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UNITED STATES ARMY AEROMEDICAL RESEARCH LABORATORY

**Preliminary Field Evaluation of Assistive
Devices on Carry Distance and Time During
Two-Person Litter Transport Scenarios**

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14. ABSTRACT
Background

Evacuating casualties often relies on dismounted litter transport, a physically demanding task that can quickly drain a Soldier's grip strength. Assistive devices could shift the load to larger muscle groups, reducing muscle strain by distributing weight more evenly along the body. Previous USAARL lab-based research demonstrated assistive device use can allow simulated dismounted litter transport over farther distances in 2-person assisted litter carries than 4-person unassisted litter carries. As a follow-on effort to the lab-based simulated litter transport study, USAARL conducted a preliminary field-based study to evaluate assistive device use on litter bearer performance during 2-person litter carries.

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litter carry, litter carriage, casualty transport, medical evacuation, stretcher, grip strength, litter bearer, assistive devices, CASEVAC, MEDEVAC

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14. Abstract (continued)

Methods

U.S. and Dutch Service Members (SMs) participating in the Army Expeditionary Warrior Experiment were recruited and enrolled under a USAMRDC IRB-approved protocol. Subjects ($n = 12$; 10 male, 2 female) were gender and height paired into 6 litter teams (2 subjects per team) to complete carries around a 160-meter (m) long course. Three litter carry conditions were tested: unassisted (UA), shoulder harness (SH) assisted, and wrist hooks (WH) assisted. Carry conditions were counterbalanced and separated by rest periods. Each attempt ended after 20 minutes (min) or upon releasing the litter due to fatigue of either subject. Total carry time and distance were measured and recorded at the end of the carry attempt.

Results

Average litter carries were 158.6 m and 2.36 min for UA, 1071.3 m and 15.8 min for SH, and 303.6 m and 4.34 min for WH. These 2-person carries showed similar trends as the previous lab-based study: both assistive devices showed improvements during assisted carries over UA carries; however, only SH was statistically significant compared to the other carry conditions.

Conclusions

This study built on the previous lab-based study, showing litter carry distance and time can be increased with assistive devices like the SH and WH by more than 6.5 and 1.8 times, respectively, in 2-person field litter carries. While these findings suggest assistive devices could benefit SMs, additional field testing and analyses are needed to fully evaluate the feasibility and practicality of the devices in operational settings through use of subjective, biomechanical, and physiological data. The next steps of this research aim to inform the development of solutions that reduce fatigue and ultimately enhance SM well-being and combat readiness.



Preliminary Field Evaluation of Assistive Devices on Carry Distance and Time During Two-Person Litter Transport Scenarios

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- The authors have no conflicts of interest to report.



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Background



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Dismounted Military Casualty Transport

Heavy Strain:

- Carrying litters (~55 pounds [lbs] per handle) is physically demanding on the Service Members' grip strength
- Harsh environments (combat, weather, terrain) add further stress

Mission Needs:

