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CISM Sport Science Abstract

Research line: Psychophysiological military fitness and operational readiness

A comparison of military-specific sensor-systems to estimate energy expenditure in soldiers

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Introduction

Physical demands during military service are high (Wyss, Scheffler, & Mäder, 2012). To avoid a misbalance between physical requirements and abilities and to prevent overuse injuries, it is crucial to quantify the demands of military-specific activities. One indicator frequently used for this purpose is energy expenditure. Researchers from Switzerland and the Netherlands each developed algorithms for energy expenditure estimation in a military environment. The present study aimed to compare data of the Swiss and the Dutch sensor-system during a military march with values from the compendium of physical activities (Ainsworth et al., 2011).

Methods

Data of sixty-four male Swiss soldiers carrying a load of 24.8 kg of load during a military 35 km march were collected. All subjects wore the sensors of the Swiss and the Dutch sensor-system simultaneously. The Swiss sensor-system developed by Wyss & Mäder (2011) consisted of two PARTwear accelerometers (HuCE microLab, Biel/Bienne, Switzerland) worn at the hip and the backpack as well as a wrist worn heart rate sensor (Mio FUSE, Mio Global, Vancouver, Canada). Only the heart rate values of the Mio FUSE are used in the Swiss algorithm; however, the device also provided its own estimation of energy expenditure, which was included in the analysis as well. The Dutch algorithm relies on acceleration data from the chest belt EQ-02 (Hidalgo Ltd, Cambridge, UK) and established algorithms for different activities (e.g. formula by Pandolf et al. (1978) for loaded marching). As a reference value, energy expenditure was calculated according to Ainsworth et al. (2011) in 1-minute intervals. For military marching with backpack, code 17012 corresponding to 7.8 MET and for breaks, code 07040 corresponding to 1.8 MET was used. A one-way ANOVA with Bonferroni post-hoc test and Bland-Altman plots (Bland & Altman, 1986) were conducted to investigate differences between the sensor-systems.

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Results

The data of forty-six subjects (age 20±1 y; height 1.78±0.07 m; body mass 76.2±10.0 kg) was included in the analysis. The reference method revealed a total energy expenditure of 17.3±2.3 MJ during the whole march (approximately 490 min, of which 80 min were spent resting). The Swiss sensor-system showed no significant differences (p<0.05) from the reference value but large standard deviations (mean overestimation of 8.0±19.7%). While the Dutch sensor-system significantly underestimated energy expenditure by -27.8±6.7%, the Mio FUSE showed a significant overestimation of the energy expenditure by 23.9±19.8%.

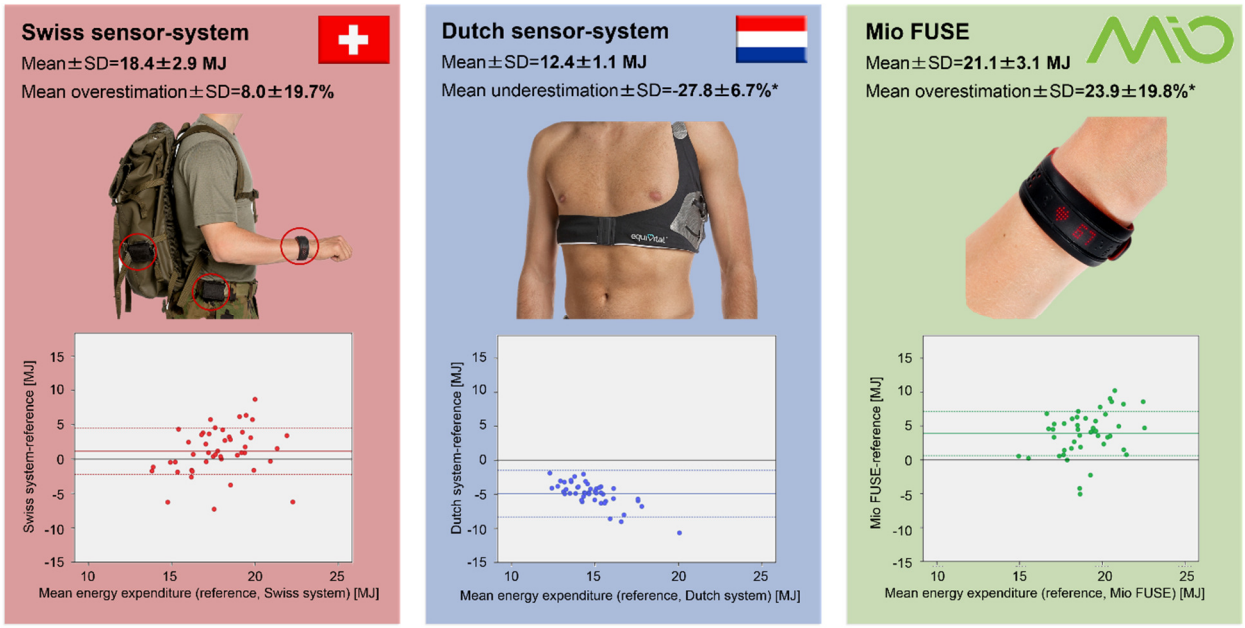

Figure 1: Mean, standard deviation (SD) and Bland-Altman plot of the energy expenditure estimated during the march by the investigated sensor systems.
Mean: * Indicates a significant over-/underestimation (p<0.05).
Bland-Altman plot: The bold line marks the mean difference between the reference and the value recorded by the sensor systems (dotted lines: ±1.96 SD).

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Discussion and Conclusion

The Swiss sensor-system demonstrated the most accurate energy expenditure estimation during military marching compared to the MET values based reference value. The Dutch sensor-system and the Mio FUSE significantly under- or over-estimated energy expenditure.

Practical implications

The actual Dutch sensor-system and the Mio FUSE cannot be recommended for estimating energy expenditure during military marching tasks. The Swiss sensor-system proved accurate on a group level, but not for each single individual. This exploratory data provides that current sensor-system need to be further improved and that further studies using a gold standard method to measure the energy requirements of military tasks are necessary.

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