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Sports participation, health behaviours, and body fat during childhood and early adolescence: a multiple mediation

Stewart A. Vella
University of Wollongong, stvella@uow.edu.au

Lauren Gardner
University of Sydney, lag994@uowmail.edu.au

Byron Kemp
University of Wollongong, bjk687@uowmail.edu.au

Matthew Schweickle
University of Wollongong, mjs815@uowmail.edu.au

Dylan P. Cliff
University of Wollongong, dylanc@uow.edu.au

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Objectives: The aim of this study was to simultaneously explore multiple pathways through which sports participation during childhood and adolescence may be associated with adiposity over time.

Design: Data were drawn from the Kindergarten cohort of the Longitudinal Study of Australian Children. A total of 4286 children provided sports participation data at age 10 years and were followed up 24 and 48 months later.

Method: Time spent in organised sports at age 10 years and time spent in physical activity at age 12 years were measured via parental-reported time-use diary. Dietary behaviours were self-reported at age 12 years. Screen time was parent-reported. Body fat was measured at age 14 using bioelectrical impedance analysis. Two parallel multiple mediation models were tested to examine the longitudinal associations between sport participation at age 10 and body fat at age 14 via the mediating variables of physical activity, screen time, and dietary behaviours. One model was run for all participants, and a second model was run only for those participants who reported participating in organised sports.

Results: There were no significant indirect relationships between sports participation and body fat via any of the mediating variables in the total sample, or among sport participants.

Conclusions: There is a dearth of evidence to support substantial rhetoric and policy to promote organised sports programs as public health initiatives in their current form during childhood and adolescence. Better quality evidence is needed, however, modifications to sport programs may be necessary to elucidate meaningful benefits for adiposity.

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Keywords: Youth Sports; Health Behavior; Health Policy; Exercise

Sports Participation, Health Behaviours, and Body Fat during Childhood and Early Adolescence: A Multiple Mediation

Sports participation is one of the most popular and time consuming leisure activities for young people. Over 40% of all children and adolescents participate in organised sports in developed countries, with participation rates even higher among high-income countries[1]. This has led organisations such as the United Nations[2], International Olympic Committee (IOC)[3] and the World Health Organisation[4] to promote sport participation as a population level health promotion strategy. The IOC, in particular, have articulated the importance of sport among young people: ‘sport has an important role to play in the current global health crisis of rising morbidity and mortality from non-communicable diseases caused by physical inactivity, already starting at a young age… and can be instrumental in invoking behaviour changes in young people to positively affect global health’ [3] p. 837).

Despite strong rhetoric and policy action (e.g.,[5]), the evidence that sport participation is associated with better health outcomes during childhood and adolescence is equivocal[6,7]. In two systematic reviews, sports participation has been established as a correlate of higher levels of physical activity[6,7]. Nonetheless, the relationship between sports participation and measures of adiposity was equivocal or non-existent. Recent evidence has suggested that the relationship between sports participation and adiposity may be bidirectional in nature[8], which may in part account for equivocal findings. Nonethless, over reliance on cross-sectional studies, and an inability to account for the multiple ways in which sport may influence adiposity over time are primary limitations of the field. For example, while sports participation may be associated with higher levels of physical activity, it may also be associated with higher caloric intake[6]. Further, models of health through sport such as the conceptual model of health through sport[9] and the settings based approach to health promotion through sport[10] do not specify the causal pathways or behaviours through which sport may influence health over time. According to the Behavioral Epidemiology framework[11], establishing the links between health behaviours and health outcomes is the foundational stage of epidemiological research. Such knowledge is necessary before intervention research and research translation can occur.

The aim of this study was to simultaneously explore multiple pathways through which sports participation during childhood and adolescence may be associated with adiposity over time. Using a longitudinal sample of Australian children, multiple mediations will be used to explore the simultaneous longitudinal associations and indirect effects of sports participation on measures of adiposity, via its association with subsequent obesity-related behaviours, including levels of physical activity, dietary behaviours, and screen time. Given strong cross-sectional associations between sports participation and physical activity[6], and strong evidence that physical activity is associated with adiposity[12], we hypothesise that sports participation will be negatively associated with adiposity over time through increased physical activity. All other analyses are exploratory.

