effort of engaging in physical activity is likely to be greater for overweight boys compared to normal weight boys, and thus may serve as a participation barrier.

We found that parental physical activity support was strongly associated with physical activity for boys and girls, accounting for 4% and 17% of the variance in physical activity, respectively. To date, few studies have specifically sought to investigate the relative influence of parental physical activity support on child physical activity in comparison to predisposing and enabling factors. Our findings are in line with the Youth Physical Activity Promotion Model (Welk, 1999), and previous evidence (Beets, Cardinal and Alderman, 2010), and demonstrate the strong influence parents exert on child physical activity. While enabling (Voss, Ogunleye and Sandercock, 2013) and predisposing factors are known predictors of child physical activity

(Babic et al., 2014), children typically have limited autonomy over their physical activity behaviour and in most cases, require support from their parents to be physically active. In the context of this study, children living in socially disadvantaged communities are likely to experience fewer opportunities to be physically active compared to children living in more affluent communities as a result of less conducive home and neighbourhood environments to walk and play in (Noonan et al. 2016a). It is therefore intuitive that parental physical activity support was the strongest predictor of child physical activity in the present study. Our homogenous sample precluded investigation of social disadvantage differences in physical activity choice and autonomy and as a result worthy of further investigation in the future.

In addition to influencing child physical activity directly, parental physical activity support exerted an indirect effect on child physical activity through influencing key mediating predisposing variables including physical activity self-efficacy and perceived physical competence, both of which are known child physical activity correlates (Seabra et al., 2013), and were significant predictors of physical activity for boys and girls in the present study. Sex-specific regression analyses revealed that boys' physical activity was more strongly associated with perceived physical competence, whereas physical activity self-efficacy more strongly associated with girls' physical activity. In the context of social-cognitive theories of motivation, children with high self-perceptions possess high motivation to be physically active and approach physical activity related tasks with a high expectancy of success, leading to greater effort in physical activity than children with low physical self-perceptions (Babic et al., 2014). Children use various sources from which to form their self-perceptions including self-comparison and evaluative feedback from significant others, typically parents. Our results suggest that positive parental physical activity support may enhance boys physical activity directly and indirectly by enhancing their perceived physical competence. Perceived physical competence can also be improved through developing motor skill proficiency via participation in organised sport (Bardid et al., 2016). Therefore, boys living in socially disadvantaged communities may benefit from school or community-based initiatives that provide organised sport opportunities for them to practice skills and build confidence.

Few mediation studies have measured the influence of parental physical activity support on boys and girls physical activity separately. This study included several mediators simultaneously in the sex-specific models rather than separate sex-specific single mediator models. Including multiple mediators simultaneously determined the most successful mediators and detected the relative magnitudes of the specific indirect effects related to all the mediators (Preacher and Hayes, 2008). We found that physical activity self-efficacy was a stronger predictor of physical activity for girls relative to boys, and for girls, parental physical activity support had an indirect effect through physical activity self-efficacy on their physical activity. This finding is consistent with social cognitive theory, where self-efficacy relates to a child's confidence to involve others (i.e., parents) to support them achieve their goals (Bandura, 1986). The stronger association for girls relative to boys may reflect varying physical activity preferences between boys and girls, and the parental physical activity support required. For example, boys are typically provided with more unstructured physical activity opportunities and independent mobility to play outdoors relative to girls who typically participate in activities which require greater logistic support from parents (e.g., dance; gymnastics; Noonan et al., 2016b). Where girls are more reliant on their parents to access physical activity opportunities this in turn relates to an increase in girls' physical activity self-

efficacy. Parental physical activity support may not relate as strongly to boys' physical activity self-efficacy, but still has a direct effect on boys' physical activity. Further experimental and longitudinal research is needed to confirm these cross-sectional associations.

