

Validation of the Phillips et al GENEActiv accelerometer wrist cut-points in children aged 5-8 years old

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1 **Validation of the Phillips et al GENEActiv accelerometer wrist cut-points in**
2 **children aged 5-8 years old.**

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4

5 **Abstract**

6 This study examined the accuracy of the Phillips et al. GENEActiv accelerometer wrist
7 worn cut-points in children aged 5-8. Fifteen children (6 girls, 9 boys) aged 5-8 years
8 wore a GENEActiv monitor on their non-dominant wrist while undertaking 5 minute
9 bouts of lying supine, playing Lego, walking at slow, medium and fast pace and
10 running. Receiver Operating Curve (ROC) analysis was employed to establish how
11 well the Phillips et al (2013) cut points classified intensity of the activities compared to
12 the actual intensity determined by indirect calorimetry. Area Under the Curve (AUC)
13 values were high for sedentary (.970), moderate (.815) and vigorous (.974) activity.

14 *Conclusion:* The Phillips et al (2013) cut-points for the GENEActiv accelerometer can
15 be used in children aged 5-8 years old to distinguish sedentary behaviour, moderate
16 and vigorous PA behaviour.

17

18 **What is Known:**

- 19 • Accelerometers are fast becoming the most widely used measure of physical
20 activity in public health research.
- 21 • The GENEActive wrist worn accelerometer has been validated for use with
22 children aged 8 years and older

23 **What is New:**

- 24 • The GENEActive wrist worn accelerometer can be used to assess physical
25 activity in children aged 5-8 years old.

- 26 • Previously established cut-points for the GENEActiv accelerometer can be
27 used in children aged 5-8 years old to distinguish sedentary behaviour,
28 moderate and vigorous PA behaviour.

29

30 Keywords: Accelerometry; Physical Activity; Validation; Preschoolers

31 **List of Abbreviations**

32 AUC: Area Under the Curve

33 BMI: Body Mass Index

34 MET: Metabolic Equivalent

35 PA: Physical Activity

36 ROC: Receiver Operating Curve

37

38

39 **Introduction**

40 Accelerometers are becoming the most widely used measure of physical activity (PA)
41 in public health research [1] and there are multiple accelerometry based devices now
42 available that purport to assess PA and sedentary behaviour. Recently, the
43 GENEActiv accelerometer has gained popularity with researchers as a means to
44 assess PA, particularly because it is designed to be worn on the wrist, is waterproof
45 has relatively long battery life, comparable to other monitors. The GENEActiv has been
46 shown to be reliable and valid measure of PA in adults [2] and children [3].

47 Given PA recommendations for health emphasise accumulation of moderate to
48 vigorous PA, [4] accelerometry based PA often use cut-points to determine the time
49 spent in different intensities of PA [1]. Only one study has established wrist-mounted
50 cut-points for British children and only for children aged 8 years or older [3]. To our
51 knowledge no authors have examined the validity of these cut-points in children under
52 the age of 8. This study examined how well the Phillips et al [3]. cut-points for
53 sedentary, moderate and vigorous PA performed on an independent sample of British
54 children aged 5-8 years old.

55

56 **Method**

57

58 *Participants*

59 An opportunistic sample of 15 healthy, Caucasian, children (6 girls, 9 boys) aged
60 between 5 and 8 years of age (6.8 ± 1.4 years) from central England took part in this
61 study following institutional ethics approval, parental informed consent and child
62 assent. Mean \pm SD of height, mass and body mass index (BMI), was 1.3 ± 0.1 m, 27.1
63 ± 7.1 kg and 16.5 ± 2.3 kg/m² respectively.

64 *Procedures*

65 Participants wore a GENEActiv monitor on their non-dominant wrist, similar to other
66 work [5], throughout the testing period. The GENEActiv has been described in detail
67 previously [2]. The GENEActiv was set to record at 80Hz and 1s epochs. Throughout
68 the testing procedure VO_2 and VCO_2 were assessed using a MetaMax 3B (Cortex
69 Biophysik GmbH, Leipzig, Germany) breath by breath gas analyser. Participants wore

70 a junior face mask (Hans Rudolph) and the MetaMax was calibrated with gases of
71 known concentration each day prior to commencing testing. All testing took place in
72 the morning (9am-12pm). Prior to beginning the protocol, each participant was fully
73 familiarised with the treadmill being used in the study (Woodway Inc, Wisconsin, USA).
74

75 After briefing and fitting with the GENEActiv monitor and gas analyser, each
76 participant performed a series of activities reflective of different levels of PA. These
77 were lying supine, seated and playing with Lego, slow walking, medium walking, fast
78 walking and a medium run. These were performed in order as per prior work [3]. All
79 activities were performed for 5 minutes with a 5 minute rest in between. Using previous
80 protocols [6,7] as guidelines, walking and running speeds were set at 3kmph⁻¹,
81 4.5kmph⁻¹, and 6kmph⁻¹ to represent slow, medium and fast pace walking and 8kph⁻¹
82 was used for running. Upon completion of the protocol, each participant's
83 accelerometer and calorimetry data was downloaded and stored on a computer. The
84 first and last minute of each bout were discarded leaving a 3 minute period for analysis.
85 This ensured that MET values for each bout were at the required intensity. Using the
86 GENEActiv post processing software, the raw 80Hz triaxial GENEActiv data were
87 summed into a signal magnitude vector (gravity subtracted) expressed in 1s epochs,
88 as is conventional [2, 3]. The VO₂ values were then converted into METs using age-
89 specific values [8] and coded into one of four intensity categories (sedentary < 1.5
90 METs), light (1.5-2.99 METs), moderate (3-5.99 METs) and Vigorous (>6 METs).