Method

Data were obtained from the Kindergarten (K) Cohort of the Longitudinal Study of Australian Children (LSAC). Commencing in 2004, the K Cohort of LSAC tracks the health and wellbeing of Australian children from 4 to 5 years of age, with follow-up data collected biennially. Families were randomly selected from the Australian Medicare database. At each time point, trained data collectors conducted structured face-to-face interviews with the child's primary parent (in 96% of cases this was the mother[13]), and collected parental-report questionnaires and child- and parent-reported time-use diaries (TUD). This study utilised data collected from Waves 4 (2010) to 6 (2014), covering a developmental period from ages 10 to 11 years until 14 to 15 years. For clarity, we refer to the ages of children as 10, 12, and 14 years of age across the three waves, respectively. At Wave 4, 3994 participants had complete sports participation data via the child-reported TUD[14]. The research methodology and survey content of Growing Up in Australia is reviewed and approved by the Australian Institute of Family Studies Ethics Committee, which is a Human Research Ethics Committee registered with the National Health and Medical Research Council. Informed consent was obtained from all participants.

The duration of organised sports participation was reported by children at 10 years of age via the TUD instrument. Children were mailed an open-ended paper diary to complete on the day before their interview over a 24-hour period[15]. These diaries were then transposed by interviewers according to a predetermined coding framework[15]. Interviewers were also trained to fill gaps in the diary by prompting the child for further information during the home interview. In the present study, two activity codes were aggregated to measure sports participation: "Organised team sports and training" and "Organised individual sports and training"[15]. The duration of time spent in these activity codes was calculated by one researcher (BK). Firstly, the duration of each activity was determined as the difference between the start time of the activity and the start time of the next activity in sequence for each child. It was assumed that the last activity of each child's day ended at the child's bed time. The total duration of organised sports participation was then aggregated for each participant, and is reported as total number of minutes. A similar process was used to create a dummy variable for school attendance (yes/no) based on the "School lessons" activity code. Finally, although children were allowed to record up to six activities concurrently in the TUD, sport participation was based on the primary activity selected at any one time. Unlike other activities such as eating or listening to music, organised sport seems less logical as a concurrent activity.

Indirect effects between sport participation and measures of adiposity were tested using the following mediating variables: time spent in physical activity; fruit and vegetable consumption; consumption of high fat foods; consumption of high sugar drinks; and, screen time.

The duration of physical activity was calculated from the TUD instrument completed by children at 12 years of age. The total time spent in physical activity was extracted from the TUD using the same process that was used to extract organised sports participation data. Fourteen activity codes were aggregated to form an overall measure of physical activity: "Organised team sports and training", "Organised individual sports and training", "Unstructured active play", "[Travel] by bike, scooter, skateboard, etc", "[Travel] by foot", "Pamphlet delivering", "Umpiring/refereeing", "Car washing", "Gardening / lawn mowing [paid]", "Gardening / lawn mowing [chore]", "Cleaning/tidying", "Walking pets/playing with pets", "Active club activities" and "Active activities (not elsewhere classifiable)". Compendia of Energy Expenditures for Youth[16] and Adults[17] were used to determine the Metabolic Equivalent of Task values of household chores and occupational tasks. These activity codes were considered to be physically active if they had a MET value of at least 3.0.

To ensure consistency with the organised sports variable, the physical activity variable was based on the primary activity selected at any one time.

Children reported their consumption of fruit and vegetables at age 12 years using a summed total of three items. Participants were asked to report “Thinking about yesterday, how often did you have…” fresh fruit, cooked vegetables, and raw vegetables or salad? The three items were scored a 0 for ‘*Not at all*’, 1 for ‘*Once*’, 2 for ‘*Twice*’, and 3 for ‘*More than twice*’.

