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Longitudinal associations between sports participation, body composition and physical activity from childhood to adolescence

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ABSTRACT

Objectives: Several important research questions have been addressed: (1) What are the cross-sectional associations between sports club participation, objectively measured physical activity, and adiposity? (2) Do measures of physical activity and adiposity predict subsequent sports club participation? (3) Does sports club participation predict subsequent measures of physical activity and adiposity? and (4) Do changes in sports club participation predict changes in objective measures of physical activity and adiposity?

Design: Longitudinal and cross-sectional.

Methods: Data from the Gateshead Millennium Study birth cohort ($n=609$ at age 7 years) were analysed for associations between adiposity, sports club participation and accelerometer-measured physical activity from ages 7y to 9y to 12y.

Results: Seventy-two per cent of 9 year olds and 63% of 12 year olds took part in a sports club. Sports club participation was significantly associated with overall accelerometer-measured physical activity at 12y (coefficient = 0.0.09; 95% CI: 0.01–0.16) but not 9y. An inverse relationship between fat mass (estimated from bioelectric impedance) and sport club participation, and between fat mass and accelerometer-measured physical activity was observed at 12y, but not 9y. Sports club participation at 9y was highly predictive of participation at 12y. Sports club participation was significantly associated with socioeconomic status; fewer children from poorer areas took part.

Conclusions: Sports club participation in adolescence may be associated with decreased levels of adiposity. Furthermore, the potential benefits of sports club participation for adiposity are likely generated from continuous participation in sports, rather than any long-term protective effects.

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1. Introduction

Paediatric obesity is at epidemic proportions, and is associated with significant short- and long-term medical, psychological and social morbidities.¹ Although, the Global Advocacy for Physical Activity recommend sports participation as a key strategy to address the growing burden of childhood inactivity² it is currently unclear whether sports participation can be an effective tool for the prevention of paediatric obesity.³ Significant limitations in this body of literature must be addressed before evidence-based

policies can be articulated under the assumption that sports participation provides a buffer against the onset of paediatric obesity.

A recent systematic review has highlighted the substantial limitations that are present within the research examining the relationships between sports participation, physical activity and obesity.³ An over-reliance on cross-sectional designs makes causal inferences impossible. In the few longitudinal studies that have been reported, none have used either objective measures of physical activity or body composition, relying on simple proxies for body composition such as the body mass index (BMI). The use of self-reported measures of physical activity is likely to inflate the observed relationships between sports participation and physical activity, particularly if reported concurrently. Further, while BMI is an adequate measure of adiposity in childhood,⁴ it can potentially bias results towards findings of no difference in sporting contexts

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due to an inability to observe the differences between overweight non-participants and muscular participants.⁵ In those longitudinal studies that have also used objective measures of physical activity,⁶ none have addressed the issue of bi-directionality specifically between sports participation and adiposity/physical activity. Furthermore, issues such as these have been articulated as important limitations beyond the literature pertaining to sports participation, and are also pertinent to research in physical activity.⁷

The purpose of this study was to address the limitations of previous research by investigating longitudinal associations between sports club participation, objectively measured physical activity, and adiposity [as measured by both BMI and fat mass index (FMI)]. Specifically, several important research questions (RQ) have been addressed: (1) What are the cross-sectional associations between sports club participation, objectively measured physical activity, and adiposity? (2) Do measures of physical activity and adiposity predict subsequent sports club participation? (3) Does sports club participation predict subsequent measures of physical activity and adiposity? and (4) Do changes in sports club participation predict changes in objective measures of physical activity and adiposity? As a secondary objective, this study also compared the strength of the associations between sports participation and BMI/FMI.

2. Methods

The Gateshead Millennium Study (GMS) is a birth cohort of adolescents born between May 1999 and June 2000, described in detail elsewhere.⁸ Briefly, all children born to Gateshead-resident mothers in pre-specified recruiting weeks were invited to participate. There were no exclusion criteria. Mothers were primarily from the white ethnic majority (98%). The sample has remained socioeconomically representative of northern England throughout the study.⁸

Data for the current analyses were collected at three separate data sweeps: in 2006–2007, 2008–2009 and 2012, corresponding to age 6–8, 8–10 and 11–13 years, hereafter referred to as 7, 9 and 12y. For each phase, all families who had not previously opted-out from the cohort were sent a letter and information leaflet inviting them to take part. Informed written consent was obtained from the main carer of each child, and children provided assent to their participation. Ethical approval for the study was granted by Gateshead and South Tyneside LREC (for the 7y data sweep) and Newcastle University Ethics Committee (9 and 12y).

