Validity and Inter-Instrument Agreement between Zephyr Bioharness and Fitbit Charge

McMaster University

School of Rehabilitation Science

Goris Nazari PT, MSc (C) . Joy C MacDermid PT, PhD . Kathryn E Sinden R. Kin., PhD . Julie Richardson PT, PhD . Ada Tang PT, PhD

BACKGROUND

Advances in technology has promoted the development of Physiological Status Monitoring (PSM) devices that are small, non-invasive as well as easy to use in capturing and monitoring physiological measures across various fields including personnel in the fire service, or construction workers as well as promoting changes in physical activity levels[1-2]. One such a device is the Fitbit Charge Heart Rate (FC-HR) – a wrist band capable of recording wrist-based heart rate, number of steps taken and total energy expenditures.

SIGNIFICANCE

- Importance of reliability and validity measures[3].
- Conceptual differences between validity and agreement parameters[3].
- Paucity of reports in current literature.

PURPOSE

To establish the concurrent validity and levels of agreement between the FC-HR and Zephyr devices at Rest, during a sub-maximal test and throughout Recovery.

HYPOTHESIS

- Zephyr and Fitbit Charge heart rate measures would demonstrate strong correlations.
- Fitbit Charge and Fitbit One activity measures would display strong correlations.

METHODOLOGY

SAMPLING:

Convenience and snowball sampling.

SETTINGS:

MacHand Lab – Institute of Applied Health Science.

SUBJECTS:

Sixty healthy participants (30 females) ranging in age from 21 – 68 years recruited from the School of Rehabilitation Science and Physical Activity Centre of Excellence, McMaster University.

EXCLUSION CRITERIA:

Individuals with "Yes" response/s to any of Physical Activity Readiness Questionnaire questions[4].

SAMPLE SIZE CALCULATION:

Based on our previous study. A null hypothesis value of 0.80 and the expectation of obtaining a test-retest reliability (ICC) of 0.90.

Table – 1 Concurrent Validity of FC-HR vs. Criterion measures.

Variables	Phases	Criterion M-1 vs. FC-HR M-2	Mean Diff.	(r)
Heart rate (bpm)	Rest	71.32 – 71.22	0.10	≥ 0.96
Heart rate (bpm)	mCAFT	131.50 – 128.00	3.50	≥ 0.93
Heart rate (bpm)	Recovery	91.62 – 90.52	1.10	≥ 0.80
Steps taken (steps)	mCAFT	819.37 – 898.99	-79.43	≥ 0.98
Energy exp. (cal.)	mCAFT	92.05 – 131.18	-39.13	≥ 0.80

ETHICAL CONSIDERATION

We received ethical approval for this study through the Hamilton Integrated Research Ethics Board (No. 0825).

MEASUREMENT PROTOCOL:

We followed the Modified Canadian Aerobic Fitness Test's (mCAFT) published stepping protocol: Canadian Society for Exercise Physiology (1998)[4].

- Rest – Ten minutes
- mCAFT – 85% HR-max.
- Recovery – Ten minutes.

STATISTICAL ANALYSIS

Demographic Characteristics described in form of means and standard deviations.

Pearson correlation coefficients (r) was used to test the hypotheses. The strength of correlation (r) was described as; 0.20-0.39 "weak", 0.40-0.59 "moderate", 0.60-0.79 "strong", 0.80-1.00 "very strong".

Average agreements were examined by testing mean differences by a one-sample t-test, p-value and confidence intervals reported. Bland and Altman plots were used to report individual levels of individual.

IBM SPSS Statistics software version 22.0 and Level of significant $\alpha \leq 0.05$.

RESULTS

SAMPLE:

Thirty males (age 48 ± 15 years, body mass index 25 ± 2.30 kg/m^2) and thirty females (age 48 ± 15 years, body mass index 24 ± 3.50 kg/m^2).

CONCURRENT VALIDITY:

Mean differences of ≤ 3.50 (bpm) and strong to very strong correlations were reported for the heart rate measures between Zephyr and FC-HR devices (Table – 1).

