

SHORT REPORT

Accelerometers identify inactive and potentially obese children (EarlyBird 3)

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Accelerometers revealed a fivefold variation in physical activity among healthy 5 year old children. They singled out habitually inactive children, most of them girls, who did little, whether at school or over the weekend. Accelerometers are of potential value in identifying, from an early age, children at risk of becoming obese.

The relentless rise in childhood obesity is well documented, but it remains unclear how much of it is attributable to physical inactivity and how much to excess energy intake. Part of the problem lies in finding suitable methods to record caloric intake and physical activity (PA) in young children. Self report and heart rate monitors are impractical in this age group, but recently developed accelerometer based activity monitors provide a reliable, unobtrusive, and minimally invasive means of recording PA. This report analyses patterns of PA in 5 year old schoolchildren using accelerometers. The aims were twofold: to establish the range of PA undertaken by contemporary children; and to assess the feasibility of using activity monitors to screen for the habitually inactive child.

METHODS

EarlyBird is a prospective cohort study monitoring the effects of lifestyle on the metabolic status of healthy children, recruited at school entry from a random, stratified sample of Plymouth schools representing all socioeconomic groups. Informed consent and assent were obtained from parents and children, respectively, and ethical approval from the LREC. Detailed anthropometric measures were obtained at baseline.

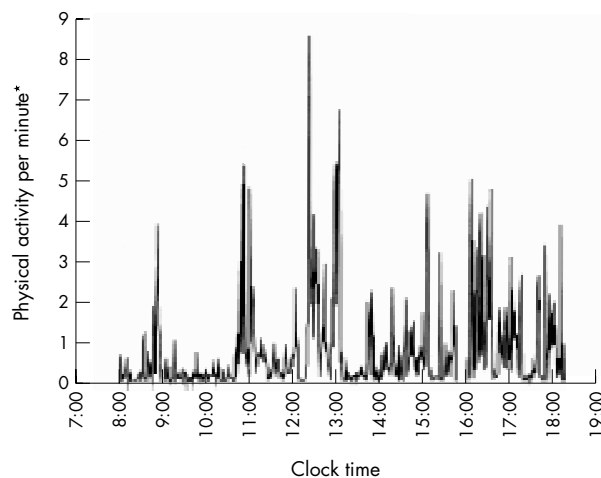


Figure 1 One day's physical activity recorded by a 5 year old child on a school day. *Arbitrary units ($\times 1000$) based on changes in acceleration in the vertical plane.

Each child was also fitted with a CSA (Computer Science and Applications) activity monitor to be worn, on the hip, during waking hours for seven consecutive days (five school days and both weekend days). This monitor is both lightweight and tamperproof. It records clock time and sums changes in acceleration in the vertical plane for each one minute interval, from which are displayed the timing, intensity, and duration of the child's PA. Data were downloaded to a PC by infrared linkage and analysed according to week/weekend day and gender. By way of an example, fig 1 shows the PA profile of a 5 year old child, recorded on a typical weekday. Relatively sedentary periods during school time are clearly interspersed with peaks of activity corresponding to morning break and lunchtime. Output from the CSA monitor is reported to be a useful measure of total PA in young children,¹ and our own studies show a test-retest correlation over 12 months of $r = 0.47$ ($p < 0.001$).

RESULTS

Baseline activity data from 100 consecutive recruits (mean age 4.8 years), were examined. Only data from those children who wore an activity monitor for at least four whole weekdays, and both weekend days, were used in the analysis. The instruments were well tolerated and only 18 children failed to meet the criteria. This report is therefore based on the remaining 82 (37 boys, 45 girls). The girls had slightly greater BMIs than the boys (16.3 v 15.6 kg/m^2 , $p = 0.03$) and carried substantially