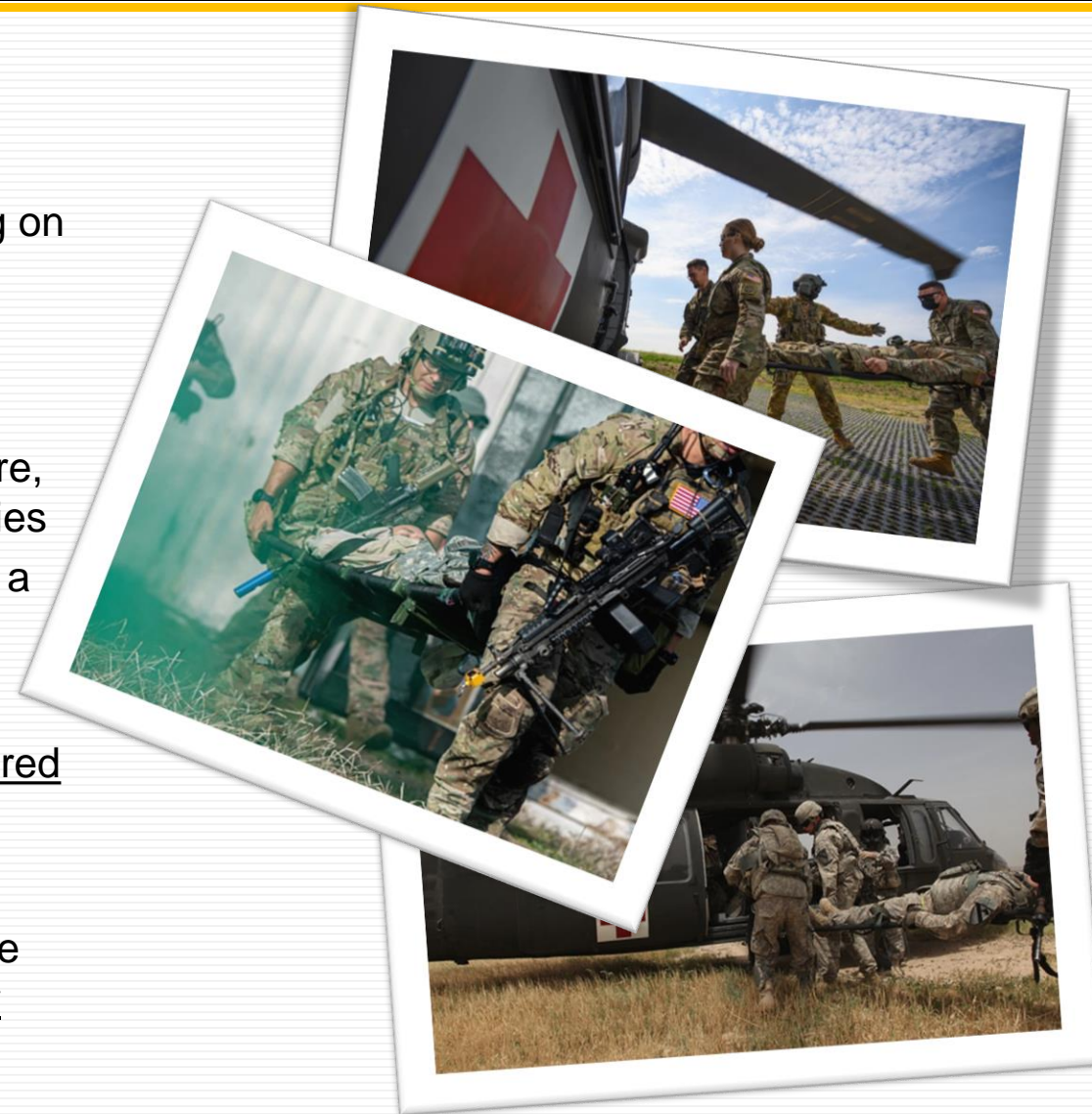
- Access to near-peer battlefield environments may be denied; therefore, dismounted evacuations may be required for critically injured casualties
- Effective litter carriage in remote locations and for mass casualties is a must

Integration Needed:

- Despite benefits, no litter carriage assistive devices are currently offered in military equipment sets

Lab-to-Field Effort:

- A previous USAARL lab-based pilot study proved that assistive device technology was beneficial during simulated litter transport, potentially enabling smaller carry teams (2-person vs. 4-person) (Ballard et al., 2023)



Images Courtesy of Defense Visual Information Distribution Service (DVIDS)