91 The accelerometer counts were coded into sedentary, light, moderate and
92 vigorous intensities using previously validated cut-points for the non-dominant hand
93 [3]. The counts were then coded into binary indicator variables (0 or 1) based on
94 intensity (sedentary versus >sedentary, less than moderate versus moderate to

95 vigorous, and vigorous versus <vigorous) in order for a Receiver Operator
96 Characteristic (ROC) curve analysis to be conducted as described previously [2]. In
97 this way we sought to compare how well the Phillips et al [3]. cut points for children
98 could classify intensity of the activities compared to the intensity determined by indirect
99 calorimetry and thus provide cross validation of their cut-points. ROC analysis was
100 undertaken using the Statistical Package for Social Sciences (SPSS, version 21).

101

102 **Results**

103 Table 1 shows the AUC, sensitivity and specificity for the Phillips et al [3]. cut-points
104 in correctly distinguishing the breath by breath derived MET values, alongside mean
105 \pm SD of METs for each intensity activity. ROC analysis indicated that the Phillips et al
106 [3]. cut-points were able to successfully discriminate between all intensity levels.
107 Sedentary and vigorous activity were the easiest to classify showing the largest AUC
108 with light activity being the most difficult to classify and indicating the Phillips et al [3].
109 cut-points for light activity were only able to correctly classify this intensity of activity
110 62% of the time.

111

112 ****Insert Table 1 Here****

113

114 **Discussion**

115 This study sought to provide cross-validation of the Phillips et al [3]. cut-points for the
116 wrist worn GENEActiv accelerometer in British children aged 5-8 years of age. No

117 study to date has examined GENEActiv determined cut-points for PA in British children
118 below the age of 8 years. The results of the present study support of the validity of the
119 Phillips et al [3]. cut-points in British children aged 5-8 years of age for sedentary,
120 moderate and vigorous PA. There was relatively poorer performance for light cut-
121 points. This may be because there is greater 'noise' in light PA for younger children,
122 making it more difficult to distinguish from sedentary activity [1]. Given that children
123 spend a large proportion of time in light PA there is a need to better classify light PA
124 using the GENEActiv to avoid misreporting of PA. The data presented here, based on
125 laboratory based activities that were predominantly ambulatory in nature, suggest that
126 the Phillips et al [3]. cut-points can distinguish sedentary, moderate and vigorous PA
127 well. As locomotor activity is however the predominant activity in an individual's day
128 the validation of accelerometers during this activity is of primary importance [9]. The
129 protocol employed in the present study is comparable to those used previously to
130 validate accelerometers in pediatric populations [3, 7]. However, the study is limited
131 by the relatively small sample size. The time commitment needed by participants,
132 particularly given their age, limited our ability to recruit a larger sample. Post-hoc
133 power calculations indicate statistical power was 0.69, with an effect size of 0.25 and
134 $P = 0.05$. We also used a fixed order of activities moving from sedentary to vigorous,
135 as per other work [3]. This might also be a limitation given the sporadic nature of
136 children's PA and the possibility of an order effect where fatigue from earlier activity
137 bouts may have influenced later activity bouts. METs were used as the criterion for the
138 cut-points, as per other studies [3]. However, using a percentage of METs at VO_2 max
139 as a criterion may be preferable in future work. Although we captured accelerometer
140 data across a range of PA intensities, including inactivity, future research would be

141 welcome examining the accuracy of the GENEActiv accelerometer during other free
142 living activities.

143

144 **Author Contribution:** MD and EE devised the Study. MD, SW, JT and EE collected
145 data and wrote the manuscript. MD performed statistical analysis.

146 **Compliance with Ethical Standards:** All procedures performed in studies involving
147 human participants were in accordance with the ethical standards of the institutional
148 and/or national research committee and with the 1964 Helsinki declaration and its later
149 amendments or comparable ethical standards

150 **Conflict of Interest:** None

151

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182 Table 1. Area under the curve (AUC), sensitivity (%) and specificity (%) of the Phillips
 183 et al. (2013) wrist worn cut-points in classifying physical activity intensity from indirect
 184 calorimetry in a sample of British children aged 5-8 years old (Data collected 2016).

| Intensity | AUC | Sensitivity (%) | Specificity (%) | METS Mean (S.D.) |
|-----------|------|--------------------|--------------------|---------------------|
| Sedentary | .970 | 92 | 90 | 1.31 (0.24) |
| Light | .621 | 81 | 56 | 2.29 (0.47) |
| Moderate | .815 | 97 | 83 | 4.11 (0.4) |
| Vigorous | .974 | 96 | 84 | 6.35 (0.5) |

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