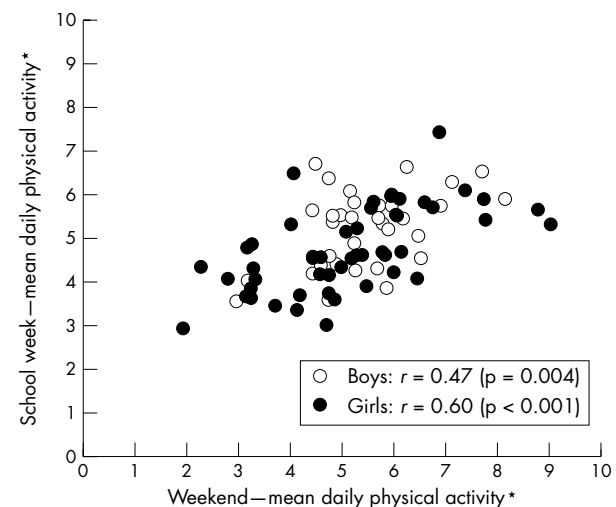


Figure 2 Comparison of mean daily physical activity on school days and weekend days. *Arbitrary units ($\times 100\ 000$) based on changes in acceleration in the vertical plane.

Abbreviations: CSA, Computer Science and Applications; PA, physical activity

more subcutaneous fat (sum of five skinfolds: $4.26 \nu 3.29\text{cm}$, $p < 0.001$).

Figure 2 shows the following:

- (1) Significantly less total PA was undertaken on school days than on weekend days (mean daily PA: $4.91 \nu 5.28$ units, $p = 0.006$).
- (2) The range of PA undertaken was less during the more structured school day than the weekend day (SD: $0.96 \nu 1.43$ units, $p < 0.001$). On school days, there was a 2.5-fold difference in accelerometer output between the lowest and highest totals, which rose to a 4.7-fold difference at weekends.
- (3) Boys were significantly more active than girls (mean daily PA: $5.26 \nu 4.81$ units, $p = 0.04$).
- (4) Importantly, there was a clear correlation in both sexes between the amount of PA undertaken on school days and at the weekend (girls: $r = 0.60$, $p < 0.001$; boys: $r = 0.47$, $p < 0.01$).

DISCUSSION

This is the first detailed study of physical activity in UK children so young. It establishes the CSA activity monitor as a credible means of measuring their activity and it provides a reference range for the PA undertaken by contemporary 5 year olds. The accelerometer is well tolerated and generates quality data from a high proportion (over 80%) of children.

Obesity is of concern, mainly because of the insulin resistance and metabolic disturbances with which it is associated.² We have shown elsewhere that insulin resistance in contemporary children is a function of excess weight gained since birth rather than weight at birth.³ The girls studied here were substantially fatter than the boys and they undertook significantly less PA. Indeed, 14 of the 16 children recording the lowest quintile of weekend activity were girls. The difference is striking and may help to explain the corresponding gender differences in cardiorespiratory fitness reported in older children.⁴ Importantly, those who suffer the metabolic consequences of obesity in adulthood tend to be those who were obese as children.⁵

Paradoxically, while schools are ideally placed to tackle the epidemic of childhood obesity, school attendance appears to impose a constraint on physical activity. Both girls and boys were significantly less active on school days than at the weekend. Physical education is arguably as important as academic education to the health of the nation, but the statutory minimum 45 minutes of physical education per week for the under sevens implies an imbalance. Not only is PA a modulator of excess weight gain in the long term, it has been shown to improve insulin sensitivity independently of body mass.⁶

Children who were inactive during the week were also inactive at the weekend. The high correlation between these scores in both sexes argues for the robustness of the CSA accelerometer as a measure of PA. It also means that those children most in need of help can be targeted. Although the relation between accelerometer readings and energy expenditure is likely to vary with type of activity, no other surrogate as practical as the accelerometer currently exists. The activity monitor could prove an important tool for "assessment" if schools are to take back responsibility for physical as well as academic education in pursuit of a healthier child.

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