

Biomechanics and Assistive Technologies Research Group



University of Defence
Military Faculty
of Medicine



**FACULTY
OF BIOMEDICAL
ENGINEERING
CTU IN PRAGUE**

Current State and Design Recommendations of Wearable Systems in Military Applications

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Who we are

A multidisciplinary team focused on research, design and development:



Methodologies

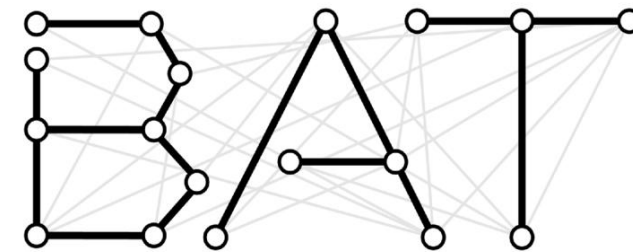


Software

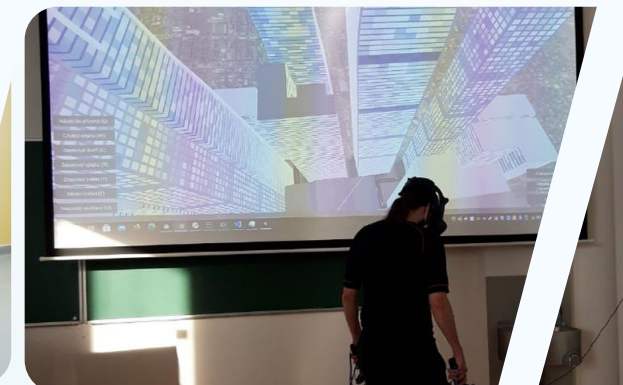


Electronic systems

for measuring and evaluating physiological, motion and image data.



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Research challenges



**Operating in
hazardous environments**



**Real vs. simulated
environments (VR, AR, ...)**



**Screening and assessing
individuals and teams**



**Training planning
and readiness assessment**



**Optimizing the
working environment**



**Optimizing individual
wearable equipment**

Introduction and motivation

Military operations involve high physical and mental demands in unpredictable environments.



