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Examining the Validity of Fitbit Charge HR ™ for Measuring Heart Rate in Free-Living Conditions

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Examining the Validity of Fitbit Charge HR™ for Measuring Heart Rate in Free-Living Conditions

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ABSTRACT

Optical blood flow sensors (i.e. photoplethysmographic techniques) have recently been utilized in wearable activity trackers. The Fitbit Charge HR™ (FBHR) is one of the widely recognized wearable activity trackers that utilizes Fitbit's proprietary PurePulse optical heart rate (HR) technology to automatically measure wrist-based HR. Despite its increasing popularity, however, no study to date has addressed the validity of FBHR for measuring HR in free-living conditions. **PURPOSE**: The purpose of this study was to examine the validity of FBHR for measuring HR using a chest strap Polar HR monitor (PHR) as a reference measure in free-living conditions. **METHODS:** Ten healthy college students (8 males; mean age = 26.5 ± 5.4 years; mean body mass index (BMI) = 24.5 ± 3.23 kg·m^2) participated in the study. The participants were asked to perform normal daily activities for 8 hours in a day while wearing the PHR (model RS400) on their chest and two FBHRs on their dominant and non-dominant wrists, respectively. HR was recorded every minute and the minute-by-minute HR data from each monitor were synchronized by time of day. Pearson correlation was used to examine the linearity of average beats-per-minute (bpm) estimated from FBHRs with respect to the PHR. Mean differences in average bpm between the monitors were examined by a general linear model for repeated measures. Lastly, mean absolute percentage error (MAPE) of minute-by-minute bpm estimated from the FBHRs were calculated against the PHR. **RESULTS:** Average HRs (mean ± SD) for PHR, FBHR non-dominant, and FBHR dominant were 75.6 ± 18.5 bpm, 72.8 ± 16.7 bpm, and 73.9 ± 17.06 bpm, respectively. Pearson correlation coefficients (r) between the PHR and FBHR non-dominant and dominant were r=.805 and r=.793, respectively. MAPE were 9.17 ± 10.9% for FBHR non-dominant and 9.71 ± 12.4% for FBHR HR dominant. ANOVA and post-hoc analyses with Bonferroni revealed significant differences in estimating HR from FBHR non-dominant wrist (p=.001) and FBHR dominant wrist (p=.001) compared to PHR monitor. **CONCLUSION:** The results indicated that the wrist-oriented Fitbit Charge HR™ device does not provide an accurate measurement of HR during free-living condition in this study. However, further research is needed to validate these monitors with a larger sample with different population groups.

INTRODUCTION

- Optical blood flow sensors (i.e. photoplethysmographic techniques) have recently been utilized in wearable activity trackers.
- The Fitbit Charge HR™ (FBHR) is one of the widely recognized wearable activity trackers that utilizes Fitbit's proprietary PurePulse optical heart rate (HR) technology to automatically measure wrist-based HR.
- Despite its increasing popularity, However, no study to date has addressed the validity of FBHR for measuring HR in free-living conditions.

PURPOSE

The purpose of this study was to examine the validity of FBHR for measuring HR using a chest strap Polar HR monitor (PHR) as a reference measure in free-living conditions

METHODS

Table 1. Demographics of participants (n=11)

	Mean	SD	Minimum	Maximum
Age	26.5	5.4	20.0	39.0
Height (cm)	176.2	6.3	164.0	192.0
Weight (kg)	70.7	8.1	57.5	100.2
BMI (kg·m^{-2})	24.5	3.2	20.7	31.3

Procedures

- The participants were asked to perform normal daily activities for 8 hours in a day while wearing the PHR (model RS400) on their chest and two Fitbit Charge HRs (FBHRs) on their dominant and non-dominant wrists, respectively.
- HR was recorded every minute and the minute-by-minute HR data from each monitor were synchronized by time of day.
- Pearson correlation was used to examine the linearity of average beats-per-minute (bpm) estimated from FBHRs with respect to the PHR.

METHODS (Cont.)

- Mean differences in average bpm between the monitors were examined by a general linear model for repeated measures.
- Lastly, mean absolute percentage error (MAPE) of minute-by-minute bpm estimated from the FBHRs were calculated against the PHR.