Four self-reported items were used to assess children’s consumption of high fat foods at age 12 years. Children were asked “Thinking about yesterday, how often did you have…” (i) meat pie, hamburger, hot dog, sausage, or sausage roll; (ii) hot chips or french fries; (iii) potato chips or savoury snacks such as ‘Twisties’; and, (iv) biscuits, doughnut, cake or chocolate. All items were scored a 0 for ‘*Not at all’*, 1 for ‘*Once*’, 2 for ‘*Twice*’, and 3 for ‘*More than twice’*. Total serves were computed using the sum of all four items.

A single item was used to assess consumption of high sugar drinks. Participants were asked “Thinking about yesterday, how often did you have soft drink or cordial?”. The item was scored a 0 for ‘*Not at all*’, 1 for ‘*Once*’, 2 for ‘*Twice*’, and 3 for ‘*More than twice’*.

Parents reported children’s time spent watching TV and playing electronic games at age 12 years using a total of four items. Parents were asked “About how many hours on a typical weekday does (your child) spend…” and “About how many hours on a typical weekend day does (your child) spend…” for both watching television and playing electronic games. A weighted weekly average was calculated by multiplying the average weekday use by 5 and the average weekend day use by 2, and then these were summed to provide a weighted weekly average for watching television and playing electronic games. The two weighted weekly averages were then summed to represent total weekly screen time. Body fat percentage was used as a measure of adiposity. Body fat percentage was measured on digital scales using bioelectrical impedance analysis at all Waves.

Covariates were assessed at Wave 4 when children were aged 10 years, and included child sex and neighbourhood socioeconomic position (SEP). Neighbourhood SEP was determined according to the Socio-Economic Indexes for Areas Index of Relative Socio-Economic Disadvantage[18] using the child's home postcode. In addition, day of the week and school attendance (yes/no) were used as covariates for the sport participation variable measured by TUD.

Two parallel multiple mediation path models were tested to examine the longitudinal associations between sport participation at age 10 (independent variable) and adiposity at age 14 (dependent variable), via physical activity, fruit and vegetable consumption, consumption of high fat foods, consumption of high sugar drinks, and screen time at age 12 (mediating variables). This approach allows for the modelling of multiple mechchanisms simultaneously, while also allowing the mediators (in this case the various health behaviours) to be correlated. The multiple mediation approach has been outlined by Hayes[19]. A diagram of the parallel multiple mediation model is given in Figure 1. First the indirect path linking sport participation at age 10 with body fat percentage at age 14, via physical activity, fruit and vegetable consumption, consumption of high fat foods, consumption of high sugar drinks, and screen time at age 12, was tested among all participants, controlling for all mediating variables at age 10, body fat at age 10, child sex, household income, day of the week that the time-use diary was completed, and whether the child attended school that day. As a majority of participants reported no sports participation (i.e., they reported 0 minutes per week), this analysis was subsequently repeated using only those participants that reported some level of sports participation at age 10 years (>0 minutes per week). Finally, both of these analyses were repeated as sensitivity analyses after removing sport participation from the measure of physical activity as a mediating variable, to allow for any potential confounding between the predictor variable (sport participation) and the mediating variable (physical activity). Missing data were estimated using the full information maximum likelihood (FIML) method. A bootstrapping procedure with 5000 resamples was used to test the indirect effects, with significance determined from 95% confidence intervals. Results are presented as unstandardised β coefficients. Analyses were conducted using Mplus version 7. Both models controlled for all covariates.

Results

Table 1 presents mean body fat percentage and covariate data over the total sample and by selected demographic variables. In total, 292 participants were missing organised sport participation data at age 10 years. Those with missing sport participation data at age 10 years lived in neighbourhoods with greater socioeconomic disadvantage (t = 6.07, , df = 4166, p < 0.001), consumed less serves of fruit and vegetables (t = 2.59, df = 3842, p = 0.003), and consumed greater serves of high fat food (t = -2.39, df = 3842, p = 0.017).

