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Predicting Load Carriage Injury Risk in Recreational Hikers

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Predicting Load Carriage Performance in Recreational Hikers

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Background

- Load carriage is a vital task to all tactical personnel
- Particularly in military populations
 - Weight 45 kg¹
 - Duration < 1 hour or > 3 days²
- Has major physiological effects
 - Increases in energy cost both static and dynamic³
 - Source of injury risk⁴





Advanced Tactical Load Assessment System (ATLAS)

- Designed to assign an individual level of risk prior to load carriage task
- Utilizes Military Risk Management Framework
- Based on:
 - Estimated Workload as % of VO2 Max
- Further modified by:
 - Load as a % of Body Weight
 - Previous Injury
 - Previous Load Carriage Events

Risk level	Level descriptor	Endorsing authority
1 to 2	Extreme	Chief of Army
3 to 5	High	Formation Commanders
6 to 9	Substantial	Commanding Officer
10 to 16	Medium	Officer In Charge
17 to 25	Low	Section/Platoon Commander



Estimating Workload

- Historically three equations
 - Giovoni and Goldman – original⁶
 - Soule and Goldman – expanded terrain⁷
 - Pandolf – expanded speeds⁸
- Estimate individual's aerobic capacity
 - 2.4 km Run
 - 20 m Progressive Shuttle Run Test
- Estimated workload is compared to maximum aerobic capacity

Level of risk	%VO ₂
1	100
5	82
9	66
10	62
13	50
15	42
16	38
17	34



Equations

$$M = 1.5 W + 2.0 (W + \underline{L})(L/W)^2 + \eta(W + L)[1.5 V^2 + 0.35 VG]$$

M=metabolic cost (watts), W=subject's weight (kg), L=external load (kg), η =terrain type (graded 1.0 to 2.1), G=terrain grade (%), V=velocity (m/s)



Equations

$$+M = K L^2 V^2$$

*M=metabolic cost (watts), K=the proportionality factor (hands =0.015 and feet = 0.064),
L=external load (kg), V=velocity (m/s)*



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Equations

$$M = 1.5 W + 2.0 (W + \underline{L})(L/W)^2 + \eta(W + L)[1.5 V^2 + 0.35 VG] + V^2(0.015L_H^2 + 0.064L_F^2)$$

M=metabolic cost (watts), W=subject's weight (kg), L=external load (kg), L_H = Load in hands, L_F = Load on feet, η=terrain type (graded 1.0 to 2.1), G=terrain grade (%), V=velocity (m/s)



Estimating Workload

- Historically three equations
 - Giovoni and Goldman – original⁶
 - Soule and Goldman – expanded terrain⁷
 - Pandolf – expanded speeds⁸
 - Equation promoted by Orr**
- Estimate individual's aerobic capacity
 - 2.4 km Run
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Level of risk	%VO ₂
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Modifiers

- Percentage of Body Weight Load
- Previous Injury and Injury Site
- Previous Load Carriage Event

Load as a % of body weight		Change to level of risk	
Previous load -carriage event		Change to Level of Risk Matrix	
<14 days ago		+1	
14–28 days		0	
> 28 days		-1	
Other site not identified above		-1	-0.5



Methods

- Recreational hikers from Tasmania Walking Company
- Pre and Post hike questionnaire
- Self Reported
 - Metabolic Fitness
 - Weight
- Velocity collected by the Tasmania Walking Company
- Average incline determined using Google Map Software



Results

- 31 Respondents
 - 7 Low Risk
 - 24 Medium

- 5 Total Injuries Reported

Risk Category	Level	Hikers	Injury
Medium	10	1	1
Medium	11	0	0
Medium	12	2	0
Medium	13	2	0
Medium	14	8	2
Medium	15	8	1
Medium	16	3	0
Low	17	2	0
Low	18	1	0
Low	19	4	0



Discussion


- Limitations
 - VO2 Max based on self-reported data
 - Using averages does not account for variances along route
- Despite these limitations, this demonstrates ATLAS has capability to predict injury risk with limited sensitivity




Conclusion

- Load carriage is a physically demanding task that can result in injury
- Being able to calculate risk associated with load carriage tasks beforehand can foster mitigation strategies
- ATLAS can be utilized with recreational hikers to predict task completion
 - Kokoda “death zone”
- ATLAS can also be used in tactical context to predict injury risk and mission success

vodafone AU 14:26 78%



Events




vodafone AU 14:26 79%

Overland Track

Participants **6**

Length	Days	Burden	Cumulative Gain
65km	6	12kg	+802m

vodafone AU 14:25 79%



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Jennifer T. Foster

Female **46**

Overland Track

30 Sep 2018 - 6 Oct 2018

6 participants

Weight	Nights	Days	Distance
12.5kg	5	6	65km

Foster Lester Anderson Lars Brooks Steiner

Depart **1pm Saturday 30 September 2018**

Return **10pm Sunday 6 October 2018**

BMI	Weight	Height	VO2 max
20.8	75kg	190cm	45.1

Bay of Fires

3 Oct 2017 - 8 Oct 2017

6 participants

Weight	Nights	Days	Distance
32kg	6	7	55.12km

Lee Lester Anderson Lars Brooks Steiner

Participants

Jennifer T. Foster

BMI	Weight	Height	VO2 max	Risk
20.8	75.0kg	190cm	42.1	Medium

Age **45** Sex **Female** **Injury**

14

Injuries (1)



Left Wrist Injury

Injury Left Wrist

Occurred **14 days ago**

Treated?

Pain  **5/10**

Wineglass Bay

1 Jan 2018 - 8 Jan 2018

13 participants

Weight	Nights	Days	Distance
24kg	5	6	35.7km

Lee Lester Anderson Lars Brooks Steiner Lester Anderson


Jamie Lester

BMI	Weight	Height	VO2 max	Risk
20.2	84.1kg	178cm	55.3	Low

Age **34** Sex **Male**

24

Fitness Test

2.4km Run Max Effort 

11:02 2 days ago VO2 max **45.1**

Tomakin J. Anderson

BMI	Weight	Height	VO2 max	Risk
35.5	94.1kg	188cm	32.56	High

Age Sex

6



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Questions?



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