

Accuracy of Wrist-worn Physical Activity Monitors to Measure Energy Expenditure

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ABSTRACT

In recent years, the popularity and demand of physical activity monitors has drastically risen with the need and want to improve physical fitness. Newer devices worn on the wrist measure both heart rate and energy expenditure but the accuracy of these measurements is unclear. **PURPOSE:** To measure the accuracy of three separate wrist-worn activity monitors to estimate energy expenditure during structured periods of aerobic exercise. **METHODS:** Twelve men and three women (22 ± 3 years, 25 ± 3 kg/m²) consented to participate in this study. Three different physical activity monitors, TomTom Cardio (TT), Microsoft Band (MB), and Fitbit Surge (FB), were randomly assigned to either the left or right wrist of each participant. The instructions for the testing procedure were thoroughly explained to every participant at the start of each trial. The treadmill started at a speed of 2 mph and increased by 1 mph every three minutes up to a max speed of 6 mph. Energy expenditure was estimated through direct measurement of oxygen consumed and carbon dioxide produced through a metabolic cart (MC, Parvo Medics True One @2400). The mean bias in energy expenditure between MC and each device was calculated. Pearson product-moment correlations and 95% equivalence testing were also calculated. Statistical significance was set at an alpha level of 0.05. **RESULTS:** The mean bias between the MC and devices at 2 mph varied from -1.9 ± 1.1 kcal/min (FB) to 0.7 ± 1.0 kcal/min (MB) while the mean bias at 6 mph varied from -1.7 ± 2.1 kcal/min (MB) to 5.2 ± 1.7 kcal/min (TT). For total energy expenditure, all devices were significantly correlated with the MC (FB: $r=0.66$, $p=0.007$; TomTom: $r=0.77$, $p<0.001$; MB: $r=0.59$, $p=0.02$). The mean bias for total energy expenditure was -25 ± 16 kcal for the FB, 26 ± 13 kcal for the TT, and -11 ± 17 kcal for the MB. The equivalence zone for MC was 88 kcal to 108 kcal but 90% confidence intervals of devices did not fall within this zone. **CONCLUSION:** The wrist-worn physical activity monitors used in this study that measure heart rate and energy expenditure tend to either underestimate or overestimate total energy expenditure from treadmill walking and running.