(INSERT TABLE 1 HERE)

The results of the first multiple mediation path model linking sport participation at age 10 to body fat at age 14 among all participants are illustrated in Table 2. Sport participation at age 10 was positively associated with physical activity and fruit and vegetable consumption at age 12, and negatively associated with consumption of high fat food and screen time at age 12, after controlling for the covariates listed above. However, none of the mediating variables were significantly associated with body fat at age 14. The direct effect of sport participation at age 10 on body fat at age 14 was not significant, (β = .007, p = 0.53), and there were no significant indirect relationships. Overall, the model was not a good fit for the data (RMSEA = .14; SRMR = .09; CFI = .46; TLI = -.32).

The results of the second multiple mediation path model linking sport participation at age 10 to body fat at age 14 among only those who reported sport participation are given in Table 2. Greater sport participation at age 10 was positively associated with physical activity at age 12 after controlling for covariates. None of the mediating variables were significantly associated with body fat at age 14. The direct effect of sport participation at age 10 on body fat at age 14 was not significant, (β = -.006, p = 0.78), and there were no significant indirect relationships. Overall, the model was not agood fit for the data (RMSEA = .15; SRMR = .10; CFI = .43; TLI = -.39).

(INSERT TABLE 2 HERE)

Sensitivity analyses following removal of sport participation from the mediating physical activity variable showed no meaningful change in results in either model. Results are reported in

Table 3. Among all participants, the direct effect of sport participation at age 10 on body fat at age 14 was not significant, (β = .003, p = 0.774), and there were no significant indirect relationships. Overall, the model was not a good fit for the data (RMSEA = .12; SRMR = .08; CFI = .52; TLI = -.17). Among sport participants, the direct effect of sport participation at age 10 on body fat at age 14 was not significant, (β = .000, p = 0.981), and there were no significant indirect relationships. Overall, the model was not a good fit for the data (RMSEA = .12; SRMR = .09; CFI = .43; TLI = -.39). In both models, sport participation at age 10 was no longer associated with physical activity at age 12.

(INSERT TABLE 3 HERE)

Discussion

The aim of this study was to simultaneously explore multiple pathways through which sports participation during childhood and adolescence may be associated with adiposity over time. Although sports participation at age 10 years was positively associated with physical activity and fruit and vegetable consumption, and negatively associated with consumption of high fat foods and screen time at age 12 years, the direct effects of sport participation at age 10 on adiposity at age 14 were not significant, and there were no significant indirect relationships. As such, in this study sports participation was neither directly associated with adiposity four years later, nor indirectly linked through its association with health behaviours.

Despite the implementation of health policies based on organised sports participation[2-5], the evidence to support the long term ~~health~~ benefits of sports participation during childhood and adolescence for levels of adiposity is equivocal. On this basis, criticisms of the promotion of sport as a public health initiative have recently emerged[17]. This study offers no further evidence to support the use of organised sports, in their current form, for the prevention of non-communicable diseases such as obesity. Some reasons for this may include the low mean time spent in organised sports (~25 mins.wk^{-1} in this study), low levels of moderate to vigorous physical activity during sports participation[20-22], and high dropout rates from organised sports during late childhood and adolescence[23]. Some limited evidence from controlled trials does suggest that sport participation can lead to decreases in adiposity when implementation is highly controlled[24], but in their current form, participation in organised sports as delivered in community settings is unlikely to be associated with the prevention of major public health problems such as obesity[6,7].

In contrast to the evidence on adiposity, the evidence to support the relationship between sports participation and higher levels of physical activity is reasonably conclusive[6,7]. This study suggests that these relationships can hold over a period of up to two years. Further, this study also suggests that sports participation predicts lower levels of screen time – a relationship previously documented in cross-sectional studies[25]. The Global Advocacy for Physical Activity has identified organised sports programs as one of the best investments for physical activity worldwide[26]. Policy in this area is justified by the body of evidence, however, relationships may not be strong. This may be because sports participation typically only includes between 20% and 50% of time spent in moderate to vigorous physical activity[20-22]. Further, the lack of experimental evidence prohibits assertions of causality[6,7], and this is also true of the current study.