The findings of this study reveal for the first time parental physical activity support as a focus for interventions designed to increase physical activity levels among children living in socially disadvantaged communities. Based on the direct and indirect associations found in this study, physical activity intervention programmes could concentrate on making parents aware of their own importance to influence their children's physical activity. However, as some parents, specifically low-income parents, may value a physically active lifestyle for their children, but face difficulty translating intention into action, due to financial constraints (Hamilton and White, 2011), and limited environmental resources (e.g., access to garden/yard, parks, playgrounds and recreational facilities (Noonan et al., 2016a) conducive for physical activity, alternative intervention design approaches to that of traditional behavioural-focussed physical activity interventions may be needed. As child physical activity is accumulated in a range of settings (e.g., organised physical activity and community play (Jago et al., 2017), a combination of school and community- based approaches may be needed, based on *what works best* for children and their family. For example, this could be after-school programmes for some children but neighbourhood play for others (Jago et al., 2017). However, to inform future physical activity intervention programmes for children living in socially disadvantaged communities, further formative research with parents of children living in socially disadvantaged communities is needed.

Strengths and limitations

This is the first study to examine the relative influence of predisposing, reinforcing and enabling factors on the physical activity levels of children from socially disadvantaged communities. The study was underpinned by a socio-ecological conceptual framework specific to children, and validated measures were used to assess physical activity and a range of correlates aligned to the Youth Physical Activity Promotion Model with a recognised target population for physical activity intervention (Marmot, 2010). As our sample was above the national average for social disadvantage, this limits generalising our results to more affluent and rural areas of the UK. Social disadvantage was based on an area-level measure that reflects a range of deprivation markers, but may not have accurately reflected the actual social disadvantage level of all participating children compared to more sensitive measures of child social disadvantage such as parent education or household income. We used validated measures to assess physical activity, parental physical activity support, perceived physical competence, and physical activity self-efficacy but the data derived from these self-report measures may have been open to bias from respondents. However, it is important to note that our self-report data demonstrated strong internal consistency. The low participant response rate may have biased results with active children more likely to have taken part in the study, and the cross-sectional study design does not determine causality.

Conclusions

To conclude, the physical activity levels of children in this study were greatest among children with smaller waists, higher cardiorespiratory fitness, and more positive parental physical

activity support, physical self-perceptions and physical activity self-efficacy. The strength of these relationships differed between boys and girls. Parental physical activity support exerted the greatest and most consistent influence on children's physical activity, and was partially mediated by boys' perceived physical competence and girls' physical activity self-efficacy. As parents influence child physical activity directly and indirectly their involvement in future child physical activity intervention programmes is essential. Our findings add to the growing evidence base on social disadvantage and child physical activity. Formative research with parents living in socially disadvantaged communities is warranted to explore the range and *interaction* between challenges they face to support different modes of physical activity participation for their children.

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Table 1. Participant characteristics.

Variable	All (*n*=194) Mean (SD)	Boy (*n*=87) Mean (SD)	Girl (*n*=107) Mean (SD)	*d*
Age	9.96 (0.30)	9.97 (0.30)	9.95 (0.30)	0.1
Stature (cm)	139.12 (7.30)	140.42 (6.99)	138.06 (7.41) *	0.3
Mass (kg)	35.01 (8.44)	35.68 (7.68)	34.45 (9.01)	0.1
BMI (kg/m²)	17.92 (3.20)	17.96 (2.90)	17.89 (3.43)	0.0
Overweight/obese (%)	24.70	20.60	28.00	0.1
BMI z-score	0.32 (1.25)	0.51 (1.16)	0.16 (1.30)	0.3
Waist circumference	63.84 (7.72)	64.57 (7.97)	63.24 (7.50)	0.2
APHV	-2.64 (0.93)	-3.49 (0.45)	-1.94 (0.57) ***	3.0
Cardiorespiratory fitness (shuttles)	38.18 (19.37)	48.37 (20.05)	29.90 (14.22) ***	1.1
Indices of multiple deprivation score	36.80 (18.20)	36.87 (19.62)	36.73 (17.05)	0.0
PAQ-C	3.45 (0.70)	3.57 (0.70)	3.35 (0.68) *	0.3
Perceived physical competence	3.05 (0.57)	3.11 (0.70)	2.98 (0.57)	0.2
Physical activity self-efficacy	3.79 (0.72)	3.68 (0.80)	3.87 (0.64)	0.3
Parental physical activity support	17.63 (3.26)	17.61 (3.84)	17.64 (2.73)	0.0

APHV, age from peak height velocity; BMI, Body mass index; PAQ-C, Physical activity questionnaire for older children; SD, standard deviation; Significant sex difference at * $p<0.05$; *** $p<0.001$.

