Accuracy of Consumer Heart Rate Monitors

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Introduction

- The accuracy of wearable technology is unknown and it is a growing market that is expected to reach $34 billion by 2020 (Castaneda, Esparza, Ghamari, Soltanpur & Nazeran, 2018).
- Wearable technology such as the Fitbit Charge 2 (FBC2) is becoming more ubiquitous as a tool to measure heart rate (HR).
- 2 Main Technologies:
    - Photoplethysmography (PPG), used in FBC2.
    - Electrocardiogram (ECG), gold standard and also used in Polar H10.

Purpose and Hypothesis

- The purpose of this study is to establish if the FBC2 is accurate at measuring HR at various working intensities (50%, 75%, and 90%)
- We hypothesized that the FBC2 would be inaccurate at moderate to high working intensities (75% and 90%)

Methods

Sixteen male and female college students (5 males, 11 females) that are physically active and healthy participated in the test.

- Calculated target heart rate (THR) at 50%, 75%, and 90% of working intensities using the Karvonen Formula.
- 5 minute warm-up – 3 minute of dynamic exercises and a 2 minute walk on the treadmill.
- Modified Balke Treadmill Test – 3.3mph or 5.3km/hr for the entire duration of the test. Incline/gradient will increase every minute by the value of 1 (starting at 0).
- HR collected a total of 3 times during the test at 50%, 75%, and 90% of THR intensity.
- A single factor ANOVA test was conducted between the FBC2 and other devices to test the hypothesis.

Results

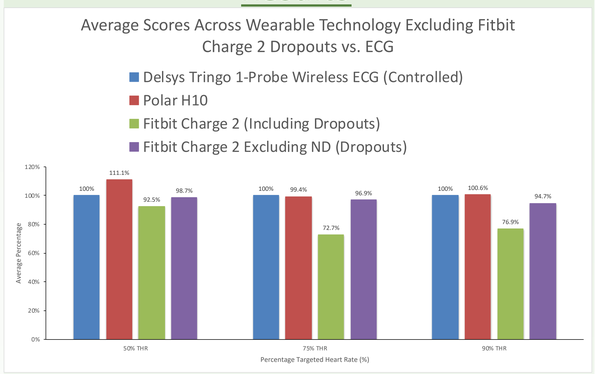


Figure 1. Percentage Difference Underestimating and Overestimating Error Rate Between all Devices

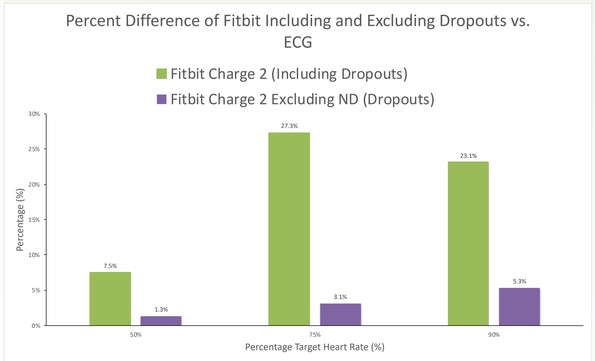
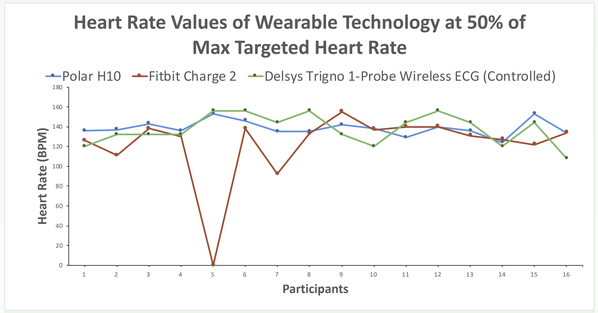
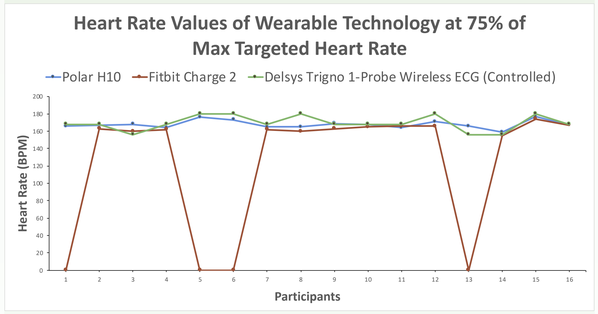
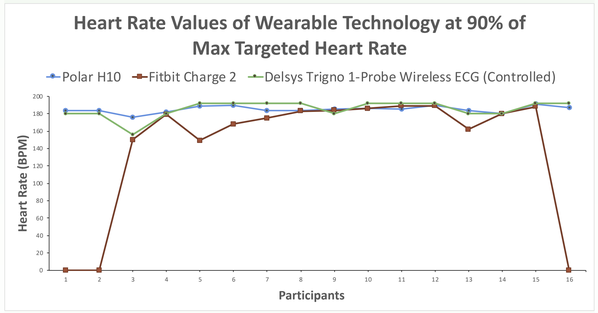


Figure 2. Underestimating Error Between FBC2 (Including D.O.) and FBC2 (Excluding D.O.)

- **Figure 2** shows on average the FBC2 scores underestimated the ECG scores by **-7.25%, -27.3%** and **-23.1%** at 50%, 75%, and 90% THR working intensities respectively.
- **Figure 2** shows that when excluding dropouts, on average FBC2 scores underestimate ECG scores by **-1.3%, -3.1%,** and **-5.3%** at 50%, 75%, and 90% THR working intensities respectively.







The graphs above shows participant at 50 %, 70%, and 90% of their heart rate at all three targeted intensities.

P-Values of Fitbit Charge 2 vs. DT ECG/Polar H10

	50% THR	75% THR	90 % THR
FC2 VS H10	0.0797	**0.0199**	**0.0250**
FC2 VS DT ECG	0.1269	**0.0165**	**0.0255**
H10 VS DT ECG	0.7593	0.4956	0.9436

Table 1. P < 0.05 to be statistically significant.

- **Table 1**, FBC2 compared to the Polar H10 at 75% and 90%, where both P < 0.05, implies that FBC2 is inaccurate.
- **Table 1**, FBC2 compared to the DT ECG at 75% and 90%, where both P < 0.05, implies that FBC2 is inaccurate.

Conclusion

- Popular devices such as the multifunctioning Fitbit have a large share in the current fitness market; it does not mean it is the most reliable device for tracking HR.
- Our results confirmed our hypothesis of the Fitbit Charge 2 being inaccurate at high working intensities (75% and 90%)
- Although, at lower intensities (50%), the FBC2 was accurate, but further research is needed to determine if FBC2 and other wearable technologies are accurate at determining HR.

References

Castaneda, D., Esparza, A., Ghamari, M., Soltanpur, C., Nazeran, H. (2018). A review of wearable photoplethysmography sensors and their potential future applications in health care. *International Journal of Biosensors & Bioelectronics, 4*(4), 195-202. doi:10.15406/ijbsbe.2018.04.00125

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