Instruments

Fitbit Charge HR (Fitbit Inc. San Francisco, CA, USA)

- The Fitbit Charge HR is a wrist-watch-style activity tracker that continuously measures HR with its PurePulse LED lights.
- As the heart beats, capillaries expand and contract and the LED lights detect that change.
- An algorithm is used to measure the HR automatically and continuously throughout the day and night.
- Proper fit of the Fitbit Charge HR is above the wrist bone, and when exercising, at least two fingers width above.
- The minute by minute heart rate data was downloaded from the Fitabase website (www.fitabase.com)

Polar Heart Rate monitor (RS400)

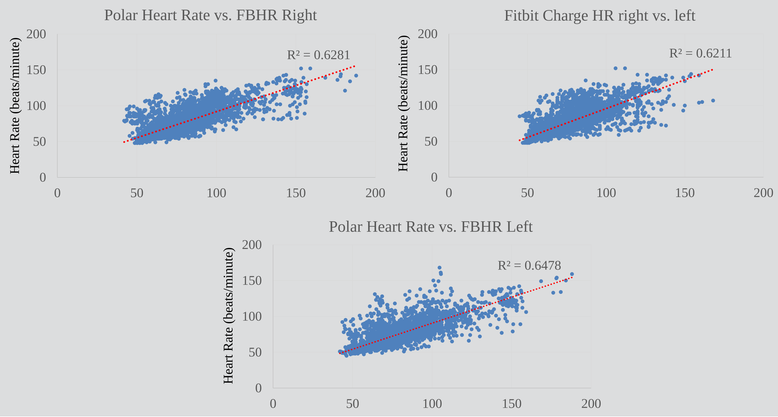
- The Polar RS400 HR Monitor Watch is geared toward the active endurance athlete who desires to easily and accurately measure HR during exercise.
- The monitor comes with a WearLink fabric chest transmitter that is easily paired with a wrist receiver.
- The software allows for users to download minute-by-minute data from the monitor.

RESULTS

Table 2. Descriptive statistics on heart rate for all monitors.

	Mean	SD	Minimum	Maximum
Polar RS400	75.6	0.27	42.0	188.0
Fitbit Charge HR Left	72.8	0.24	45.0	168.0
Fitbit Charge HR Right	73.8	0.25	48.0	152.0

Figure 1. Correlation between Polar Heart rate and Fitbit Charge HRs



RESULTS (Cont.)

Figure 2. Minute by minute comparison between Polar heart rate and Fitbit Charge HR left.

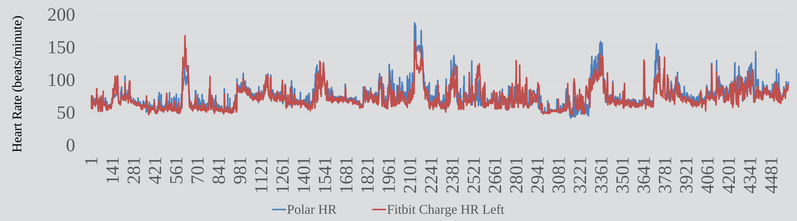


Figure 3. Minute by minute comparison between Polar heart rate and Fitbit Charge HR right.

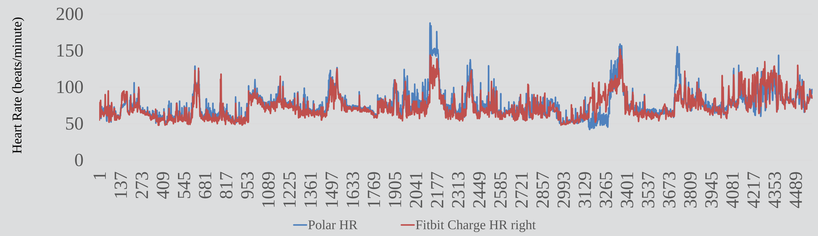
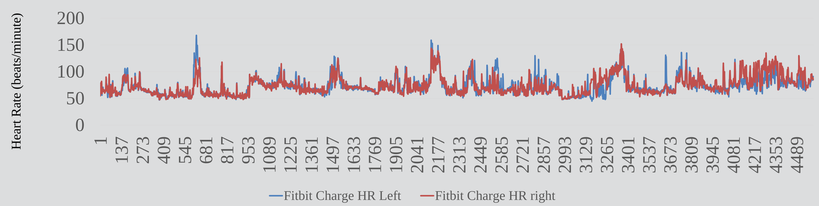


Figure 4. Minute by minute comparison between Fitbit Charge HR Left and Fitbit Charge HR right.



- Average HRs (mean ± SD) for PHR, FBHR non-dominant, and FBHR dominant were 75.6 ± 18.5 bpm, 72.8 ± 16.7 bpm, and 73.9 ± 17.06 bpm, respectively.
- Pearson correlation coefficients (r) between the PHR and FBHR non-dominant and dominant were r=.805 and r=.793, respectively. MAPE were 9.17 ± 10.9% for FBHR non-dominant and 9.71 ± 12.4% for FBHR HR dominant.
- Mean absolute percentage errors were 9.17% for FBHR non-dominant and 9.71% for FBHR dominant.
- ANOVA and post-hoc analyses with Bonferroni revealed significant differences in estimating HR from FBHR non-dominant wrist (p=.001) and FBHR dominant wrist (p=.001) compared to PHR monitor.

CONCLUSION

- The results indicated that the wrist-oriented Fitbit Charge HR™ device does not provide an accurate measurement of HR during free-living condition in this study.
- However, further research is needed to validate these monitors with a larger sample in different population.