Levels of Agreement:

The average agreement bias of heart rate in pair-wise device comparison indicated small mean differences of ≤ 4.00 and narrow confidence intervals (Table – 2).

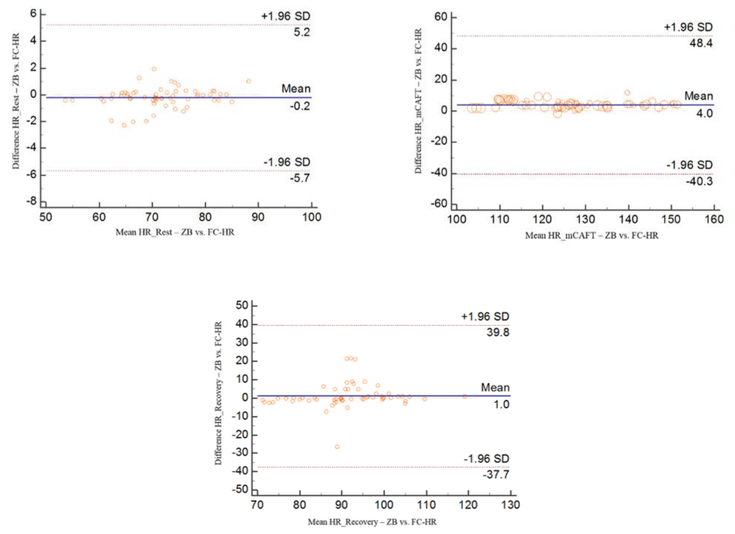
Bland and Altman plots (Figures 1) display individual agreements in pairwise comparison.

Table – 2 Heart Rate Inter-device Agreement.

T-test of Difference	Mean Diff.	Std. Error	95% Confidence Interval
Zephyr vs. FC-HR – Rest	-0.02**	0.05	-0.03 – -0.09
Zephyr vs. FC-HR – mCAFT	4.00**	0.16	3.72 – 4.35
Zephyr vs. FC-HR – Recovery	1.00**	0.23	0.60 – 1.50

*** p < 0.05*

Figures 1 Bland and Altman plots.



DISCUSSION

Since this study was the first of its kind, our validity and agreement results could not be directly compared with those reported in the literature.

The wider limits of agreement during the mCAFT and subsequently throughout Recovery could be due to large variability within our study sample as well as the nature of mCAFT. Since mCAFT is a sub-maximal test, it requires participants to achieve their 85% of age – related heart rate maximum during the test, therefore inclusion of participants ranging from 21 – 68 years with mean (SD) of 48 (15) years of age for both men and women, and with calculated 85% heart rate maximum mean (SD) of 146.50 (13.00) and 146.10 (12.85) beats/min. for women and men respectively, could have contributed to these wider limits of agreement.

IMPLICATIONS

1. Exceeding maximum heart rate can be dangerous to health.
2. In athletes, provides valuable information regarding overtraining.
3. A common techniques used to determine work related physiological demands.

CONCLUSION

The FC-HR proved to be a valid device in terms of heart rate measures. In addition, comparison between FC-HR and Zephyr heart rate measures provided valuable information and possible interchangeable.

ACKNOWLEDGEMENTS

This work was supported by a Ministry of Labour Grant (FRN: 13-R-027).

REFERENCES:

1. Johnstone, J.A., Ford, P.A., Hughes, G., Watson, T. and Garrett, A.T. (2012a). Bioharness™ multivariable monitoring device: Part I: Validity. *Journal of Sports Science and Medicine* 11(3), 400- 408.

2. Gatti U.C., Schneider S. and Migliaccio G.C. (2014). Physiological condition monitoring of construction workers. *Automation in Construction* 44, 227–233.

3. Streiner, D. L., & Norman, G. R. (1995). *Health measurement scales: a practical guide to their development and use* (2nded). New York: Oxford University Press.

4. Canadian Society for Exercise Physiology (1998). *The Canadian Physical Activity, Fitness and Lifestyle Appraisal* (2nd ed.). Ottawa, ON.