While sports participation at age 10 was associated with healthier lifestyle behaviours at age 12 years including greater physical activity, greater fruit and vegetable consumption, lesser consumption of high fat foods, and lesser screen time, it is unclear why these behaviours were not associated with measures of adiposity at age 14 years. For example, physical activity is associated with reduced adiposity during childhood, as is consumption of high fat foods[12,27]. However, the evidence is not strong for the influence of sedentary behaviours on adiposity during childhood[28]. It is currently unclear if the lack of association between participation in organised sports and measures of adiposity is due to the weak relationships between sports participation and health behaviours, or because the health behaviours themselves are not associated with measures of adiposity in this sample. This is an important differentiation because sports programs may legitimately be promoted as public health programs if they influence health behaviours over a number of years. However, if this influence is weak, or if the health behaviours themselves do not translate into reduced levels of adiposity, then organised sports programs may not be legitimately held up as programs for public health, at least when reduced adiposity is the desired outcome.

The use of a large, longitudinal sample is a strength of the current study, as is the use of multiple mediation pathways. Multiple mediation pathways are particularly important when the mediating variables may be related[29]. Limitations of the study include the 24-month time lag between Waves which may obscure meaningful short-term associations between variables. Likewise, the longitudinal nature of the study precludes inferences regarding causality. Further, an inability to differentiate between types of organised sport participation limits conclusions to those pertaining to organised sports as a whole. However, different sports programs and different age groups may have very different effects on health and health behaviours[22]. Whether participants maintained sports participation over the 48 months from which data were drawn may influence subsequent health behaviours and adiposity, however, this was not accounted for in the analyses. The use of a 24-hour recall time-use diary may also limit the study by virtue of missing some sport participation. A 7-day recall period would help to ameliorate this concern. Lastly, sports participation may influence a wide range of health behaviours beyond those included in this study. It is possible that by not accounting for behaviours such as alcohol consumption, this study misses an important causal pathway between sports participation and subsequent health.

Conclusion

In conclusion, we have explored the simultaneous pathways through which sports participation at age 10 years may be associated with measures of adiposity at age 14 years. There was no direct or indirect effect of sports participation on subsequent adiposity, although sports participation did beneficially predict some health behaviours at age 12 years, namely higher physical activity, greater fruit and vegetable intake, lesser consumption of high fat foods, and lesser screen time. There is a dearth of evidence to support substantial rhetoric and policy to promote organised sports programs as public health initiatives in their current form, at least in regards to levels of adiposity. Better quality evidence is needed, however, limited experimental research suggests that when implemented in a controlled environment, sports programs can have meaningful benefits to adiposity among young people.

Practical Implications

- Sport participation is positively associated with healthy behaviours, and negatively associated with unhealthy behaviours, at a later age.
- Sport participation has no association with body fat at later age
- Policy makers should consider the design and implementation of sports programs to best address public health issues

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Table 1.

Mean body fat percentage and covariate data over the total sample and by selected demographic variables.

	N (%)	Mean (SD)							
		Sport (mins.day^{-1})	Body Fat Percentage	SEP	PA (mins.day^{-1})	Screen Time (mins.wk^{-1})	High Fat Food (serves.day^{-1})	Fruit and Veg (serves.day^{-1})	High Sugar Drinks (serves.day^{-1})
Total sample	4286	25.86 (53.89)	20.91 (10.05)	1012.67 (63.83)	101.34 (99.52)	1800.63 (1021.50)	2.21 (1.61)	3.14 (1.67)	1.44 (1.15)
Male	2194 (51.2)	26.34 (54.47)	16.28 (8.83)	1013.82 (61.06)	114.77 (104.65)	1875.62 (1044.23)	2.37 (1.73)	3.03 (1.59)	1.54 (1.17)
Female	2092 (48.8)	25.36 (53.28)	25.96 (8.78)	1011.46 (66.59)	87.67 (92.04)	1720.05 (986.31)	2.12 (1.47)	3.27 (1.55)	1.34 (1.12)
Sport participants[10]	1097 (25.6)	94.16 (64.36)	20.79 (9.43)	1015.94 (68.45)	108.94 (100.38)	1731.79 (953.26)	2.14 (1.51)	3.27 (1.53)	1.42 (1.12)
Non-participants[10]	2897 (67.6)	-	21.00 (10.30)	1013.16 (60.69)	98.68 (99.12)	1824.61 (1023.44)	2.26 (1.63)	3.12 (1.57)	1.45 (1.16)
Sport data Missing	292 (6.8)	-	20.24 (9.72)	984.11 (76.70)	96.74 (98.67)	1831.68 (1251.91)	2.50 (1.87)	2.83 (1.73)	1.56 (1.14)

