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Characteristics of the activity pattern in normal weight and overweight boys

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ABSTRACT

Objective. To assess whether the activity pattern differs between normal weight and overweight boys across weekdays and weekend days.

Methods. Physical activity was recorded every 2 s by accelerometry in 32 normal weight and 15 overweight boys aged 8–10 years for four weekdays and two weekend days (South-West England 2007). Summary activity measures and activity pattern characteristics (frequency, intensity and duration of ≥4 s (short) and ≥5-min (long) bouts of ≥light, ≥moderate, ≥vigorous, and ≥hard activity) were recorded.

Results. Normal weight boys accumulated more ≥hard activity ($p<0.05$) but other summary measures did not differ by weight status. However, the activity pattern differed in overweight relative to normal weight boys. The most frequent short bouts were shorter and less intense ($p<0.05$). All long bouts were less intense and ≥moderate long bouts were shorter and less frequent ($p<0.05$). Overall, less activity was accumulated on weekends (frequency of more intense short bouts, intensity of most frequent long bouts and duration of ≥light, ≥moderate (and for overweight boys ≥vigorous) short bouts dropped-off) ($p<0.05$).

Conclusion. Despite equivalent summary activity measures overweight boys exhibited fewer and shorter bouts, particularly sustained ≥moderate bouts, relative to normal weight boys suggesting that the activity pattern may be important for weight control.

Introduction

Overweight children tend to have lower levels of activity and spend less time in activity of ≥moderate intensity than normal weight children (Page et al., 2005). However, whether sporadic activity, i.e. frequency, intensity, and duration of short activity bouts, differs between normal weight and overweight children is unknown. Although children's activity patterns are mostly sporadic, containing short, frequent bursts of activity (Bailey et al., 1995), physical activity assessed using accelerometry has typically been expressed on a minute-by-minute basis in children. Therefore, a major limitation of the existing literature is that the activity patterns of overweight/obese children (and children in general) have very rarely been assessed on a short-bout basis. Assessment of this pattern of activity in childhood is important as physiological responses affecting growth and development may vary according to activity patterns (Rowland, 1998).

Recently, aspects of the activity pattern that differ between weekdays and weekends were identified (Rowlands et al., 2008a). Since children potentially have more control over weekend free-time, inter-individual differences in the activity pattern might be maximized on weekend days (Page et al., 2005). Investigation of whether the activity pattern differs between normal weight and overweight children could inform the structure of activity interventions targeting overweight children. Therefore, the aim of this study was to assess whether, a) activity levels and b) aspects of the activity pattern differ between normal weight and overweight boys across weekdays and weekend days.

Methods

Fifty-four boys, aged 8 to 10 years, were recruited from schools in Devon and assessed between October 2006 and March 2007. Stature and seated stature were measured to the nearest 0.1 cm and body mass to the nearest 0.1 kg. Boys were classified as a) normal weight ($N=38$) or b) overweight ($N=16$) using UK BMI age- and sex-specific cut-points (Cole et al., 1995). This classification uses the 85th percentile of the 1990 UK data as a cut-off point for overweight. Experimental protocols received Institutional Ethics approval and parental informed consent and child assent was obtained.

Participants wore an ActiGraph GT1M accelerometer (ActiGraph, LLC, Pensacola, FL), set to record data every 2 s, for seven days. Thresholds for the classification of moderate (MPA: 4–6 METS, 3581–6130 counts min^{-1}) and vigorous (VPA: >6 METS, >6130 counts min^{-1}) activity were taken from Mattocks et al. (2007). Thresholds for sedentary behaviour (SB: 0–300 counts min^{-1}), light (LPA: 300–3581 counts min^{-1}) and hard (HPA: >9630 counts min^{-1}) activity were taken from Stone et al. (2009a). The thresholds of Stone et al. (2009a) were created from high-frequency accelerometer data (counts $2\ s^{-1}$) and have been translated into counts min^{-1} for the purpose of this paper. To describe 2 s accelerometer data, the thresholds of Mattocks et al. (2007) (which are expressed in counts min^{-1}) have been divided by 30. Output measures included total activity (TPA), accumulated minutes in SB,

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Table 1
Descriptive data for normal weight ($N=32$) and overweight ($N=15$) participants (South-West England 2007).

Variable	Normal weight (NW)			Overweight (OW)		
	Mean or median	SD or IQR	Range	Mean or median	SD or IQR	Range
Age (y)	9.3	8.9,9.8	8.3–10.1	9.5	0.5	8.4–10.1
Height (cm)	132.1	129.4,138.4	109.0–144.0	139.9[a]	7.8	130.0–155.0
Weight (kg)	28.4	3.8	17.4–34.9	40.4[a]	7.4	31.4–52.0
Body mass index (kg m^{-2})	16.2	1.1	13.7–18.0	19.9[a]	18.8,21.6	18.3–26.3
Sitting height (cm)	67.3	3.2	60.0–74.0	71.8[a]	3.3	68.0–80.0

SD = standard deviation; IQR = inter-quartile range.
[a] Significantly higher in OW boys ($p<0.01$).

LPA, MPA, VPA and HPA and frequency, intensity and duration of ≥4 s (short) and ≥5-min (long) bouts of ≥light (≥LIGHT), ≥moderate (≥MOD), ≥vigorous (≥VIG), and ≥hard (≥HARD) activity. Short bouts include all bouts which are greater than or equal to 4 s in duration. For analyses of ≥5-min bouts, up to 30 s of data (10%) were allowed to drop below the threshold based on previous recommendations (Masse et al., 2005). This allowed for a brief interruption in the activity bout if, for example, the child was to stop to re-tie their shoelace. For inclusion in data analysis, each child needed a minimum of 10 h of wearing time for at least three weekdays and one weekend day (Rowlands et al., 2008a). Activity data were analyzed between 6:00 AM and 9:00 PM (Rowlands et al., 2008a).