Physical exertion and fatigue



Psychological stress



Time pressure

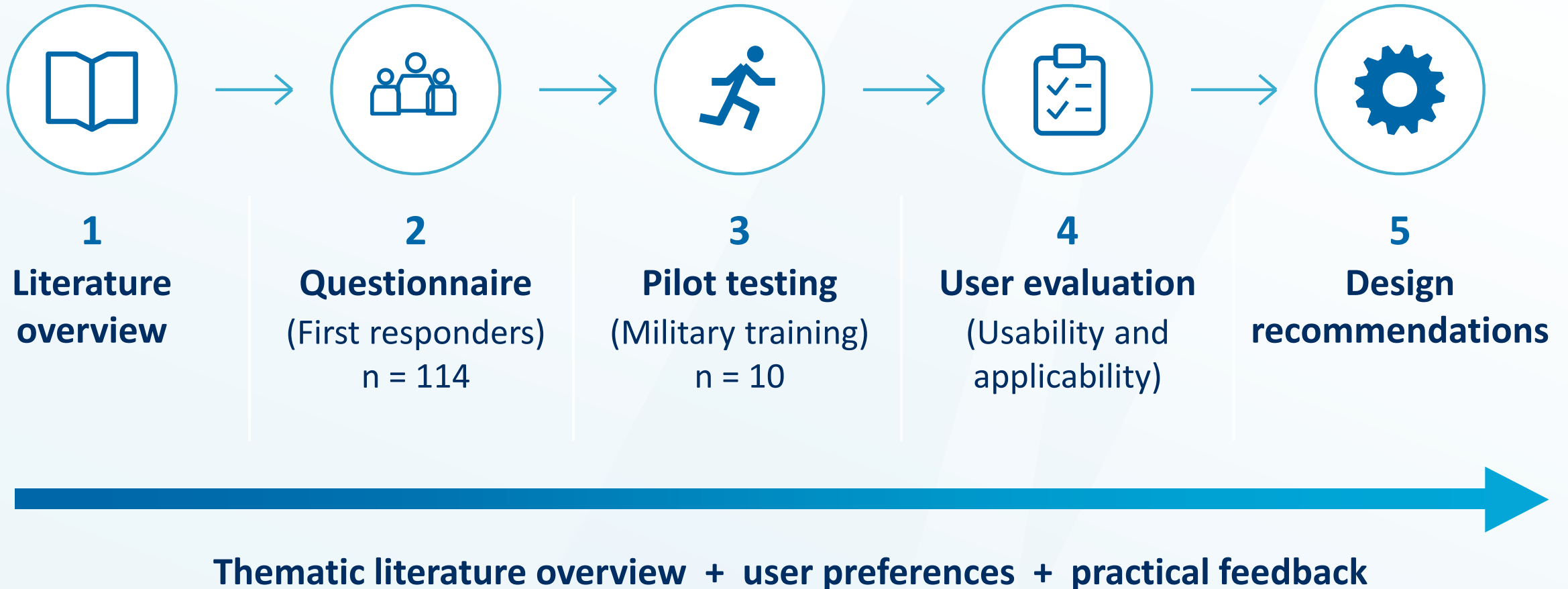


Unpredictable conditions (hazards, terrain, weather)

Continuous physiological monitoring can support safer and more effective military operations.