At each timepoint, height was measured to 0.1 cm with a Leicester portable height measure (Chasmors, London, UK) and weight measured to 0.1 kg in light indoor clothing, and BMI and BMI z-score according to UK 1990 data⁹ were derived. The fat mass index (FMI)¹⁰ was the measure of body fatness used in the present study. We have shown previously that having a fat mass outcome greatly increased the ability to detect associations compared to having only a proxy for fat mass as the outcome measure between ages 7 and 9y.¹¹ Fat mass was estimated from TANITA bioelectrical impedance (TBF-300MA) by applying constants for the hydration of fat-free mass¹² having first estimated total body water using validated sex and age-specific prediction equations.¹³ FMI was then calculated by dividing fat mass by height squared.¹⁰

At 7, 9 and 12y children were asked to wear an Actigraph GT1M accelerometer on the right hip for 7 days, removing it only for bed and water-based activities. They were also given a time sheet to log when the monitor had been worn. Data were collected in 15 s sampling intervals (epochs) but collapsed to 60 s epochs when summarised. Data were reduced manually as described previously.¹⁴ Three constructs of physical activity (total volume of physical activity in mean counts per minute, cpm; amount of time spent in moderate-vigorous intensity physical activity (MVPA)

(minutes, and proportion of time spent in MVPA); and one of sedentary behaviour (proportion of time spent in SB)) were used in the present study. The cut-point of 3200 cpm¹⁵ was used to define the threshold for MVPA, and 1100 cpm for sedentary behaviour^{16,17} (defined as no trunk movement as measured by accelerometry).¹⁷ The Actigraph GT1M model has been shown to have a consistent bias of 9% relative to model 7164¹⁸ which has been used widely in previous research. A +9% correction was therefore applied to the data before applying cutpoints. Previous analysis of this cohort showed that 3 days of recording provided test–retest reliabilities of approximately 70% for each of the constructs¹⁴ with a minimum of 6 h recording per day.

At 9 and 12y children self-completed the 'Youth Sports Survey' questionnaire (adapted from Godin and Shepherd 1985¹⁹) assessing which school- and outside-school sports clubs they had participated in recently, time spent at each club and how many times per week they attended. Total time spent in each club per week was calculated, and times for all clubs summed and used in analyses.

Analyses were performed in STATA 12 and SPSS19. Sample size was fixed by the size of the cohort. Linear regression analyses were used to test for both cross-sectional and longitudinal associations; β coefficients and 95% CI are reported, with R^2 and p value. Significance was set at $p < 0.05$. Socio-economic status (SES) was described using Townsend scores,²⁰ an area-based measure derived from the UK census in 2001, and divided into quintiles. Sports club participation was the initial dependent variable, before being one of the independent variables in the analyses with 12y FMI, 12y BMI and 12y BMI z-score as dependent variables. The adjusted models are presented with each independent variable included one at time with adjustment for SES and sex, due to their role as likely confounders of all the associations tested, but not including the other independent variables due to likely collinearity.

3. Results

A total of 609 participants were involved in data collection at 7y, 585 at 9y and 525 at 12y. Not all children provided data for each variable of interest. Participant characteristics are displayed in Table 1.

At 9y, 581 children answered the questions on sports club participation. Four hundred and sixteen children (72%) took part in a sports club. Of these, 209 (50%) children took part in a school-sports club, and 342 (82%) in an outside-school sports club. One hundred and thirty-five (32%) children participated in both a school- and an outside-school club. At 12y, 512 children answered the question, 324 participated in any club (63%); 208 (64%) took part in a school-sports club and 252 (78%) in an outside-school sports club. One hundred and thirty-six (42%) children participated in both a school- and an outside-school sports club. This corresponded to more than 40 different sports and activities clubs. Two hundred and thirty-six children participated in a sports club at both 9y and 12y.

In univariate analyses, 12y sports club participation was significantly associated with all accelerometry variables. After adjustment for sex and SES, 12y sports club participation was positively associated with total cpm and negatively associated with %SB, but no longer associated with MVPA (Table 2). At 9y, sports club participation was not associated with 9y accelerometer measured physical activity or sedentary behaviour (data not shown).

In univariate regression analyses, 12y FMI was significantly inversely associated with 12y sports club participation, and MVPA and total activity as measured by accelerometry. These associations remained after adjustment for sex and SES (Table 3). Neither 12y BMI nor BMI z score were associated with 12y sports club

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