Note. SEP = Socioeconomic position as measured by the Socio-Economic Index for Areas; PA = Physical activity; Veg = Vegetables

Table 2.

Unstandardised results of the multiple mediation path model linking sport participation at age 10 to body fat at age 14.

	All Participants			Sport Participants		
	β	SE	95% CI	β	SE	95% CI
a paths						
Sport$_{10}$ → Physical Activity$_{12}$	.079*	.017	.045, .113	.093*	.029	.036, .168
Sport$_{10}$ → Fruit & Vegetable$_{12}$	.021*	.011	.001, .041	.009	.017	-.026, .050
Sport$_{10}$ → High Fat Diet$_{12}$	-.022*	.009	-.040, -.007	-.015	.014	-.042, .013
Sport$_{10}$ → High Sugar Drinks$_{12}$	-.008	.007	-.019, .006	-.004	.011	-.027, .018
Sport$_{10}$ → Screen Time$_{12}$	-.033*	.013	-.057, -.012	-.022	.019	-.059, .016
b paths						
Physical Activity$_{12}$ → Body Fat$_{14}$	-.016	.015	-.045, .014	-.056	.030	-.118, .001
Fruit & Vegetable$_{12}$ → Body Fat$_{14}$	-.014	.023	-.058, .032	.031	.047	-.118, .123
High Fat Diet$_{12}$ → Body Fat$_{14}$	-.019	.023	-.066, .025	-.087	.045	-.177, .003
High Sugar Drinks$_{12}$ → Body Fat$_{14}$	.012	.032	-.049, .073	-.051	.059	-.168, .063
Screen Time$_{12}$ → Body Fat$_{14}$	.008	.016	-.023, .040	.024	.031	-.032, .090
Indirect effect						
Sport$_{10}$ → Physical Activity$_{12}$ → Body Fat$_{14}$	-.001	.001	-.004, .001	-.005	.003	-.014, .001
Sport$_{10}$ → Fruit & Vegetable$_{12}$ → Body Fat$_{14}$	.000	.001	-002, .001	.000	.001	-.001, .004
Sport$_{10}$ → High Fat Diet$_{12}$ → Body Fat$_{14}$	.000	.001	-.001, .002	.001	.002	-.001, .006
Sport$_{10}$ → High Sugar Drinks$_{12}$ → Body Fat$_{14}$	.000	.000	-.001, .000	.000	.001	-.001, .004
Sport$_{10}$ → Screen Time$_{12}$ → Body Fat$_{14}$	.000	.001	-.002, .000	-.001	.001	-.004, .001
Covariates						
Body Fat$_{10}$ → Body Fat$_{14}$	.206*	.019	.170, .243	.165*	.027	.115, .222
Physical Activity$_{10}$ → Body Fat$_{14}$	-.006	.014	-.034, .021	.020	.030	-.044, .086
Fruit & Vegetable$_{10}$ → Body Fat$_{14}$	.009	.017	-.025, .043	-.001	.047	-.062, .065
High Fat Diet$_{10}$ → Body Fat$_{14}$	.004	.019	-.034, .039	.024	.045	-.039, .084
High Sugar Drinks$_{10}$ → Body Fat$_{14}$	.024	.028	-.035. .077	.021	.059	-.080, .110
Screen Time$_{10}$ → Body Fat$_{14}$	.113*	.026	.065, .167	.065	.031	-.004, .137
Sex → Body Fat$_{14}$	1.875*	.071	1.733, 2.008	1.912*	.126	-1.661, 2.154
Neighbourhood SEP$_{10}$ → Body Fat$_{14}$	-.015	.016	-.048, .016	-.065*	.030	-.131, -.012

Note. *Significant as per 95% bias-corrected confidence intervals estimated through 5000 bootstrapped resamples; Subscript numerals indicate child age.