Methods: Overview



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- Protocol approved by the U.S. Army Medical Research and Development Command Institutional Review Board
- To test the effects of distributing litter carriage loads to larger muscle groups by using assistive devices, a field-based evaluation of previously selected commercial-off-the-shelf devices was conducted (Ballard et al., 2023)
- Volunteers were a pool of international Service Members (SM) 18 to 40 years old participating in the Army Expeditionary Warrior Experiment (AEWE) 2024
- Subjects completed 2-person litter transport on a fixed outdoor course under the following carry conditions:
 - Unassisted (UA)
 - Shoulder Harness Assisted (SH)
 - Wrist Hooks Assisted (WH)
- Evaluated litter bearer performance and fatigue assessment metrics pre- and post-litter carry
 - **Operational Performance:** Carry Distance, Time
 - **Biomechanical/Physiologic:** Grip Strength, Electromyography (EMG)
 - **Subjective:** Perceived Exertion, Pain/Discomfort, Fatigue, User Acceptance
 - **Kinematic:** Posture



Shoulder Harness (SH)



Wrist Hooks (WH)



Methods: Test Conditions



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2-Person Unassisted (UA)

2-Person Shoulder Harness (SH)

2-Person Wrist Hooks (WH)



Counterbalanced Litter Team Carry Condition Orders

	Team 1	Team 2	Team 3	Team 4	Team 5	Team 6
Condition 1	UA	SH	UA	SH	WH	WH
Condition 2	SH	WH	WH	UA	UA	SH
Condition 3	WH	UA	SH	WH	SH	UA

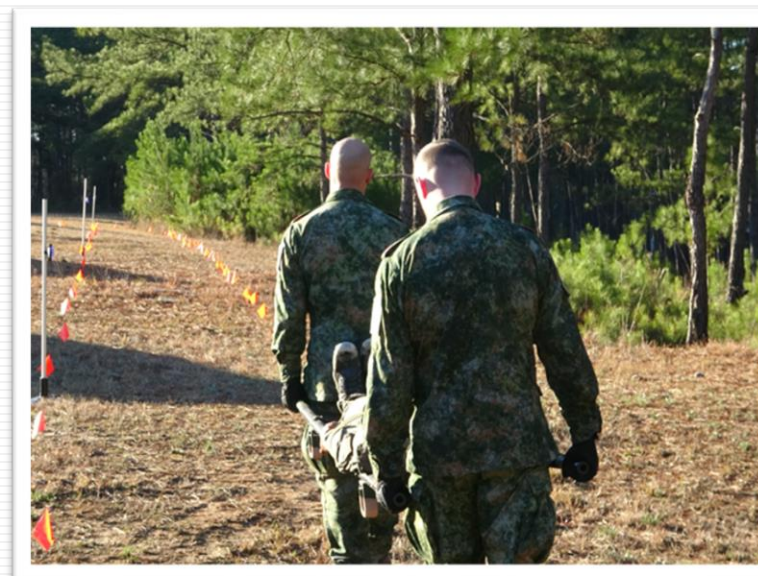
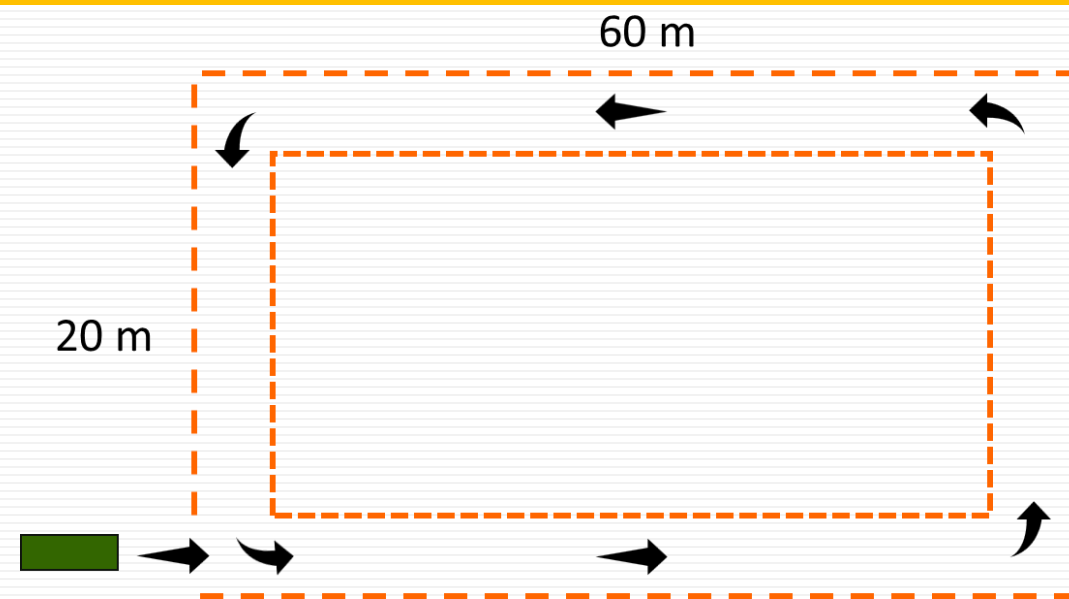


