Validation of a Wrist-Mounted Photoplethysmography Device During Graded Exercise Testing

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The electrocardiogram (ECG) serves as the gold standard of heart rate (HR) monitoring but is rarely used outside of a clinical environment. Newly developed wearable technology is more usable outside of a clinical setting, but has not been validated against this gold standard. Increased ease of use as well as increased portability will allow for more flexible study design. **PURPOSE**: The purpose of this study is to determine the validity of a wrist mounted photoplethysmography (PPM) device used for measuring HR during incremental treadmill exercise using ECG as the criterion HR measurement. **METHODS**: Twenty-two subjects (13 men, 9 women; 35.8 ± 6.3 yr, 14.6 ± 7.5 % body fat, VO_2max: 55.5 ± 0.49 ml·kg^{-1}·min^{-1}) performed a Bruce treadmill protocol graded exercise test. HR was recorded at rest and at the end of each minute with the Mio Alpha PPM device and ECG simultaneously. HR was compared between methods across the entire testing session (rest and exercise values) and separately for each exercise test stage using paired-samples t-tests. Validity coefficients were determined using the Pearson correlation. **RESULTS**: HR across the entire intensity range (rest to maximal exercise) exhibited a significant correlation between methods ($r = 0.97$, $p < 0.001$). However, HR was significantly different (overall mean HR: ECG = 124 ± 39 b·min^{-1}, Mio = 123 ± 37 b·min^{-1}, $t_{359} = -2.504$, $p = 0.013$). Significant correlations were observed at rest and each exercise test stage, with r values ranging from 0.67 to 0.96 (all $p < 0.001$). HR was significantly different between methods at rest (ECG = 66 ± 13 b·min^{-1}, Mio = 68 ± 16 b·min^{-1}), stage 3 (ECG = 144 ± 13 b·min^{-1}, Mio = 143 ± 13 b·min^{-1}, $p = 0.014$), stage 4 (ECG = 168 ± 13 b·min^{-1}, Mio = 164 ± 14 b·min^{-1}, $p = 0.004$), and stage 5 (ECG = 178 ± 12 b·min^{-1}, Mio = 173 ± 18 b·min^{-1}, $p = 0.039$). **CONCLUSION**: Correlational analyses indicated a strong agreement between HR methods overall, as well as individually at rest and during each exercise test stage. However, mean comparisons observed significant differences between methods. From a practical standpoint, the mean difference between methods did not exceed 3 b·min^{-1} except for stage 5. Therefore, a PPM device may not provide accurate HR monitoring at maximal exercise intensities.