Table 3.

Unstandardised results of the sensitivity analyses linking sport participation at age 10 to body fat at age 14 following removal of sport participation from the physical activity variable.

	All Participants			Sport Participants		
	β	SE	95% CI	β	SE	95% CI
a paths						
Sport$_{10}$ → Physical Activity$_{12}$	.012	.016	-.019, .045	.017	.028	-.035, .072
Sport$_{10}$ → Fruit & Vegetable$_{12}$	.021*	.011	.001, .041	.009	.017	-.026, .039
Sport$_{10}$ → High Fat Diet$_{12}$	-.022*	.009	-.040, -.004	-.015	.014	-.042, .013
Sport$_{10}$ → High Sugar Drinks$_{12}$	-.006	.007	-.019, .008	-.004	.011	-.027, .017
Sport$_{10}$ → Screen Time$_{12}$	-.033*	.013	-.057, -.0008	-.022	.019	-.059, .016
b paths						
Physical Activity$_{12}$ → Body Fat$_{14}$	-.012	.017	-.046, .022	-.045	.036	-.115, .023
Fruit & Vegetable$_{12}$ → Body Fat$_{14}$	-.014	.023	-.058, .032	.031	.047	-.062, .123
High Fat Diet$_{12}$ → Body Fat$_{14}$	-.019	.023	-.065, .025	-.084	.045	-.174, .004
High Sugar Drinks$_{12}$ → Body Fat$_{14}$	.011	.032	-.049, .073	-.049	.059	-.167, .067
Screen Time$_{12}$ → Body Fat$_{14}$	.009	.016	-.023, .041	.025	.032	-.032, .092
Indirect effect						
Sport$_{10}$ → Physical Activity$_{12}$ → Body Fat$_{14}$	.000	.001	-.004, .001	-.001	.002	-.007, .001
Sport$_{10}$ → Fruit & Vegetable$_{12}$ → Body Fat$_{14}$	.000	.000	-002, .001	.000	.001	-.001, .004
Sport$_{10}$ → High Fat Diet$_{12}$ → Body Fat$_{14}$	.000	.001	-.001, .002	.001	.002	-.001, .006
Sport$_{10}$ → High Sugar Drinks$_{12}$ → Body Fat$_{14}$	.000	.001	-.001, .000	.000	.001	-.001, .003
Sport$_{10}$ → Screen Time$_{12}$ → Body Fat$_{14}$	.000	.001	-.002, .000	-.001	.001	-.004, .001
Covariates						
Body Fat$_{10}$ → Body Fat$_{14}$	.206*	.019	.170, .244	.166*	.028	.116, .222
Physical Activity$_{10}$ → Body Fat$_{14}$	-.009	.017	-.035, .021	.017	.033	-.048, .083
Fruit & Vegetable$_{10}$ → Body Fat$_{14}$	.009	.017	-.025, .043	-.001	.032	-.063, .065
High Fat Diet$_{10}$ → Body Fat$_{14}$	.004	.019	-.034, .039	.023	.031	-.039, .084
High Sugar Drinks$_{10}$ → Body Fat$_{14}$	.017	.020	-.035, .076	.019	.049	-.082, .108
Screen Time$_{10}$ → Body Fat$_{14}$	.089*	.020	.066, .168	.068	.036	.000, .140
Sex → Body Fat$_{14}$	.467*	.071	1.733, 2.012	1.926*	.127	-1.668, 2.168
Neighbourhood SEP$_{10}$ → Body Fat$_{14}$	-.013	.015	-.048, .016	-.066*	.031	-.134, -.014

Note. *Significant as per 95% bias-corrected confidence intervals estimated through 5000 bootstrapped resamples; Subscript numerals indicate child age.