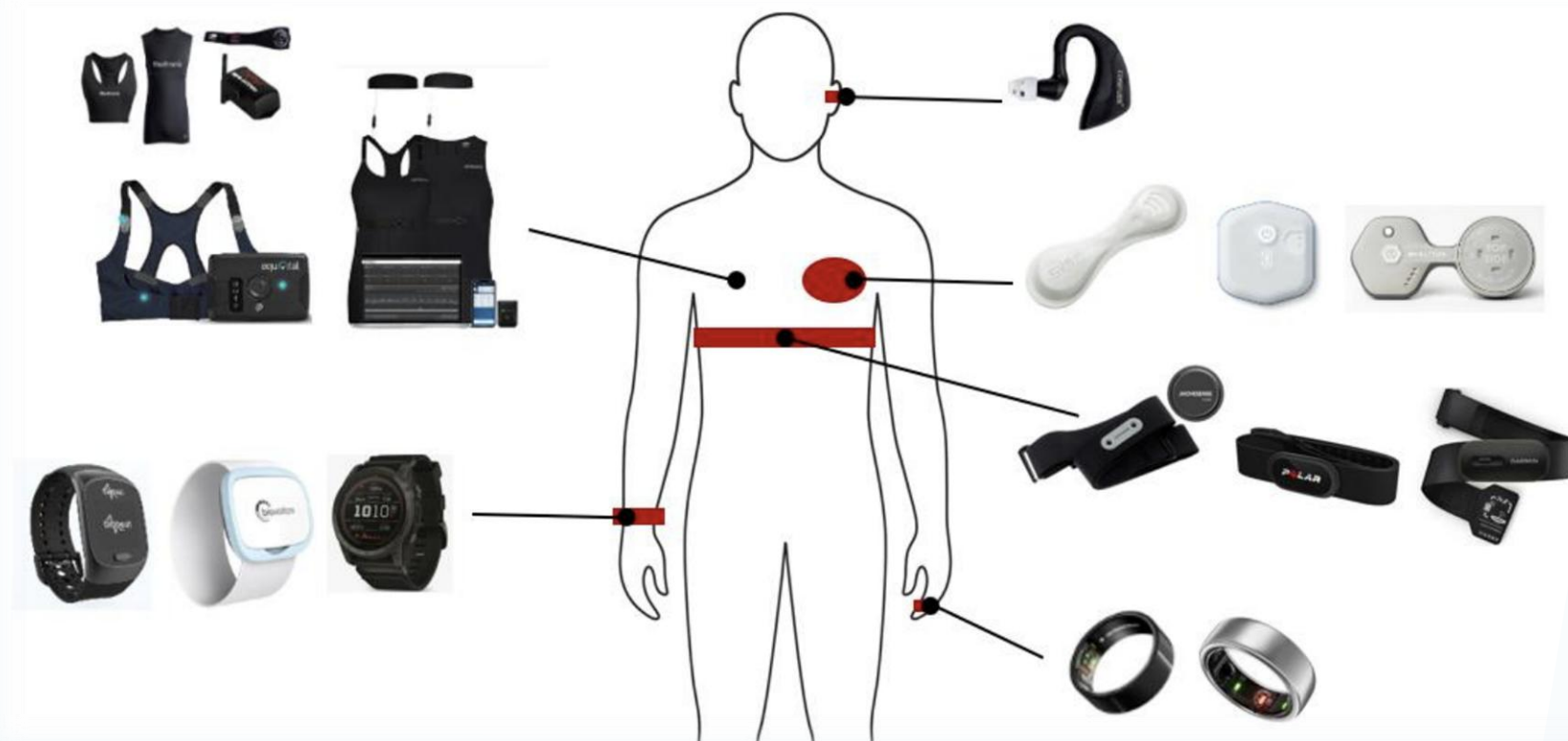
Research design

From literature to user requirements and practical evaluation.



Current state of wearable systems

Classification depends on function, body placement and architecture.



Body placement



Head



Torso



Upper limbs (e.g. wrist)



Lower limbs (e.g. ankle)

Architecture



On-body systems



In-body systems

Function



Monitoring



Medical support



Communication



Alerts

Three implementation approaches

From standalone devices to fully integrated solutions.

1

Commercial devices



Smart T-shirt, chest straps, smartwatches, etc.

2

Multimodal Systems



Combination of multiple sensors (e.g., ECG, EMG, PA, etc.)

3

Integrated into equipment



Smart vests and uniforms.

Application areas in military environments

Six application domains identified in the literature review.



External risk detection

Hazards and exposure



Passive health protection

Physiological status



Localization and tracking

Position and activity



Treatment and rehabilitation

Recovery and biofeedback



Personnel preselection

Response to workload

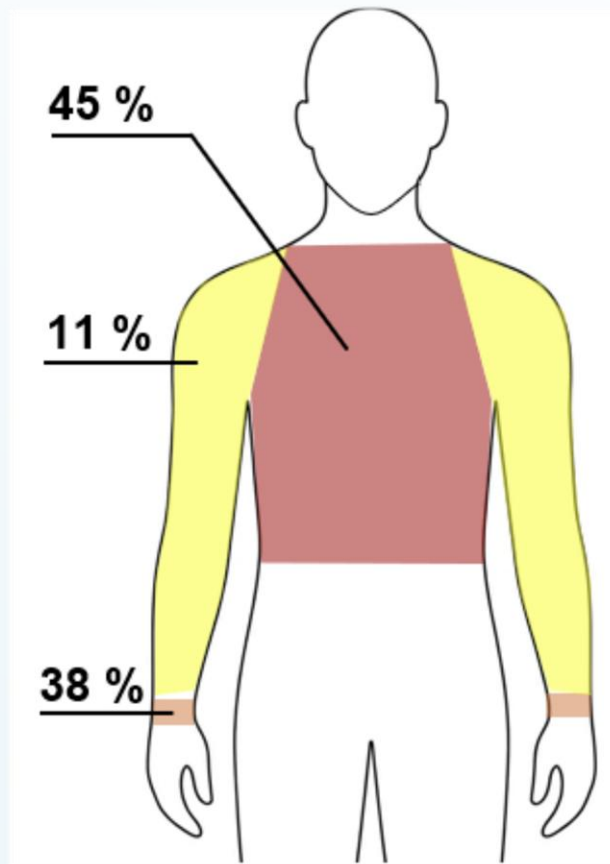


Training and education

Performance assessment

Questionnaire survey – first responders

n = 114 respondents (military, police, fire and rescue, emergency services)



**Preferred placement
on the body**

Most preferred monitored parameters



Heart rate **31 %**



Respiration **26%**



Other **23%**



≤ 150 g

Preferred device weight
(majority of respondents)

Pilot testing in tactical training

Testing of a CTU-developed wearable system.



Participants

10 students
(University of Defence)



