Validation of the RT3 in the measurement of physical activity in children

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Summary
The aim of this study was to assess the absolute validity of the RT3 accelerometer in children in the estimation of energy expenditure in inactivity, walking and running and would thus appear appropriate for the objective measurement of physical activity levels.

The RT3 (Stayhealthy Inc.)* is a triaxial accelerometer that integrates acceleration from three planes to yield a vector magnitude. Its predecessor, the TriTrac has been validated in adults and children in both laboratory and field settings.3,4 The TriTrac can distinguish between light, moderate and vigorous activity,1,2 and has been found to be a valid measure of energy expenditure in both boys and men in a number of activities.5

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setting. Validity was examined in terms of limits of agreement.

Method

Twenty children (8 girls and 12 boys) aged between 7 and 12 years, with no contraindications to physical activity, were included in the study. Exclusion criteria were any neurological or musculoskeletal conditions. Parents and subjects were briefed on the protocol and safety, and written consent was obtained. Approval for this study was granted by the Human Ethics Committee of Trinity College Dublin. Subjects were recruited through staff in the School of Medicine.

Subjects were requested not to eat for 3 h before commencement of the test to avoid the influence of the thermal effects of food on energy expenditure. Height was measured to the nearest 0.1 cm using a stadiometer (Seca 220) and weight was measured to the nearest 0.1 kg using a Seca electronic scales. Participants were familiarized with the treadmill (Viasys LE 300 CE), fitted with the RT3 accelerometer (Stayhealthy Inc.) and a face mask attached to the Oxycon mobile system.

At the start of testing the subject had an initial 10 min period of inactivity to collect baseline/inactivity data. Subjects watched a DVD during rest periods and were requested to reduce extraneous movements so as to minimize expired air changes. Each exercise was performed for 5 min followed by a 5 min rest period where the subject was seated in a chair placed on the treadmill. The exercises were: walking at 3 km$^{-1}$, brisk walking/running at 6 km$^{-1}$, brisk walking/running at 6 km$^{-1}$ on an incline of a 10% gradient, and running at 9 km$^{-1}$. For safety reasons a research assistant stood beside the treadmill at all times and the child could lightly place his/her hands on the cross bar if required. It was decided a priori (based on pilot work in this laboratory) that the final exercise of running on the treadmill at 9 km$^{-1}$, would not performed by subjects under 8 years of age (six subjects). Throughout the testing process the child was verbally encouraged to maintain the pace.

Expired respiratory gases were collected and oxygen consumption was measured on a breath by breath basis using the Oxycon mobile system (Viasys Healthcare) which has been validated. The light-weight portable system records data breath-by-breath collected through a facemask which is sent to the host computer via telemetry. The system was calibrated daily with standard gases. The sensorbox and data exchange unit were attached to the cross arm of the treadmill.

The age, gender, height and weight were entered into the RT3 to set a profile from which activity and total energy expenditure is calculated. The RT3 unit was attached to the waistband on the right side. The same accelerometer was used by all subjects.

Following each exercise session, the data from the RT3 was downloaded. The metabolic measures were collected continuously from 5 min prior to the beginning of the first 5 min resting period to the completion of the final stage of the running at 9 km$^{-1}$. The data used for comparison between the methods was the average of the last 2 min of each activity.

The data were expressed graphically in means and confidence intervals for each activity with both measures (repeated measures). Limits of agreement and 95% confidence intervals between the measures were calculated, according to the method described by Bland and Altman. Pearson product-moment correlation coefficients were also calculated for the energy expenditure data with both methods for each activity. SPSS (version 12) was used for data analysis and Prism software was used for creating the graphs. This study had 80% power to detect a smallest average difference between pairs of 0.33 with a significance level of 0.05.

Results

Twenty children (8 girls and 12 boys) completed the study. The mean age and 95% CI was 10.2 (9.1, 11.3) years in the girls and 8.2 (7.5, 8.9) years in the boys. The heights and weights were 144 (134.5, 153.5) cm and 37.7 (30.6, 44.8) kg in the girls and 136 (129.9, 142.1) cm and 30.8 (26.5, 35.1) kg in the boys.

Fig. 1 presents the means and 95% confidence intervals of energy expenditure in kcal min$^{-1}$ with both methods for each activity. There was no significant difference between the two measures for most activities (other than 6 km$^{-1}$) as can be seen by the confidence intervals on the repeated measures. Pearson correlations between the two methods for each activity measured ranged from $r=0.56$ for walking at 3 km$^{-1}$ to $r=0.84$ for running at 9 km$^{-1}$ (all $P<0.01$). Fig. 2 presents the limits of agreement of energy expenditure measured by the RT3 and physiological energy expenditure for baseline, 3 and 6 km$^{-1}$.

The limits of agreement between the two measures were found to be very close for inactivity and walking at 3 km$^{-1}$. Walking at 6 km$^{-1}$ on an incline of ten degrees and on the level and running at 9 km$^{-1}$ showed slightly wider limits of agree-

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Figure 1  Means and 95% confidence intervals of energy expenditure measured by gas analysis (indirect calorimetry) and estimated by the RT3 accelerometer.

Figure 2  The limits of agreement of energy expenditure for baseline, 3 and 6 km h⁻¹.

time spent inactive may also be a focus of research. Rowlands et al.⁵ investigated correlations between the RT3 activity counts for unregulated activities (which included hopscotch, kicking a ball and sitting). It is difficult to interpret the relationship between activity counts and VO₂ for sitting as the analysis was performed for all regulated activities combined. The validity of the RT3 in measuring other typical activities across bio-mechanically diverse activities warrants investigation and could be done with the portable gas analysis system.

The ability to detect periods of inactivity is of particular importance when studying activity levels as so much of the day is spent sedentary in both adults and children. The ability of the RT3 to measure inactivity accurately does provide a means of determining periods of inactivity in those with and at risk of diseases associated with inactivity. The monitor can be worn during most activities of daily life and as it is unobtrusive does not interfere with regular activity.

In summary the RT3 was found to be a valid measure of walking and running at speeds of 3, 6 and 9 km h⁻¹ in this cohort of children aged 7—12 years. In addition the RT3 permits classification of specific activity levels. On the basis of these findings the use of the RT3 accelerometer was deemed appropriate for the objective measurement of physical activity in children.

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References