Tracking HRV with a wearable sensor in daily life

Veronica Dudarev, Guy Davis, James T. Enns

Goals

Establish reliability of Biostrap HRV in sleep.

Compare reliability of sleep and daytime HRV.

Background

Daily Biostrap HRV differs from lab standards in two important ways.

Technology: PPG vs ECG. In the lab HRV is acquired from an electrocardiogram (ECG), wearable devices use photoplethysmography (PPG).

In the lab PPG is a valid measure of heart rate and HRV (1-2) and commercial wearable devices show good convergence with benchmark ECG and PPG equipment (3-4).

Context: Life vs Lab. Are PPG measurements valid outside of the controlled lab? The biomarker is highly sensitive to physical activity, posture change, breathing, effort (including mental effort), food & drink. Is tracking HRV viable without contextualizing all these factors?

How much can we trust daytime HRV?

Approach

Night-time sleep is as close to the controlled lab environment as real life ever gets.

By comparing stable night HRV measures with the messy daytime measures, we will benchmark daytime Biostrap HRV.

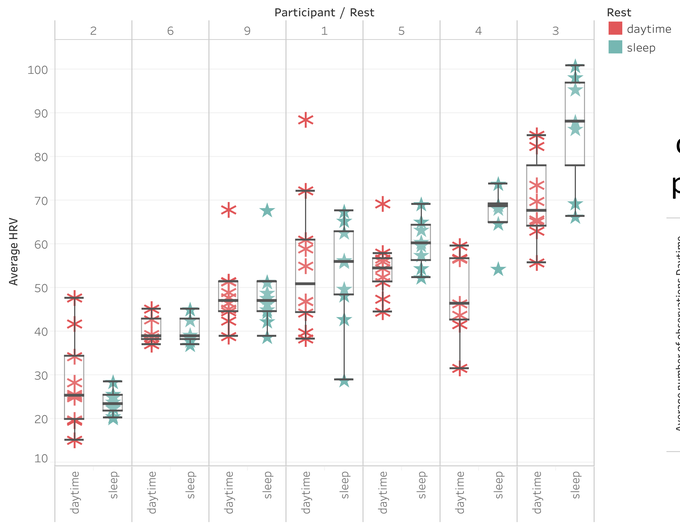
Conclusions

Wearable sensor provides highly reliable HRV values.

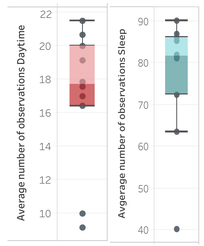
Night-time measures are dense, with excellent within-night and between-night reliability.

Daytime measures are sparser, with more variance, but yet are very reliable across days.
Daytime measure correlates strongly with night-time, excellent overall participant reliability, weaker participant x day reliability.

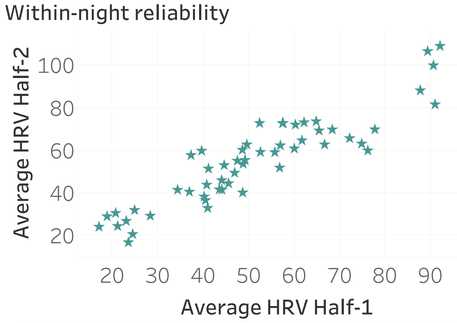
Average HRV per day / night, per participant



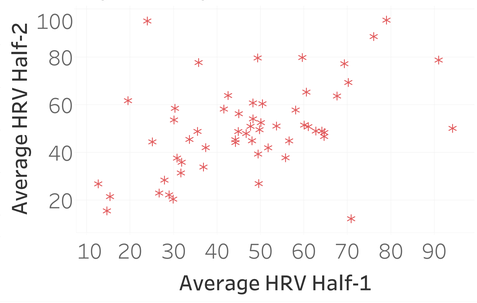
Number of observations per day/night



Within-night reliability



Within-day reliability



Results

HRV cleaned for zeros and measures more than 3 standard deviation above a participant's average.

Day/night reliability

Night HRV *Cronbach's alpha* = .96
Daytime HRV *Cronbach's alpha* = .88.
Correlation between average night-time and day-time HRV per participant r = .91, p =.004.

Within-day/night reliability

Each day/night split into halves, with HRV averaged for each half. Mixed model regression predicting HRV during the second half of a day/night from HRV during the first half, with participant as a random factor.
Sleep HRV, b = .92, t = 10.22, p < .001.
Daytime HRV, b = .23, t = 1.58, p = .15.

Methods

Participants

N = 10 people (aged 18 + years, no heart conditions) wore a HRV sensor continuously for 7-11 days. 3 sensors malfunctioned, data are reported for N = 7.

Equipment

Biostrap sensor (www.biostrap.com) – a wrist- infra-red PPG sensor that samples heart rate and blood oxygenation for 1 minute at 5-minute intervals. Heartbeat data processed by Biostrap algorithms to clean artifacts and compute rMSSD (HRV measurement).

References

1.Jeyhani et al. (2015, August). *2015 37th Annual International Conference of the IEEE EMBS*.
2.Pinheiro et al. (2016, August). *2016 38th Annual International Conference of the IEEE EMBS*.
3.Dur et al. (2018). *JMIR mHealth uHealth* 1–28.
4.Sneddon et al. (2018). *Thorax 73,* A197.