Investigating the change in energy expenditure before and after familiarization with a passive load-bearing Exoskeleton: A case series

Background
Exoskeletons represent an emerging technology that has the potential to improve soldier performance in the field. The effect of passive load-bearing exoskeletons, capable of redistributing the weight of soldier-carried heavy loads on energy expenditure (EE) is of particular interest to the military. EE can be impacted by several factors including: weight of the exoskeleton, additional payload and individual movement patterns during gait. Therefore, assessing the impact of exoskeletons on soldiers’ EE can be complex. In addition, EE is also impacted by coordination patterns during gait, it is likely that EE during walking (Metabolic cost of walking) with the exoskeleton will decrease after a period of familiarization. Therefore, it is critical to examine influence of additional payload and of familiarization before making recommendations about exoskeleton use in relation to EE.

Objectives
1. QUANTIFY THE IMPACT OF A FAMILIARIZATION PERIOD ON ENERGY EXPENDITURE.
2. DETERMINE THE INFLUENCE OF THE PASSIVE EXOSKELETON ON ENERGY EXPENDITURE.

Methodology

Participants
One expert user was instrumented with a mobile Spiroergometry device (COSMED K5®) and walked on a treadmill wearing a payload of 12kg. Three Canadian soldiers naïve to the exoskeleton were instrumented with a mobile spiroergometry device (METAMAX® 3B) and walked on a treadmill wearing a payload of 38kg.

Familiarization Process
1 year utilisation (Preliminary testing, General training, Obstacle course, Progression)
9 days utilisation (3 hours/User weakness, Direct feedback, Movement variety, Progression)

Conditions
Baseline 1
OLD Exo F
NEW Exo NF
Baseline 2
New Exo F

Data analysis
The mass-specific net cost of transport (J*kg/m) was calculated and divided by the speed in m/min. Results were compiled into 5 conditions and a One-Way repeated measures ANOVA was used to quantify group effects.

Results

Conclusion
With adequate familiarization, exoskeletons can reduce EE during walking with loads between 12-38Kg. A period of 3 hours over 2 weeks of familiarization may optimize the use of a new device and permit the user to develop more efficient coordination patterns during walking. The optimal amount of familiarization is not clear. At a certain payload, it is possible that the weight distributing properties of the exo compensate for its added weight.

Operational relevance
These results suggest that regardless of their experience, soldiers should be properly familiarized with exoskeletons before EE is assessed. This will ensure accurate measure of actual impact on operational performance.

References

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