Table 2. Sex-specific hierarchical multiple regression analyses assessing the predictive associations between parental physical activity support, perceived physical competence, physical activity self-efficacy, cardiorespiratory fitness, waist circumference and Physical Activity Questionnaire for Older Children scores.

|		Boys				Girls			
		Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
					Standardized Beta				
Demographic									
Social disadvantage		-0.14	-0.14	-0.13	-0.10	0.19 *	0.13	0.12	0.12
Predisposing									
Perceived physical competence			0.50 †	0.40 †	0.42 †		0.24 ***	0.09	0.03
Physical activity self-efficacy			0.16	0.06	0.06		0.34 †	0.23 ***	0.25 ***
Reinforcing									
Parental physical activity support				0.27 **	0.32 ***			0.47 †	0.47 †
Enabling									
Cardiorespiratory fitness					-0.15				0.15 *
Waist circumference					-0.18 *				-0.03
	R^2	0.02	0.37	0.41	0.44	0.03	0.27	0.44	0.46
	Adj R^2	0.01	0.34	0.38	0.40	0.03	0.24	0.41	0.43
	Adj Δ R^2	0.01	0.33	0.04	0.02	0.03	0.21	0.17	0.02
	Model significance	$F_{(1, 80)}$ = 1.69 $p=0.20$	$F_{(3, 78)}$ = 15.06 $p<0.001$	$F_{(4, 77)}$ = 13.52 $p<0.001$	$F_{(6, 75)}$ = 10.00 $p<0.001$	$F_{(1, 103)}$ = 3.66 $p=0.06$	$F_{(3, 101)}$ = 12.21 $p<0.001$	$F_{(4, 100)}$ = 19.35 $p<0.001$	$F_{(6, 98)}$ = 13.85 $p<0.001$

*$p<0.10$, **$p<0.05$, ***$p<0.01$, †$p<0.001$

Table 3. Total and indirect effects of parental physical activity support on physical activity (perceived physical competence and physical activity self-efficacy) through each mediator (bootstrapping procedure with 95% bias-corrected and accelerated confidence intervals) by sex.

	Bootstrap Effect	95% CI	Normal Effect	SE	Normal Theory Tests	
					z	p
Boys						
Total effect	0.04	(0.01,0.08)*				
Physical competence	0.04	(0.02,0.08)*	0.04	0.01	3.12	**0.002**
Physical activity self-efficacy	0.00	(-0.03,0.03)	0.00	0.01	0.42	0.67
Girls						
Total effect	0.03	(0.01,0.06)*				
Physical competence	0.01	(-0.01,0.03)	0.01	0.01	1.16	0.24
Physical activity self-efficacy	0.02	(0.01,0.05)*	0.02	0.01	2.20	**0.03**

