WG 4 (Physiological Health)

Wearable Devices for Training Load Monitoring in Military Settings: Key Lessons Learned

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Introduction:
Wearable sensors offer valuable insights into physical behaviors, enabling personalized training loads and early detection of musculoskeletal injury (MSKI) risk. This study aims to integrate wearable devices for long-term monitoring of training loads in a military context and develop a predictive model for MSKI.
Methods:
This ongoing 5-year study involves 263 soldiers across five military training courses (paratroopers, n=42; infantry, n=83; navy, n=134 in three courses), each lasting 17-28 weeks. Continuous data were collected on heart rate, sleep patterns, distance covered, and stress levels. A machine learning algorithm was created to predict injury risk, with the model tested and refined three times across different courses.
Results:
MSKI rates were high (~70%) across all courses, with soldiers regularly exceeding planned distances. Heart rate (HR) predominantly stayed in low zones, and sleep duration was insufficient across all courses. The predictive model achieved 83% accuracy in forecasting injuries one week in advance for the Navy SF 1st course (precision: 0.82, recall: 0.79, F1 score: 0.81). Injured soldiers showed significant differences, including lower normalized daily distance ($p<0.001$), more low-activity periods ($p<0.001$), shorter high-intensity activity duration ($p<0.001$), reduced sleep duration ($p=0.02$), more sleep interruptions ($p=0.02$), less REM sleep ($p=0.02$), and higher stress levels ($p<0.01$).
Conclusion:
Wearable sensors were successfully deployed in a military setting for continuous monitoring of training loads. The predictive model identified injury risk up to one week in advance, highlighting potential for injury prevention and optimized training. Further refinement is needed to improve model accuracy, with future studies focusing on load management and enhanced interdepartmental collaboration for soldier health and readiness.

WG 4 (Physiological Health)

Developing Countermeasures for the Subterranean Environment

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Background:
Tunnel warfare has been one of the most complicated forms of combat while each tunnel presents unique challenges and potential surprises. Yahalom, a special engineering combat soldier unit, was established to fill the gap for subterranean warfare; however, understanding the psycho-physiological changes associated with the subterranean environment is yet limited.
Purpose:
To investigate the psychophysiological strain associated with performing military tasks in the SubT environments.
Methods:
Twenty-six active duty Yahalom soldiers signed an informed consent form after the study protocol was approved by the IDF Medical Crops IRB Committee. The soldiers entered either a "linear-type" or a "metro-like" training SubT facility. Environmental conditions were monitored for O2, CO2, temperature, and humidity. Before entering the SubT and after exiting the SubT, they underwent cognitive tests using the Flanker task, and collected the subjective measures of anxiety (VAS, visual analog scale), and rate of perceived exertion (RPE). Physiological measures included blood lactate levels, continuous heart rate (HR) monitoring, and gas exchange (VO2, VE) using the K5 device (COSMED).
Results:
HR was significantly increased from 115±8 b/min to 162±10 b/min during the SubT activity, VE was 67±9 l/min, and VO2 2201±479 ml/min which is equivalent to 31 ml/kg/min. Anxiety, VAS scale and Flanker test were not significantly changed. Blood lactate, however, was 7.2±3.5 mmol during the SubT, and remained at 4.8±1.9 even 10 minutes after exiting the SubT.
Conclusions:
Both objective (HR, VO2, VE) and subjective (RPE, VAS) measures of exertion reflect low aerobic strain under a training SubT compound. However, lactate levels were significantly elevated and remained high even during 10 minutes of recovery. No substantial differences were observed between the linear tunnel and the metro one. Additional experiments are warranted to elucidate the anaerobic strain during SubT activities.