



Childhood predictors of adolescent behaviour: The prospective association of familial factors with meeting physical activity guidelines

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ABSTRACT

Little is known about the longitudinal association of familial socio-demographic factors, behaviours, attitudes, or home environment with meeting physical activity guidelines. Our objective was to a) describe 4-year change in the prevalence of meeting guidelines, and characteristics of participants across categories of physical activity maintenance, and b) identify familial factors in childhood that are longitudinally associated with meeting guidelines in adolescence.

Data on 17 parent- and child-reported family variables and objectively measured physical activity (ActiGraph GT1M) were available from 406 children (10.3 ± 0.3 years, 53.5% female) participating in the SPEEDY study. Average duration of week- and weekend day moderate-to-vigorous physical activity (MVPA, ≥ 2000 cpm) at baseline and follow-up (14.3 ± 0.3 years) were calculated to determine whether participants met 60 min MVPA/day guidelines at each assessment. Descriptives were calculated across four MVPA change categories. Multi-level logistic regression examined the association of baseline familial factors with meeting guidelines at follow-up, adjusting for sex, baseline physical activity, family socio-economic position, and school clustering.

At follow-up, 51.5% and 36.1% of adolescents met guidelines on weekdays and weekend days, respectively (baseline: 68.0%, 67.2%). Girls were less likely than boys to remain sufficiently active, particularly on weekdays. Family social support was positively associated with adolescents meeting guidelines at weekends (OR 1.2; 95% CI 1.0–1.4). The presence of play equipment at home was negatively associated with meeting guidelines on weekdays (OR 0.5; 95% CI 0.3–0.8).

Interventions that foster parent's facilitation of physical activity may help to encourage the upkeep of healthy behaviours during the transition from childhood to adolescence.

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1. Background

The World Health Organisation cites inactivity as the fourth leading risk factor for global mortality (World Health Organisation, 2010). In children, physical activity is associated with improved cardiovascular risk factors (Ekelund et al., 2012), anthropometric indicators (particularly body composition, waist circumference and fat mass) (Hills et al., 2011; Wilks et al., 2011) and bone health (Boreham and McKay, 2011). It is also suggested that regular engagement in physical activity is beneficial for young people's mental health and self-esteem, and for improved cognitive performance and scholastic achievement (Biddle and Asare, 2011; Brown et al., 2013; Singh et al., 2012). However, data from several countries suggest that the majority of children are

insufficiently active to confer such health benefits (Janssen and Leblanc, 2010; Andersen et al., 2006). Understanding the modifiable influences of physical activity in young people is therefore a public health priority.

The family, as the primary unit of socialisation during childhood, is central in shaping engagement in health behaviours, including physical activity (Maccoby, 1992; Atkin et al., 2015). There is substantial evidence that parenting behaviours and family processes also play a critical role in adolescent well-being (Gavazzi, 2011). Familial factors, such as logistical support (e.g. provision of transport or covering cost), co-participation, or encouragement, have been consistently and positively correlated with physical activity in children and adolescents (Sallis et al., 2000; Brown et al., 2016). For example, a recent meta-analysis demonstrated a moderate-sized positive, cross-sectional association between parental modelling and child physical activity (especially pertinent for fathers and sons) (Yao and Rhodes, 2015). However, the reliance upon cross-sectional data in this review and within the evidence base more broadly is a key limitation that hinders our capacity to draw causal inferences. Longitudinal studies are required to better characterise

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familial and home influences on changes in children's activity with age. This is especially important given that levels of physical activity decline substantially throughout childhood and into adolescence (Nader et al., 2008; Dumith et al., 2011).

In keeping with the socio-ecological model (Stokols, 1996), influences on behaviour may be location and time-specific. Evidence suggests that declines in physical activity during late childhood are not evenly spread across the day and week, with larger decreases observed on weekend days (Rowlands et al., 2008), and during leisure time on weekdays (McMinn et al., 2013). Previous work in the SPEEDY (Sport, Physical activity and Eating behaviour: Environmental Determinants in Young people) cohort, also analysed here, indicated that family support was associated with 1-year change in physical activity at weekends, but not weekdays (Corder et al., 2013). In contrast, peer support was only associated with change in weekday physical activity. As this has implications for intervention design, stratification of analyses by week- and weekend-day is pertinent to inform context-specific intervention strategies.

The objectives of the current study are therefore to:

a) Describe 4-year change in the prevalence of meeting guidelines over the transition from primary to secondary school, and demographic characteristics of participants across four categories of physical activity maintenance:

- (i) Maintained below physical activity guidelines
- (ii) Maintained above physical activity guidelines
- (iii) Decreased from above to below physical activity guidelines
- (iv) Increased from below to above physical activity guidelines;

b) Identify family factors in childhood that are longitudinally associated with meeting physical activity guidelines at week and weekend days in adolescence.