Note. Bootstrap generated confidence intervals. CI, confidence interval; *95% confidence interval does not encompass zero
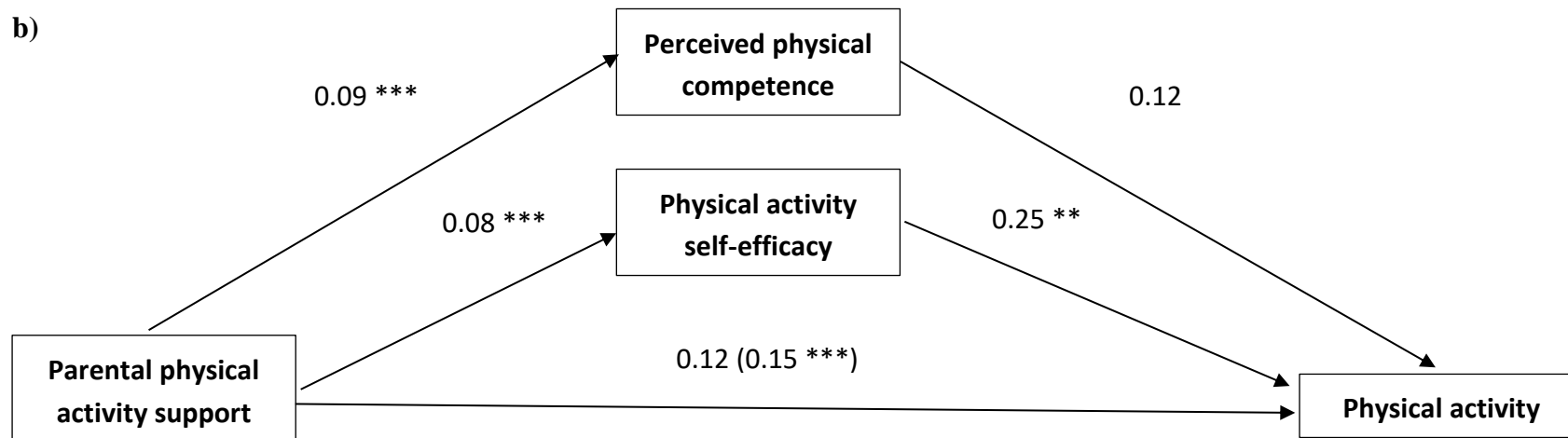
a)
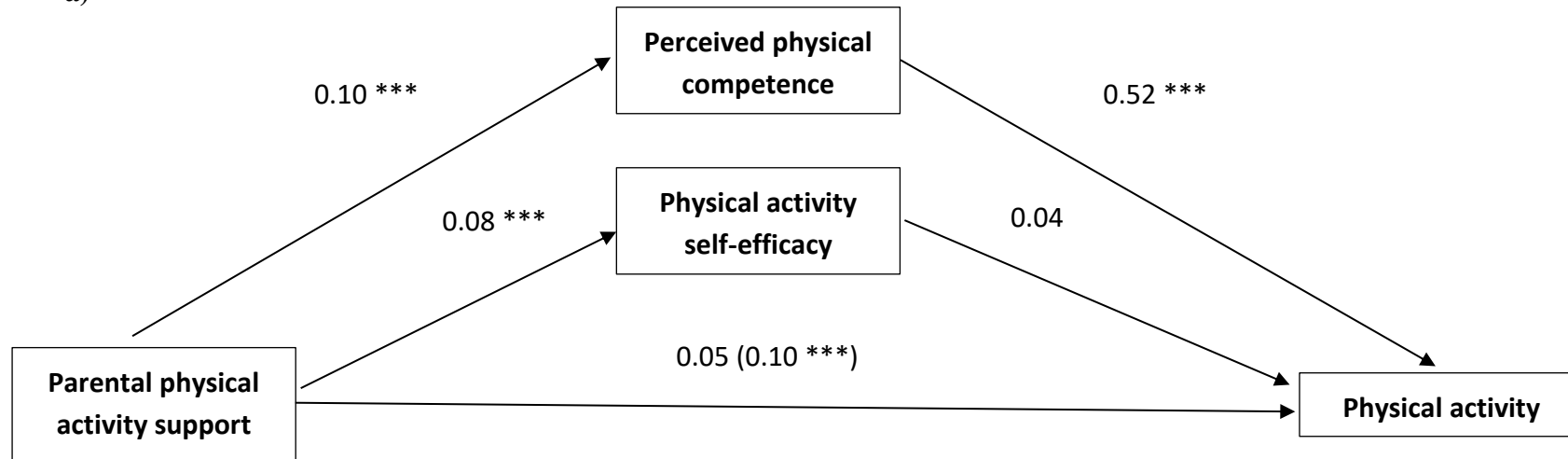
b)

Figure 1. Regression models predicting physical activity for boys (panel A) and girls (panel B). Values signify unstandardised regression coefficients. The direct effect of parental physical activity support on each predictor of physical activity are outside parentheses. The total effect is inside parentheses. ** $p<0.01$; *** $p<0.001$.