Measured signals

Heart activity (ECG)
Respiratory activity
Physical activity

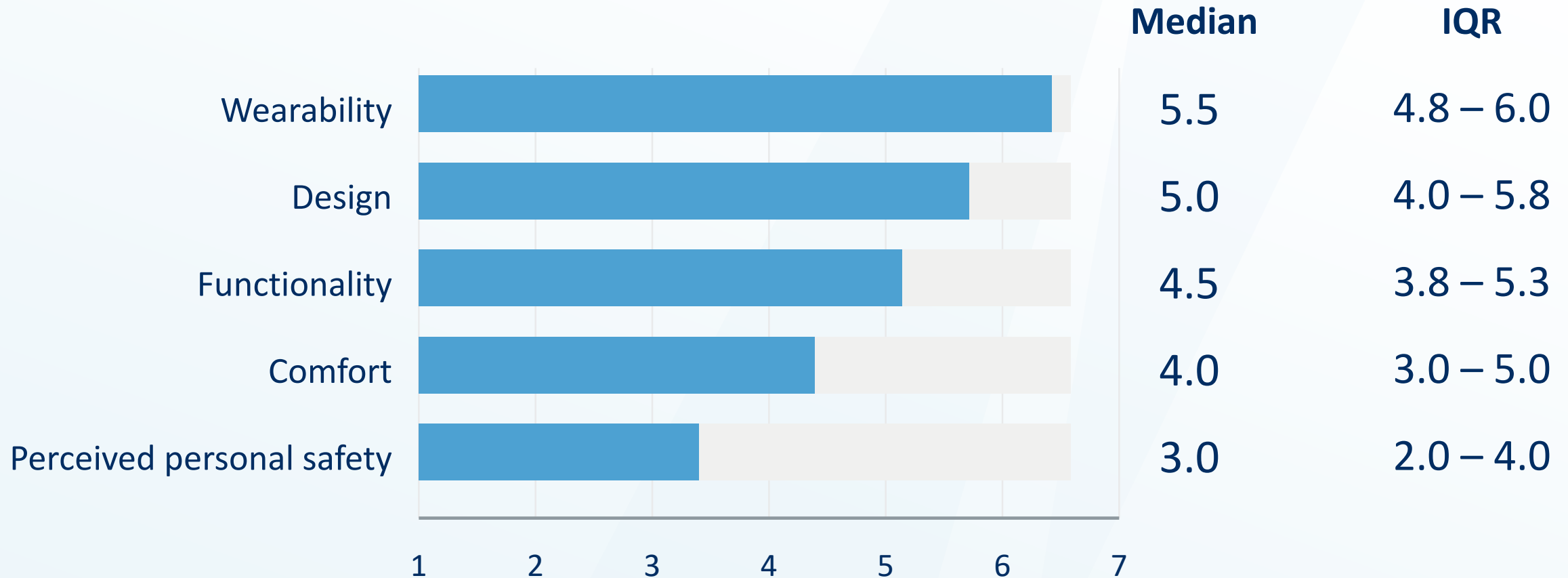


Practical setting

Tactical training activities
Equipment worn during
real movement

User evaluation – applicability and usability

Assessment of the wearable system during military training.



Pilot evaluation, n = 10; descriptive statistics.

Practical limitations and user feedback

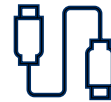
Technical functionality does not automatically guarantee operational usability.



Discomfort during wear



Impractical placement of recording unit



Restrictive cabling



Ergonomic limitations during movement



Need for better integration with equipment

Design recommendations

Based on literature review, user preferences and pilot evaluation.



Technical reliability



Resistance to water, dust, shock



Operational temperature
-40 to +40 °C



Reliable skin contact



Battery autonomy ≥ 24 h



Data and communication



Data encryption



Local data recording



Suitable interfaces



Communication
requirements



Human factors



Low weight (≤ 150 g)



Comfort and ergonomics



Minimal restriction
of movement



Compatibility with equipment



Easy maintenance

Conclusions



Significant potential

Wearable systems can support physiological monitoring in military applications.



Operational requirements

Technical design must reflect real deployment conditions.



End-user validation

Practical testing is essential to identify ergonomic and usability limitations.



Further validation with larger samples and in different operational conditions is required.

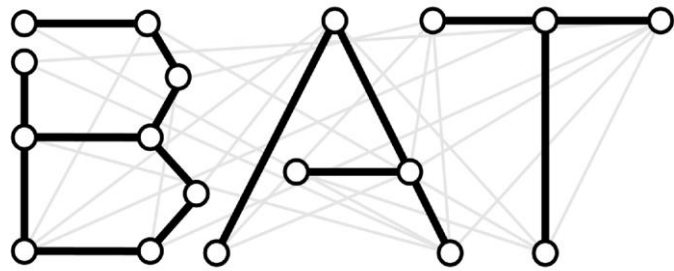
Thank you for your attention



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