Comparison Between Smartwatch-Derived and CPET-Measured VO₂max

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Background. Maximal oxygen consumption (VO_2max) during exercise and the percentage of predicted VO_2max (%pVO_2max) are standard measures of cardiorespiratory fitness with established clinical predictive value. They are usually measured during a cardiopulmonary exercise test (CPET), which requires expensive equipment and experienced personnel. Novel smartwatches estimate VO_2max using proprietary algorithms, but their accuracy remains undetermined.

Aims. To determine smartwatch device accuracy in estimating VO_2max and %pVO_2max using data from CPET as a reference.

Methods. 215 adults (44 (21%) male; median [interquartile range; IQR] 56 [32, 62] years old) were recruited from two population-based cohorts, the Avon Longitudinal Study of Parents and Children (ALSPAC) and TwinsUK. Participants performed a maximal CPET on a semi-recumbent bike to measure VO_2max and wore a Garmin Vivoactive 4s (GV4) smartwatch for 60 days following CPET. The first and last VO_2max estimates provided by GV4 were compared to CPET measures. %pVO_2max was measured using predicted VO_2max from Wasserman and Whipp's anthropometric-based equations. In a subgroup wearing the smartwatch during CPET, peak heart rate (HR) from GV4 and CPET was also compared. Agreement was assessed using Bland-Altman analysis (bias and limits of agreement (LoA)), absolute percentage error (APE), reported as median [interquartile range], and Pearson's correlation coefficient (cc).

Results. VO_2max and %pVO_2max measured during CPET was 22.4 [17.5, 27.4] ml/kg/min and 90.9% [78.1%, 101.3%], respectively. VO_2max estimates from GV4 were moderately correlated with CPET measures (cc=0.62 and 0.66 for first and last estimates) and showed a large positive bias ~14 ml/kg/min with LoA from 0 – 27 ml/kg/min. Correlation between VO_2max from GV4 and anthropometric-based prediction of VO_2max was high (cc>0.90). Agreement between %pVO_2max from GV4 and CPET was poor (cc~0.15, bias ~52%, LoA 7-98 %).

Conclusions. GV4 provides estimates of VO_2max that overestimates but moderately correlates with CPET measured VO_2max. The agreement for %p VO_2max is poor.