Statistical analyses

Descriptive statistics were calculated for all variables. A series of two-factor mixed-model ANOVAs (weight status by day (weekday/weekend)) were used to determine whether there were differences in, a) overall activity (TPA, SB, LPA, MPA, VPA, HPA) and, b) activity pattern (frequency, intensity and duration of ≥4 s and ≥5-min bouts of ≥LIGHT, ≥MOD and ≥VIG activity per day (≥HARD, ≥4 s bouts only)). Post-hoc analyses were carried out using the Tukey's test adapted for repeated measures. Alpha levels of 0.05 were used for all statistical tests. All analyses were performed using SPSS version 11 for Windows (SPSS Inc., Chicago, IL).

Results

Seven participants were eliminated due to incomplete activity data. Forty-seven participants ($N=47$) were included; 32 were classified as normal weight (NW) and 15 as overweight (OW) (Cole et al., 1995). There were no significant differences in age between groups ($t_{45}=-0.9$, $p=0.353$). However, standing height ($t_{45}=$

Table 2
Descriptive data for weekday and weekend short bouts (≥4 s) and long bouts (≥5 min) of physical activity for normal weight (NW; $N=32$) and overweight (OW; $N=15$) boys (South-West England 2007).

Output measure	Weekdays		Weekend days	
	NW	OW	NW	OW
TPA (counts day^{-1})[a]	517741;443779,587203	529083;400531,600875	432523;346493,556515	378872;345509,483431
SB (min day^{-1})[a]	694;677,721	677;657,728	714;676,754	729;694,743
LPA (min day^{-1})[a]	155;138,172	171;139,179	150;115,172	142;126,166
MPA (min day^{-1})[a]	34;28,38	33;22,39	27;19,38	23;20,28
VPA (min day^{-1})[a]	9;8,14	8;6,13	8;6,14	7;5,10
HPA (min day^{-1})[a,b,c]	3;2,5	2;1,5	2;1,4	1;0,3[d,e]
≥LIGHT, ≥4 s bouts				
Frequency (per day)	910;819,1006	997;835,1097	908;794,989	928;870,1053
Intensity (counts 2 s^{-1})[b]	66;64,69	63;60,68	66;61,73	61;58,67
Duration (s)[a,b]	12.2;11.1,13.3	11.2;10.6,12.4	11.1;9.8,12.3	9.9;9.0,11.4
≥MOD, ≥4 s bouts				
Frequency (per day)[a]	288;255,336	247;196,339	238;175,343	209;137,270
Intensity (counts 2 s^{-1})	192;184,205	192;185,194	195;184,205	188;181,197
Duration (s)[a]	7.2;6.6,8.2	6.9;6.6,7.5	6.5;5.7,7.6	6.1;5.4,6.6
≥VIG, ≥4 s bouts				
Frequency (per day)[a]	63;51,117	64;38,91	49;35,102	42;18,61
Intensity (counts 2 s^{-1})	288;276,297	285;265,300	287;276,297	277;269,292
Duration (s)[a,c]	5.5;5.0,6.1	5.9;5.0,7.6	5.2;4.8,7.1[e]	4.8;4.6,5.6[d,e]
≥HARD, ≥4 s bouts				
Frequency (per day)[a]	12;6,16	9;4,17	8;3,12	4;1;11
Intensity (counts 2 s^{-1})	414;398,438	417;405,453	407;392,455	399;365,432
Duration (s)	5.0;4.7,6.8	5.3;4.5,8.9	5.8;4.4,8.5	4.7;4.0,6.0
≥LIGHT, ≥5 min bouts				
Frequency (per day)	16;13,17	18;14,20	14;10,19	15;13,20
Intensity (counts 2 s^{-1})[a,b]	60;51,65	51;47,57	50;44,65	41;38,46
Duration (s)	714.7;625.4,754.9	677.6;604.4,713.6	655.7;569.2,823.6	619.6;532.8,696.4
≥MOD, ≥5 min bouts				
Frequency (per day)[b]	4;3,5	2;1,3	2;1,4	2;1,3
Intensity (counts 2 s^{-1})	111;96,124	93;69,116	110;94,126	95;55,120
Duration (s)[b]	448.2;382.0,516.3	391.6;258.3,480.7	444.5;373.3,507.1	340.0;239.2,435.0
≥VIG, ≥5 min bouts				
Frequency (per day)	0.3;0.0,0.8	0.0;0.0,1.0	0.0;0.0,0.9	0.0;0.0,0.5
Intensity (counts 2 s^{-1})	29;0,95	0;0,91	0;0,121	0;0,58
Duration (s)	75.5;0.0,195.0	0.0;0.0,179.8	0.0;0.0,245.8	0.0;0.0,154.0

Median; inter-quartile range displayed.
[a] Weekday/weekend difference (main effect, $p<0.05$).
[b] Weight status difference (main effect, $p<0.05$).
[c] Weight status × type of day interaction ($p<0.05$).
[d] Significantly different across type of day ($p<0.05$); refers to those aspects of activity which differ significantly between weekdays and weekend days.
[e] Significantly different across weight status ($p<0.05$); refers to those aspects of activity which differ significantly between normal weight and overweight boys.