

## Validity of Wrist-worn Physical Activity Monitors to Measure Heart Rate

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### ABSTRACT

Numerous physical activity monitors exist and are used to track and improve fitness levels. Due to the increasing popularity of these devices, newer products have been developed that measure heart rate (HR) at the wrist. Little is known about how accurate these devices are at measuring HR at the wrist and how they compare to each other. **PURPOSE:** To determine how accurately HR was measured by three different wrist-worn physical activity monitors. **METHODS:** Recreationally active men (n=9) and women (n=3) participated in this study. The average age and weight of participants was  $22 \pm 3$  years and  $73.9 \pm 12$  kg. TomTom Cardio (TT), Fitbit Surge (FB) and Microsoft Band (MB) physical activity monitors were used. The TT, FB, and MB were randomly assigned to the right or left wrist for each participant. The testing procedure included speeds of 2, 3, 4, 5, and 6 mph with each speed lasting three minutes. HR was measured by electrocardiography (ECG) using standard limb lead II and by the three different physical activity monitors. HR was recorded from each device every minute throughout the duration of the procedure. Pearson product moment correlations and bias between electrocardiography (ECG) and physical activity monitors with 95% limits of agreement (Bland-Altman analysis) were calculated. Repeated measures ANOVA [Speed x Device] were also calculated. Statistical significance was set at  $p < 0.05$ . **RESULTS:** At 2 mph and 3 mph, only TT HR was significantly correlated with ECG heart rate ( $r = 0.693$ ,  $p = 0.012$  and  $r = 0.592$ ,  $p = 0.043$ ). At 4 mph and 6 mph TT was significantly correlated with ECG ( $r = 0.911$ ,  $p < 0.001$  and  $r = 0.853$ ,  $p < 0.001$ ). Significant correlations were calculated between FB and ECG at 4 mph ( $r = 0.691$ ,  $p = 0.013$ ), 5 mph ( $r = 0.953$ ,  $p < 0.001$ ) and 6 mph ( $r = 0.924$ ,  $p < 0.001$ ). Only FB had a significantly different HR than the ECG at 2 mph (99 vs 85 bpm,  $p = 0.037$ ). The largest mean bias was found between ECG and FB at 2 mph [ $-13$  bpm  $\pm$  24 bpm (95% limits of agreement)], while the smallest mean bias was found between TT and ECG [ $-2$  bpm  $\pm$  12 bpm (95% limits of agreement)]. **CONCLUSION:** With increasing speeds, physical activity monitors more accurately measure HR but individuals should be aware that these devices may overestimate HR during slower walking speeds.