2. Methods

2.1. Study design and participants

The SPEEDY study was conducted in Norfolk (UK) to examine individual and collective factors associated with (changes in) physical activity and dietary behaviour in schoolchildren. Ethical approval was obtained from the University of East Anglia Faculty of Health Ethics Committee. The longitudinal analyses presented here use data collected between April and July 2007 (SPEEDY-1), and May and July 2011 (SPEEDY-3). Full details on participant recruitment, study procedures and sample representativeness for the wider SPEEDY study have been described elsewhere (van Sluijs et al., 2008). Briefly, at baseline primary schools in Norfolk were purposively sampled to achieve heterogeneity in urban and rural locations; 92/157 schools approached participated in measurement sessions. All Year 5 children (aged 9–10 year, $N = 3619$) at participating schools were invited to participate; parents of 2064 children provided written informed consent (57% response rate) at baseline. Participants with an active postal address (and who had not withdrawn from the study) were contacted four years later (Year 9; aged 13–14 years). Due to ethical restrictions, we were unable to track individual participants through the school system, and re-recruitment was therefore only possible via the home address. At both time points, measurements were conducted during the school Summer term (April–July), with all variables assessed using the same methods. At follow-up, measurements were conducted at secondary schools with at least five responding participants; remaining participants were offered home visits.

2.2. Data collection

At baseline, trained staff conducted measurement sessions in schools, comprising physical measurements and the distribution of questionnaires (children completed questionnaires under supervision at school, parents at home) and accelerometers (van Sluijs et al.,

2008). Height was measured to the nearest millimetre using portable Leicester height measures, and weight to the nearest 0.1 kg using a non-segmental bio impedance scale (Tanita, type TBF-300A). Body mass index (kg/m^2) was calculated and children's weight status was derived using established protocols (Cole et al., 2000). Age and gender were self-reported during the baseline measurement session, and ethnicity was parent-reported using the UK standard classification (Office for National Statistics, 2015).

2.2.1. Physical activity

Physical activity was measured using waist-mounted ActiGraph accelerometers (GT1M, ActiGraph LCC, Pensacola, FL, USA), validated for the assessment of children's energy expenditure in free-living conditions (Eisenmann et al., 2004; Ekelund et al., 2001). Children were instructed to wear the accelerometer continuously on their right hip throughout waking hours for seven consecutive days, except when participating in water-based activities. The accelerometer was set to record activity counts in five-second epochs. Data were cleaned using specially designed software (MAHUFFE Processing Software, available at: http://www.mrc-epid.cam.ac.uk/Research/Programmes/Programme_5/index.html) to remove the first day of data collection and any days with <500 min of recording (defined as a valid day) (Mattocks et al., 2008). To be included in the weekday analysis, at least three valid weekdays were required (for weekend analysis, at least one weekend day was required); this cut-off was based on previous research in British schoolchildren (Mattocks et al., 2008). Periods of ≥ 10 min continuous zero counts were coded as non-wear time. (Mattocks et al., 2008) Data recorded after 11 pm and before 6 am were excluded, to ensure a focus on daytime activity. Average daily minutes of moderate-to-vigorous physical activity (MVPA), MVPA defined as ≥ 2000 cpm, corresponding to a walking pace of about 4 km/h in children (Trost et al., 1998). Those obtaining an average of 60 or more minutes of MVPA per day were labelled as 'meeting physical activity guidelines' (Chief Medical Officers of England Scotland Wales ANI, 2011), and this binary variable (at follow-up) was treated as the primary outcome for longitudinal analysis. Participants were also categorised as (1) Maintained below PA guidelines; (2) Maintained above PA guidelines; (3) Decreased from above to below physical activity threshold; (4) Increased from below to above physical activity threshold.

2.2.2. Family and home environment variables

Seventeen family and home environment variables, all questionnaire-reported and assessed at baseline, were included in this analysis (see Table 1 for a detailed description of the assessment and construction of variables). These included physical activity levels of parents, home and family environment variables (e.g. availability of play equipment and social support for physical activity). Parent-reported level of education was used as a proxy for family socio-economic status (SES), and, together with child sex and meeting physical activity guidelines at baseline (yes or no), included as confounders in all analyses.

2.3. Statistical analysis

Descriptive statistics were calculated for the demographic characteristics of the total sample, and for the four categories of physical activity maintenance. Multinomial logistic regression was conducted to identify significant differences in demographic factors between maintenance categories, and relative risk ratios presented. Relative risk ratios (RRR) demonstrate the probability of one group compared with another (e.g. boy vs. girls (reference group)) meeting physical activity guidelines at follow-up. A relative risk ratio of 4.2, for example, would indicate that boys are 4.2 times more likely to meet guidelines at follow-up than the girls. Using 'meeting MVPA guidelines at follow-up' as the outcome variable, multi-level logistic regressions were conducted for each exposure variable in turn, adjusting for sex, meeting physical activity guidelines at baseline, SES, and school-level clustering. Exposure variables

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