Methods: Data Collection



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- 12 subjects paired into 2-person litter teams ($n = 6$ teams)
 - Each team completed 3 carry conditions: UA, SH, and WH
- Manikin-loaded standard U.S. military litter: 204 lbs
- SMs started all carries from a standing position by lifting the loaded litter off a NATO Wheeled Litter Carrier
- Litter carry course: Approximately 160 meters (m) per lap
- Single attempt per carry condition until:
 - Litter team elected to stop carrying due to fatigue
 - 20-minute maximum carry time was reached
- Carry time and distance measured at the end of each attempt
- Rest period of approximately 20 min between conditions





Methods: Statistical Analyses



- Software
 - R (v4.2.1) with RStudio (v 1.4.1743) (R Foundation, Ames, IA)
- Descriptive Statistics
 - Range
 - Mean
 - Median
 - Standard Deviation (SD)
 - Minimum and Maximum Values
- Statistical significance at $p \leq 0.05$
- Between-group comparisons for the independent condition variable, Carry Condition
 - One-way Analyses of Variance (ANOVA)
 - Tukey Post-hoc
- Carry Condition had three levels: UA, WH, SH
 - Dependent variables
 - Carry Time
 - Carry Distance

One litter team only completed the SH carry condition. The standard ANOVA became unbalanced (2 conditions had 1 less data set than the third condition); however, all assumptions of a standard ANOVA were checked and met, so the standard ANOVA was still used.



