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Validation of PerformTek® Wrist Based Heart Rate Sensor

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Overall Summary

Examination of PerformTek® wrist based biometric sensor (n=51 tests) resulted in valid data when compared to chest strap benchmark. Similar group means, low percent error and bias, high correlations in combination, appropriate frequency distribution and similar rates of poor tracking indicate the PerformTek® wrist based device provides similar validity as chest strap sensors under these conditions.

Statistical Summary

Device	Number of tests analyzed	Group means ($\bar{x}$±SD)	Percent error	Bias	Correlation (r^2)	Data distribution % between -5 to 5 from benchmark	95% confidence lower	95% confidence upper
Standard chest strap (CSHRM)vs BTLE chest strap (BTLECS)	20	CSHRM=115±23 BTLECS=114±24	2.4%	-0.8	0.89	88%	-17.0	15.5
PerformTek wrist (PTW) vs CSHRM (excellent and good)	44	CSHRM=125±26 BTLECS=125±26	2.6%	0.1	0.96	85%	-10.5	10.6
PerformTek wrist vs CSHRM (all quantitatively scored tests)	51	CSHRM=125±26 BTLECS=126±26	3.9%	1.3	0.87	81%	-18.1	20.8

PURPOSE

This report examines the accuracy of Valencell, Inc.'s PerformTek® wrist sensor for measuring heart rate during exercise.

INTRODUCTION

Healthy living has seen a global resurgence as people place more value on staying active to live more fulfilling, healthier and longer lives. In this environment, fitness applications enjoy a meteoric rise across mobile phones, gaming and consumer fitness products. Workout efforts are optimized when receiving feedback on target heart rate zones and physical activity (Jeukendrup and Van Diemen, 1998). Additionally, heart rate monitoring of training intensity provides more accurate information than self-reports of training intensity (Gilman and Wells, 1993). The American College of Sports Medicine reports that heart rate monitoring has been shown to result in improvements in cardiorespiratory fitness when used for exercise prescription (ACSM, 2011).

Valencell has previously demonstrated validation of earbud (Eschbach, 2013) and forearm (Eschbach et. al. 2014) based PerformTek sensor technology. Additionally, research has demonstrated the validity of two different chest strap heart rate sensor (Eschbach, 2015). Until recently biometric sensors placed on the wrist were not accurate enough to utilize during dynamic exercise. Newly developed technology is hoped to provide valid biometric data at the wrist which will allow relatively seamless transition into wrist based devices already in use.

METHODS

Trials examining validity of PerformTek® wrist based sensor technology (Valencell Inc., Raleigh, NC) was completed using 68 exercise trials (33 participants). In the final analysis 51 exercise trials by 28 individuals (11 males, 17 females) were quantified. Reason for elimination of 17 tests (all included in appendix A) included the following: 7 tests (10.1%) had significantly poor performance of the benchmark device (chest strap heart rate monitor); 8 tests (11.7%) had failure of the recording of benchmark device that prevented upload of data to computer.

Trials consisted of a dynamic 8-minute treadmill session involving resting, walking, and running while heart rate was monitored via the PerformTek sensor and a traditional chest strap heart rate monitor (polar cx800, Polar Electro, Kempele, Finland). Heart rate was recorded continuously on both devices and statistical analysis was completed using 5-second data averaging (4800 data points). Statistical analysis examined validation using group means, percent error, bias, frequency distribution, and 95% limits. Analysis was completed using SPSS and Microsoft Excel.

A separate study to provide context was completed that included traditional chest strap vs. BTLE chest strap (Eschbach, 2015).

Table 1. Protocol (at 1% grade)

Time (min)	Protocol (speed in mph)
0:00 – 0:30	Standing
0:30 – 1:15	3.4
1:15 – 2:00	2.2
2:00 – 3:30	Self-selected running speed (ranging from 5.5 to 9 mph)
3:30 – 5:00	3.0
5:00 – 6:00	Self-selected running speed (ranging from 5.5 to 9 mph)
6:00 – 6:20	2.0
6:20 – 8:00	Standing

Figure 1. PerformTek® wrist sensor and placement.

RESULTS

Results comparing the chest strap and PerformTek wrist device indicated similar group means (chest strap =125, PerformTek = 126 beats) high correlation (r^2 = 0.87), low bias and percent error (bias=1.3 beats, % error 3.9%) It was found that 81% of PerformTek® HR measurements fell within ± 5 BPM of chest strap HR measurements. This data is similar to the results comparing two different chest straps (Eschbach, 2015) indicates that the wrist based sensors provide an accurate and valid measure of heart rate.

Figure 2. Correlation/regression analysis PerformTek® vs. Chest Strap (4800 data points).

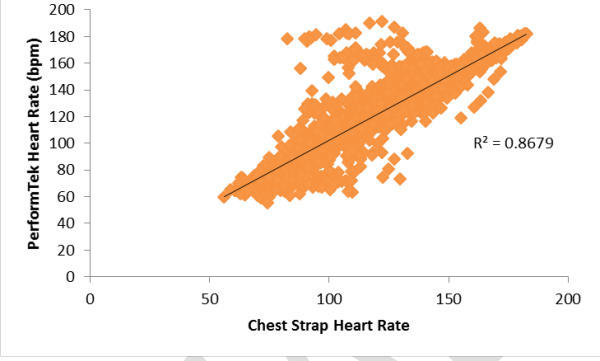


Figure 3. Frequency distribution PerformTek® vs. Chest Strap (4800 data points).

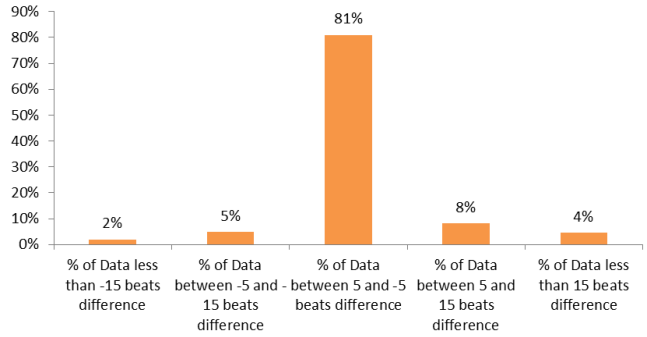
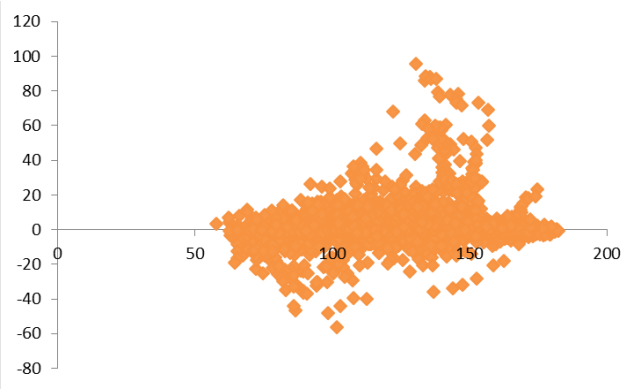


Figure **4**. Bland-Altman plot PerformTek® vs. Chest Strap (4800 data points).



CONCLUSION

Similar group means, low percent error and bias, along with high correlations in combination with appropriate frequency distribution indicate the PerformTek® wrist based device provides similar

validity as chest strap sensors. Heart rate monitoring using the PerformTek® wrist sensors system may be used effectively as an alternative to ECG or chest strap monitors.

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