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**CISM Sport Science Abstract**

*Research line: Psychophysiological military fitness and operational readiness*

**Accuracy of the optical heart rate device Polar OH1 during rest and exercise**

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**Introduction**

Accurate, inexpensive, and comfortable heart rate (HR) measurement devices that can be applied in the clinical and sport setting are of growing interest. In a military setting, sensors worn on the upper arm were reported to be much more comfortable than chest belts (Beeler et al., 2018). This paper aims to validate the upper arm-worn optical HR device Polar OH1 in terms of HR accuracy against an electrocardiogram chest monitor during rest and exercise.

**Methods**

Ten volunteers (5 female; age  $24.7 \pm 1.9$  years, height  $172.5 \pm 8.4$  cm, weight  $67.5 \pm 9.7$  kg) performed five activities for 5 minutes each with 1-minute rest periods in between: sitting and reading, household chores, walking and running on a treadmill at 5.5 and 11km/h, respectively, and a strength training circuit. The Polar OH1 (1Hz) was mounted on the non-dominant upper arm and the criterion device Polar H10 (1000Hz) with the Pro Strap was placed around the chest (Polar Electro Oy, Kempele, Finland). The data was analysed as overall (mean HR over a single activity) and continuous (mean HR over 10-second intervals) data. Descriptive statistics and Bland-Altman analysis were performed as well as equivalence testing to the overall data and Polar OH1 accuracy to the continuous data. Polar OH1 accuracy was calculated as the percentage where the concurrent measurements were within 5% from the criterion values. The analysis of all activities combined included data of all five activity tasks and the rest periods in between.

**Results**

Considering all activities, the Polar H10 and the Polar OH1 recorded an average HR of  $96.2 \pm 32.0$  and  $96.3 \pm 31.9$  bpm, respectively, which represented an absolute error of 2.2bpm (2.6%) in the Polar OH1 (Table 1). The systematic bias of the Polar OH1 was 0.1bpm with  $\pm 7.2$  bpm limits of agreement. The 95% confidence interval (-0.61, +0.40bpm) for the absolute mean error of the Polar OH1 fell into the proposed equivalence zone ( $\pm 5\%$ ; -4.81, +4.81bpm) of the criterion values. Considering the continuous data, 89.2% of all 10-second intervals obtained by the Polar OH1 were within 5% from the Polar H10. The Polar OH1 measured the least accurate data (76.7%) during the household chores, whereas the most accurate HR measurements (99.3%) were observed during the running activity (Table 1).



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*Table 1: Error rates of the optical heart rate monitor Polar OH1 compared to the electrocardiogram monitor Polar H10.*

	Polar H10 $\pm$ SD	Polar OH1 $\pm$ SD	Mean absolute error (%)	Systematic bias ( $\pm$ LoA)*	Polar OH1 accuracy per 10s-intervals** [%]
	[bpm]	[bpm]	[bpm]	[bpm]	
All activities	96.2 $\pm$ 32.0	96.3 $\pm$ 31.9	2.2 (2.6)	0.10 ( $\pm$ 7.22)	89.2
Sitting and reading	63.7 $\pm$ 12.6	63.3 $\pm$ 12.9	2.3 (3.5)	-0.45 ( $\pm$ 6.17)	83.7
Household chores	79.6 $\pm$ 11.6	80.1 $\pm$ 11.1	3.4 (4.3)	0.46 ( $\pm$ 10.52)	76.7
Walking at 5.5 km/h	91.6 $\pm$ 13.7	91.6 $\pm$ 13.0	1.6 (1.7)	0.01 ( $\pm$ 5.59)	97.0
Running at 11 km/h	145.1 $\pm$ 20.6	144.9 $\pm$ 20.4	0.8 (0.5)	-0.21 ( $\pm$ 3.14)	99.3
Strength training	116.8 $\pm$ 20.3	117.4 $\pm$ 20.0	2.1 (1.9)	0.52 ( $\pm$ 7.54)	89.2

\*representing the information of a Bland and Altman plot with the systematic bias and the 95%-limits of agreement (LoA)

\*\*Percentage, where the heart rate obtained by the Polar OH1 was within 5% from the criterion Polar H10.

SD = Standard deviation; bpm = beats per minute.

### **Discussion**

The Polar OH1 demonstrated excellent concordance with the criterion device Polar H10 in the HR measurement during a range of low- to high-intensity activities. When compared to previous studies, the Polar OH1 appears to be the most accurate optical HR measurement device on the market (Gilgen-Ammann et al., 2018; Horton, Stergiou, Fung, & Katz, 2017).

### **Practical implications**

The Polar OH1 is a very promising device with high practical application in a clinical and sport setting. Moreover, with the device placement on the upper arm, it is particularly useful for the HR monitoring during military services, as it does not interfere with other field equipment (Beeler et al., 2018). The Polar OH1 can be recommended to accurately assess HR over a range of activities.

### **References**

- Beeler, N., Roos, L., Delves, S. K., Veenstra, B. J., Friedl, K., Buller, M. J. & Wyss, T. (2018). The wearing comfort and acceptability of ambulatory physical activity monitoring devices in soldiers. *IJSE Transactions on Occupational Ergonomics and Human Factors*, 6:1, 1-10, doi:10.1080/24725838.2018.1435431
- Gilgen-Ammann, R., Buller, M. J., Bitterle, J. L., Delves, S. K., Veenstra, B. J., Roos, L., . . . Wyss, T. (2018). Evaluation of pulse rate measurement with a wrist worn device during different tasks and physical activity. *Current Issues in Sport Science*, 3. doi:10.15203/CISS\_2018.011
- Horton, J. F., Stergiou, P., Fung, T. S., & Katz, L. (2017). Comparison of Polar M600 Optical Heart Rate and ECG Heart Rate during Exercise. *Medicine & Science in Sports & Exercise*, 49(12), 2600-2607. doi:10.1249/MSS.0000000000001388