Results: Anthropometry & Demographics

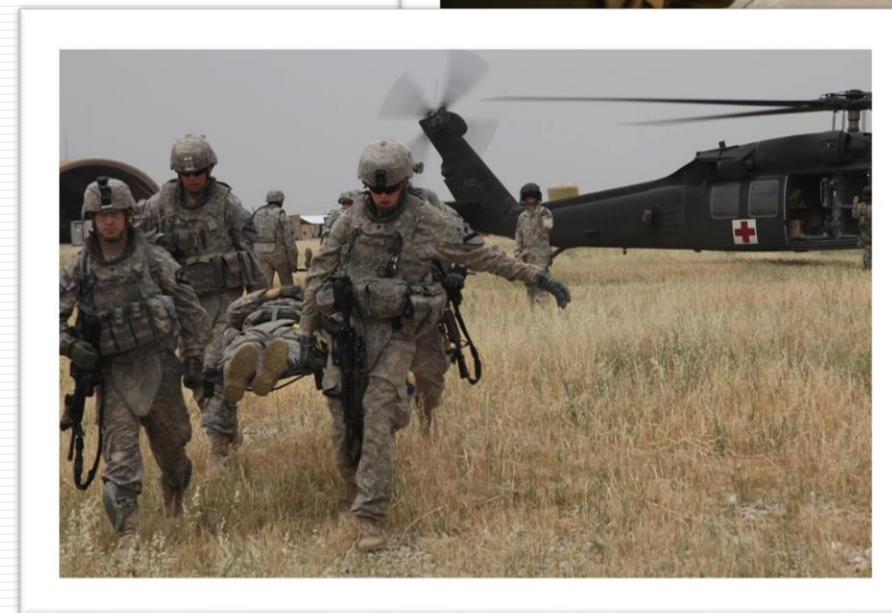
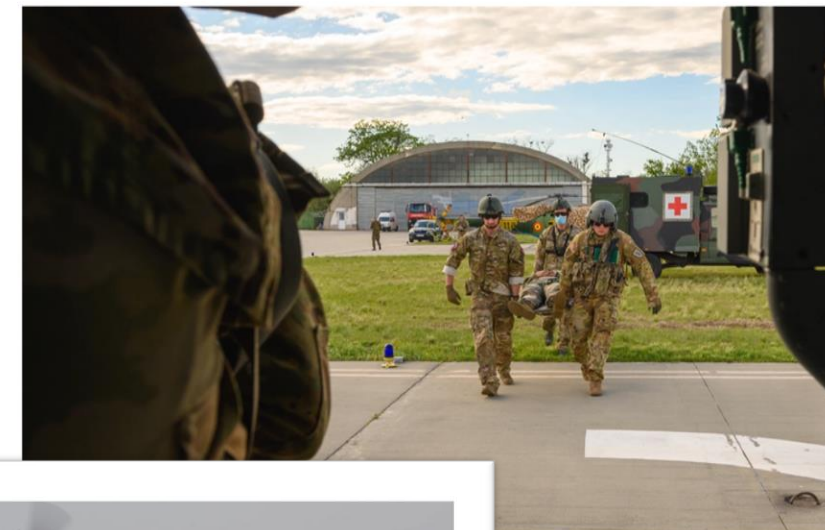


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Anthropometry Mean (SD)		Demographics Mean (SD)				
Height cm in		Weight kg lbs		Age years	Years of Service	Number of Deployments
179.95 (6.39)	70.85 (2.52)	89.89 (12.73)	198.17 (28.06)	25.75 (5.67)	4.62 (4.88)	0.58 (0.99)

Centimeters (cm)
Inches (in)
Kilograms (kg)

While the study was open to both males and females, gender differences were not assessed because only one female litter team participated in the study.



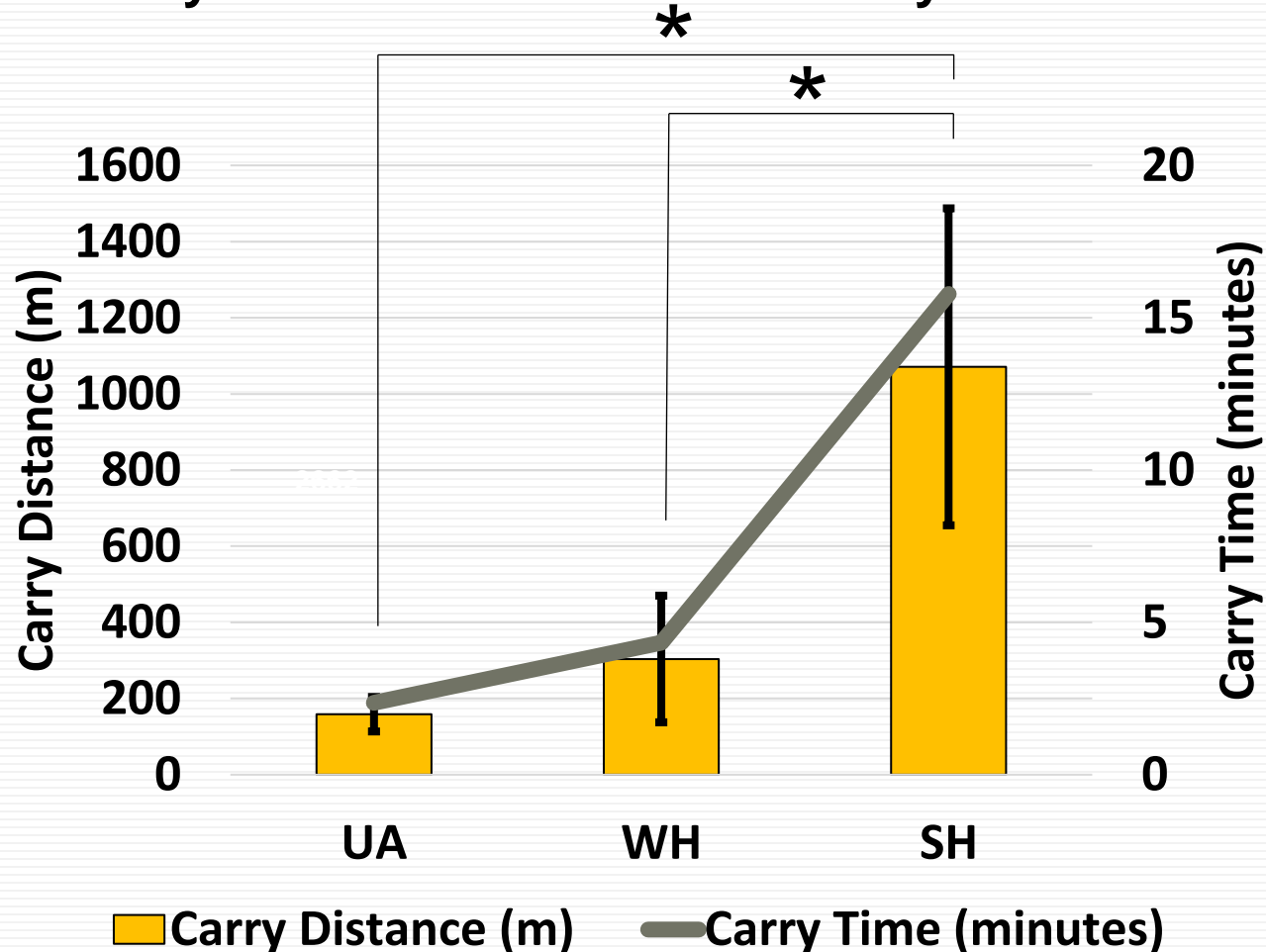
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Results: Average Carry Distance and Time



Carry Time and Distance Per Carry Condition



Note: Error bars indicate +/- 1 standard deviation for carry distance

Preliminary Results

Condition	Average Carry Distance (m) (SD)	Average Carry Time (min) (SD)
UA	159 (46)	2.2 (0.7)
WH	304 (167)	4.3 (2.1)
SH	1,071* (416)	15.8* (6.1)

SH carry time and carry distance were 6x greater than UA carries.

*Indicates a statistically significant difference ($p \leq 0.05$) between SH and other carry conditions.



Discussion



- These 2-person carries showed findings similar to the previous lab-based study (Ballard et al., 2023)
 - Soldiers carrying litters with Shoulder Harness assistive devices:
 - Covered greater distances compared to unassisted and wrist hook carries.
 - Carried litters for longer times compared to unassisted and wrist hook carries.
- Shoulder harness SD has a larger variance; however, it was still statistically significant compared to the other carry conditions.
 - Three of the teams hit the 20-minute maximum allotted carry time.
- SH device performance was likely due to shifting the load to larger muscle groups, reducing muscle strain, such as grip strength by distributing weight more evenly along the body.
- Study findings suggest litter carry with an assistive device may allow:
 - Faster casualty evacuation times
 - Evacuation from greater distances
 - Reduced fatigue among litter bearers



Future Work



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- Future work will include:
 - Larger population
 - Different genders
 - Fit, form, and function assessments
 - Field testing integrated with combat gear in experimental operational scenarios
- This work should also not be used to infer the endorsement of a specific type or brand of assistive device



Promising results from this study, alongside ongoing research and field testing, could help to implement litter carriage assistive devices, making improvements in tactical evacuation events and creating a more lethal fighting force.



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